AN EVALUATION OF AGRI-ENVIRONMENTAL PROGRAMMES AND WESTSIK'S CROP ROTATION EXPERIMENTS

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Abstract.
In spite of extensive knowledge, both environmental and cost-effectiveness of agri-environmental programs show great variations and are often considered unsatisfactory in many countries of EU. From a scientific point of view, the design and implementation of these programs are driven rather by income than environmental objectives. The best known and most remarkable example of continuous production in Hungary is the Westsik's crop rotation experiment established in 1929, which is still in use to study the effects of manure treatments, develop models and predict likely effects of different cropping systems on soil properties and crop yields. In this respect, Westsik's crop rotation experiment is an efficient tool for studying the effects of agri-environmental programmes as it models various possible methods of nutrient management (fallow, straw, farmyard and green manure), and gives assistance in answering the questions related to the sustainability of agri-environmental projects, where farmers must adopt technologies which serve agricultural and environmental goals.

Key words: crop rotation long-term field experiment, CAP, agri-environmental programs

INTRODUCTION

The common agricultural policy (CAP) was initiated in 1957 to integrate markets, secure income and the supply of farm products to the population. Subsidy arrangements have included agricultural price supports, direct payments to farmers, supply controls, and border programmes. The EU instituted several policy reforms including the introduction of agri-environmental programmes into the CAP Buller, (2000). More recent reforms, in 2000 and 2003, initiated the decoupling of farm subsidies from commodity production and placed additional emphasis on environmental concerns Gorman et al. (2001), Finn (2003), Kleijn, Sutherland (2003). Farmers must comply with environmental, food quality and safety regulations and must improve animal welfare, as a precondition for receiving direct subsidy under the CAP. Member states are to receive more time for the implementation of agri-environmental programs (Gunderson et al, 2004).

The recent CAP reforms established two "pillars" or program pathways in the budget: Pillar 1 for market and price support policies and Pillar 2 for rural development, which include an increased attention to the production of environmental goods and services. The aim of Pillar 2 is different from good farming practices, which are generally considered to be a set of mandatory, threshold level of environmental obligations for the farm operator. The good farming practice is defined by basic environmental standards or national legislation, where national laws can define more ambitious rules for good farming practice than the EU and as a consequence of the polluter pays principle, embedded in the Environmental Treaty farmers have to comply with these obligations. Farmers who receive direct payments from Pillar 1 of the CAP will be subject to "cross compliance" obligations under the Good Agricultural and Environmental Conditions (IEEP, 2007).

Pillar 2 also has numerous implications for agri-environmental programs, which includes measures for improving the competitiveness of the agricultural and forestry sector (Axis 1), the environment and the countryside (Axis 2), the quality of life in rural areas and diversification of the rural economy (Axis 3) (European Commission 2005). Axis 4 or LEADER is organised to assist bottom up projects and initiatives integrating the goals of the other Axis. Axis 2 is the most important for financing agri-environmental programs, but other Axis also offer possibilities for co-financing environmentally relevant programmes. Under the 2003 reforms, environmental concerns are separated from other rural development issues and prospects for funding are also improved.

Agri-environmental measures as important parts of the European Environmental Policy have been discussed and evaluated since 1992 and resulted in institutional changes in the rural development policy, which is the legal framework of agri-environmental programs. Agri-environmental programs have been criticized by Lowe and Baldock (2000) for their low economic and environmental effectiveness and low acceptance. According to the European Court of Auditors (2005) the objectives are not clear and the effects of the programmes are not transparent. Within the former Regulation (EEC) No. 2078/1992 and the Regulation (EC) No. 1257/1999 the environmental and the cost-effectiveness of agri-environmental programs also varied widely (Marggraf 2003) and they were not in line with the original objectives of the Regulations. According to Fischler (2000) Member States did not exploit the scopes and opportunities offered by the EU. Research results of Jordan, (1999) and Hagedorn et al (2001) also support the viewpoint that agricultural lobbies at regional levels have maintained strong influences upon the design of agricultural policies, which weakened the position of agri-environmental programs. A differentiated analysis carried out by Eggers et al. (2004) in Germany instance concluded that the main problem concerning the design and implementation of agri-environmental measures are an institutional problem, since decentralised approaches are not explicitly provided by the Regulations and there is no necessity for governments to support or implement any kinds of local organisations.

MATERIALS AND METHODS

The crop rotation experiment established by Vilmos Westsik in 1929 offers an excellent opportunity to study agri-environmental programs in many respects. The experiment, applying green, straw and farmyard manure treatments, offers and excellent opportunity to study the ecological impacts as well as economic aspects of different production methods. One of the main practical objects of the Westsik's crop rotation experiment was to measure the long-term effects of different organic manure and inorganic fertilisers on rye and potato production. In this way, the 15 treatments can logically be grouped as follows:

- control treatments where no fertilisers were applied,
- straw manure treatments,
- farmyard manure treatments,
- green manure treatments,
- second crop green manure treatments.

The first group covers the control treatments where fallow or organic manure was applied without fertilisers. The second group shows the effects of different straw manure treatments. The third group is used to study forage production and farmyard manure treatments. One group is used to compare the different utilisation of a lupine main crop and a further one is to study the method of production and application of lupine green manure as second crop.

Crop rotations can be divided into three series except for one, coded F-8, which has four series. At the beginning of the experiment, the size of the plot was 2,880 square meters, but later, due to the introduction of mechanisation, it was reduced to 2,700 square meters. When determining the field sizes, the following factors were given primary importance: (i) reliability of the experimental results and (ii) their suitability for agronomic and economic evaluation. The total area of crop rotation is 12.4 hectares. The 46 plots of the experiment provide an opportunity to test the long-term effects of numerous agri-environmental programs and practical information for farmers in the planning of sound crop rotation and fertilisation systems. This is one of the reasons why the Experimental Farm is visited by hundreds of farmers every year.

RESULTS AND DISCUSSIONS

The integration of environmental goals with agricultural policy began in the 1980s. Since then the CAP has been increasingly adapted to better serve sustainability purposes. The objectives of the CAP include assisting agriculture to fulfil its multifunctional role in society: producing safe and healthy food, contributing to a sustainable development of rural areas, and protecting and enhancing the status of the farmed environment and its biodiversity. Half the European Union's land area is farmed and it highlights the importance of farming in a natural environment. Farming has contributed to creating and maintaining a variety of valuable semi-natural habitats. Under the Common Agricultural Policy (CAP) farming and nature exercise a profound influence on each other. Farming also supports a diverse rural community that is a fundamental asset European culture and plays an essential role in sustainable agriculture. The links between the natural environment and farming practices are complex. Agricultural practices can also have an adverse impact on natural resources. Pollution of soil, water and air, fragmentation of habitats and loss of wildlife can be the result of inappropriate agricultural practices and land use. EU policies are therefore focused on reducing risks of environmental degradation, while encouraging farmers to continue playing a positive role in the maintenance of the countryside Ángyán et al. (2000), (EC) 1698/2005.

Figure 1: Landscape in Nyírség with Westsik's crop rotation experiment

In agri-environmental programs, crop and livestock systems should maximise for mutual support. Crop residue is an excellent feed for animals. Livestock manure can be composted and returned to the fields as a source of plant nutrient. Various crop and livestock components can be integrated to minimise the effects of weather-related adversities, as they can be crucial for the survival of a farm. The productivity and stability of soils depend greatly on the balance between living and non-living components. The organic matter in the soil serves as a continuous nutrient supply and a factor stabilising the soil's physical environment. Soluble nutrients removed from soil through plant growth and harvesting must be replaced, either with fertilisers or through decomposition of soil organic matters to maintain productivity.

In agri-environmental programs, where the use of synthetic chemicals is reduced or eliminated, the action of soil microorganisms becomes a major factor in nutrient cycling and plant growth. Cropping systems can reduce off-farm inputs to decrease environmental and health hazards associated with the use of agricultural chemicals and, at the same time, offset rising production costs and maintain soil fertility. The reduction of leguminous plants in the cropping system results not only from the availability of fertilisers, but also from the use of fossil energy as a source of energy in agriculture. Because of these changes, farmers are no longer compelled to use one part of their land for the production of forage for their draft animals.

Many farmers have eliminated all livestock from their operations, moving to cash grain enterprises and making them entirely dependent upon fertilisers and other chemicals. However, where nitrogen fertiliser is expensive or not available, producers depend on the nitrogen fixed by legumes to maintain the nitrogen cycle and to improve the fertility of the soil. The quantity of nitrogen fixed varies greatly, from zero to several hundred kilograms per hectare, according to the soil type, structure, soil pH and nutrient content, temperature, water regimes and management of the legumes.

Table 1:

Treatments and yields in Westsik's crop rotation experiment

	Organic Matter Treatments	Crop I.	Crop 2.	Crop 3.	Yield (t/ha)	
					Potato	Rye
F-1	Fallow	Fallow=	Rye	Potato	4.35	0.93
F-2	Green manure	Lupine=	Rye	Potato	8.60	2.43
F-3	Root manure	Lupine=	Rye	Potato	8.05	2.16
F-4	Mulch	Rye+	Potato	Rye	8.74	1.87
F-5	Straw manure	Rye+	Potato	Rye	9.93	2.08
F-6	Straw manure	Rye+	Potato	Rye	11.77	2.31
F-7	Straw manure	Rye+	Potato	Rye	7.91	1.34
F-8	Green manure	Lupine=	Rye+	Potato	12.61	2.62
F-9	Green forage	Lupine=	Rye	Potato	9.25	2.43
F-10	Farmyard manure	+Forage	Rye	Potato	10.18	2.01
F-11	Farmyard manure	+Forage	Rye	Potato	12.10	2.50
F-12	Green manure s.crop	Rye+	Rye	Potato	11.46	2.43
F-13	Green manure s.crop	Rye+	Potato	Rye	10.89	2.19
F-14	Green manure s.crop	Rye+	Potato	Rye	10.51	2.18
F-15	Green manure s.crop	Rye+	Potato	Rye	7.96	1.34

Crop 4 in F-8 treatment is rye

There are other benefits from using legumes in the crop rotation, but they are often disregarded because of the difficulties in quantifying them. Regardless of the amounts of fertilisers applied the yields of cereals grown after leguminous crops or in a crop rotation are higher than of those grown in a monoculture,. This response is often referred to as the leguminous effect in crop rotation. As additional nitrogen does not eliminate this yield difference, most of the response must be due to factors other than nitrogen availability. Crop rotation breaks the weed and insect cycles that often predominate in continuous cropping. Crop rotation also enhances soil structure and improves water regime. In this way, leguminous crops have long-term benefits in crop rotations, resulting in enhanced soil organic matter content, which not only improves nitrogen availability, but also improves soil structure by reducing soil erosion and cultivation costs.

The replacement of herbicides with alternative management techniques such as ridge tillage, cultivation, crop rotation and ecological techniques is the only viable approach to decreasing the intensive use of herbicides in agri-environmental programs. This substitution requires long-term research and success will only be achieved slowly. The trend towards highly active compounds, which are more environmentally friendly, is more likely to dominate herbicide shifts in the immediate future. These compounds will be used at low rates, which greatly decrease their likelihood of having an environmental impact. For every farmer who starts agri-environmental programs, the most important problem is transition and until the pest cycles are broken by a good crop rotation or other methods, it may be necessary to continue using synthetic materials.

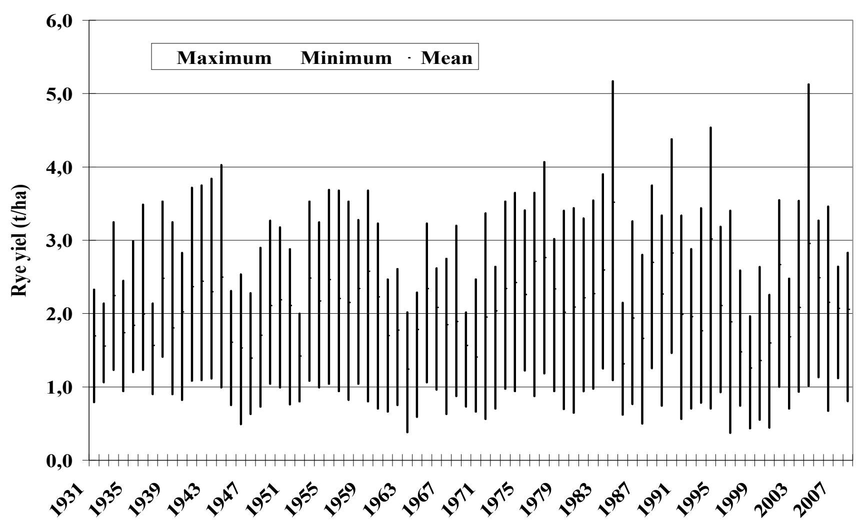

Figure 1: Rye yields in the crop rotation experiment

Understanding the limitations, uncertainties and probabilities of resources is beneficial in agri-environmental programs, and we must not forget that they may include undesirable components, resulting from nature or human activities (drought, pests, or requirements of a program). Success involves an understanding of each part of the production and the system must be taken into account as a hole. Alternative agriculture demands more management time and skills than conventional one. Farmers must understand the complex relationships among crops, weeds, insects, diseases and soil fertility well enough to suppress threats to a crop and encourage the factors that make a crop thrive. The increasingly demanding management requirements of agri-environmental programs may be a barrier to its more widespread adaptation. To manage pest and nutrient problems, conventional farmers needed much less understanding of this relationship. Acquiring new, complex managerial skills and applying them on the farm takes time. Without chemicals, weed and insects problems could only be solved if farmers recognised them in time and used preventive measures. This means that the farmer has to live on the farm and to pay a close attention to growing plants and environmental problems.

Interest in agri-environmental programs is often motivated by a desire to reduce health and environmental hazards. The bottom line for many farmers, however, is the economic outcome. The adaptation of agri-environmental programs requires that they be at least as profitable as conventional methods or have significant non-monetary advantages, such as the preservation of the rapidly deteriorating soil quality or water resources. The economic performance of agri-environmental programs can be improved by reducing per unit expenditures on production inputs, increasing output per unit of input, reducing capital expenditure on industrial goods, producing more profitable crop and livestock. Until now, very few studies have considered the impacts of agri-environmental programs on the economic performance of the farm.

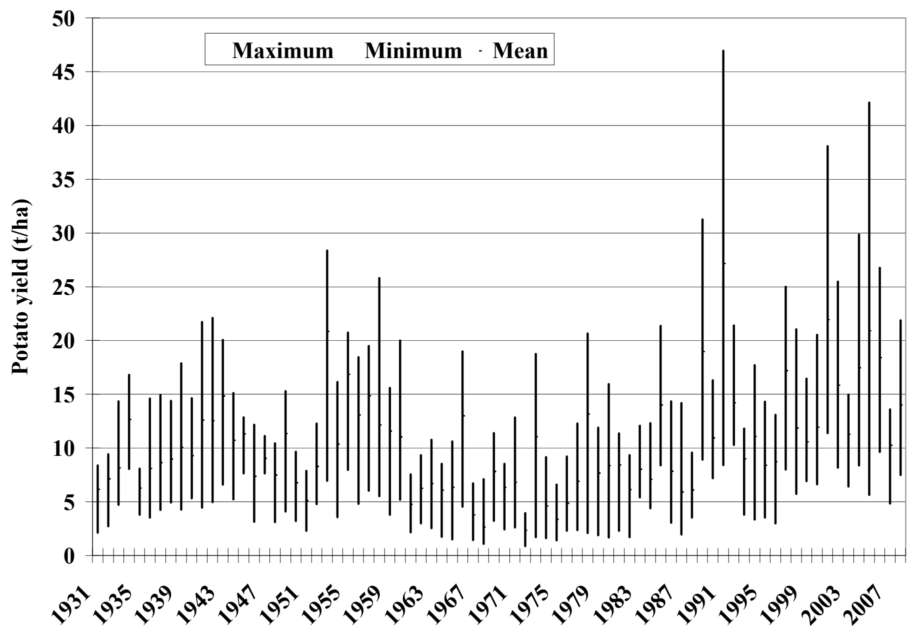

Figure 2: Potato yields in the crop rotation experiment

Out of the two-plant species, rye proved to be the more balanced one as regards productivity. Its yield variations may primarily be attributed to climatic factors, while, in the case of potato, the variations can closely be related to changes in varieties or in the quality of seed potato. The first improvement in the average yields of potato occurred in the early 1940's, when a growing demand arose for potatoes as an important foodstuff. During and immediately after World War II, the average potato yields decreased in the crop rotation experiments. The next increase was achieved in the second half of the 1950's, and was related to the development in potato research and in seed potato production. Westsik (1951, 1965) and Lazányi 1994, 2003 published detailed information on the economy and ecological performance of treatments.

The problem relating to agriculture is as old as agriculture itself. The core of the problem has always been soil erosion and the loss of soil fertility. Today, when energy input into agricultural production has increased, a new aspect has been added to this problem, further exacerbating the old one. Sustainable development wants to secure higher standards of living now and for future generations as well. An important recommendation of the United Nations Conference on Environment and Development held in Rio de Janeiro (1992), was that individual countries should prepare strategies and action plans to implement their part of the agreements. Agenda 21 also lays a great emphasis on the need for all sectors of society to participate in the formation of effective national strategies for sustainable development and emphasises international co-operation, in order to make progress on the problems affecting the environment of the whole world.

In the U.S., efforts to achieve a balance between agriculture and environmental quality are based on soil erosion, water quality management and farmland protection. Both soil erosion, water quality management and farmland protection have their own constituency and a widely accepted policy tools. The agri-environmental strategy of the EU is enhancing the sustainability of agro-ecosystems and measures set out to address the environmental concerns, encompass environmental requirements (cross-compliance) and set asides. Technical assistance to farmers in order to support the selection and execution of agri-environmental programs would be crucial for the ecological effectiveness of EU politics. Up to now, EU schemes have not offered financial supports for single policy interventions designed to improve environmental performance on farms and rural landscapes, which is a continuing policy issue in all modern nations. In the EU current agri-environmental efforts are unsatisfactory in terms of their effects on the environment as well as in terms of cost-effectiveness.

Considering future prospects for the EU subsidy system, solutions are needed to better target agri-environmental payments and to motivate farmers to promote sustainability. New approaches should include concepts that combine environmental planning, targeting agri-environmental programs, alternative models of remuneration, and advisory schemes that better integrate environmental services into the technical assistance provided for farm operations. Improved environmental performance is far from settled in agriculture, and there are many opportunities to learn more about good examples. The purpose of this paper is to summarize arrangements for blending regulatory and compensatory incentives for providing environmental goods and services on farms and in rural communities.

There is a general agreement that farm and food production yields many non-commodity outputs. Most agricultural commodities are traded in on markets while most non-commodity outputs are provided by other means. The term “multifunctionality” has focused to describe concerns about the provisions for both commodity and non-commodity outputs. Nonmarket goods and services are now a prominent part of the debate on agricultural policy in rich nations and an integral part of international negotiations on reducing trade barriers for farm and food commodities.

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