Pesticide Application as a Product Service System (PSS) in Austrian Crop Farming and Viniculture

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Abstract

The concept of product service systems (PSS) is intended to contribute to a reduction of material flows and therefore to a dematerialisation of society. Much research work has been done over the past decade to analyse PSS. Until now, however, implementations are scarce and initial enthusiasm has given way to a more realistic view. The author along with other researchers investigated the PSS concept in conjunction with pesticide management in Austrian farming. Outcomes show that plant protection offered as a service has growing potential for crop farming and viniculture. Not surprisingly the most consistent implementations have been found where the economic profits both for the customer and for the supplier reach a maximum. Unfortunately an ecologically benign pesticide application cannot be called upon to act as the main driver of the service development. Incentives and promoting instruments are insufficient to boost the service application within a reasonable time span.

Introduction

Product service systems (PSS) have been proposed as a strategy for dematerialisation of the economy via reducing material flows. The core idea of PSS is to sell the use of a product instead of the product itself. Offering products in conjunction with service can provide the same level of performance, but minimise the environmental burden. Thus, 'a PSS should be defined as a system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs and have a lower environmental impact than traditional business models' (Mont 2002). The concept has been intensively investigated in recent years. It was thus assumed that PSS promotes a shift from resourceintensive product consumption to a more or less intangible – and therefore sustainable – service (Kang & Wimmer 2008; Mont & Tukker 2006). Well-known examples of PSS are car-sharing schemes, ski rental or chemical management services (Jakl 2003). But after nearly a decade of research the tangible results for PSS are scarce, and in reality they have not spread widely.

The present article reports on the experiences and results gathered from three interconnected research projects on PSS plant protection. Apart from reporting the experiences and results from the projects, the author also wishes to discuss the question of why the dissemination of PSS can be so tenacious and time consuming. In retrospect, the motives for choosing the subject PSS in plant protection can be summarised as follows: identifying and encouraging an eco-efficient mode of pesticide management, reducing the amount of pesticides released into the environment and fostering quality management in pesticide application. The first project *Innovazid* started in 2003 and examined the status quo of plant protection services in Styria. The project collected first information about how plant protection services are regionally designed and implemented (Vorbach et al. 2004). The project *Ser-Vino* focussed on Styrian viniculture and its need for a plant protection service. Service models were designed to demonstrate the costs of the service. This was done to foster a successful implementation of service concepts (Vorbach et al. 2007a). Finally, the project *Serplant Pro* broadened the provincial focus of the former projects to include the whole of Austria, focussing on crop farming and viniculture. Key questions such as service design, insurance, contracting, seasonal organisation and stakeholder interests were examined in detail (Vorbach 2007). In order to disseminate the service concept, the results were published in a manual (Vorbach et al. 2007b). *Serplant Pro* was simultaneously launched with other PSS projects within the Austrian programme on technologies for sustainable development, funded by the Austrian Ministry for Transport, Innovation and Technology. PSS concepts have been a constant research topic in this programme (Hinterberger 2006; Wimmer 2007).

The impact of pesticides

Plant protection involves a package of measures to prevent damage to crops. In practice the application of chemicals – pesticides in terms of herbicides, fungicides or insecticides – is of outstanding importance at least for conventional farming. Yet pesticides may cause undesirable adverse effects on non-target organisms, human health and the environment, and they have at least the potential to act in an adverse manner. A regulatory framework is thus foreseen to approve ingredients and products and to monitor and identify unwanted residues in food and environmental media. A great number of approved pesticides have potentially harmful properties: In early 2010 the national *Pflanzenschutzmittelregister* – a registry comprising all plant protection products authorized for application in Austria – classified 364 out of 575 entries (63 %) as *environmentally harmful*, which is a requirement for appropriate labelling of the product.[1] This means that such products may be potentially harmful to aquatic organisms, non-biodegradable or show bio-accumulative properties. A considerable proportion of these products additionally have toxic properties for humans and are therefore of occupational relevance. To minimise potential risks and keep them controllable, much depends on the circumstances of application. It should therefore be in the interest of society to reduce both the overall amount of pesticide application as well as the inherent hazard potential of it. Yet the basic trends point in the opposite direction: consumption of plant protection products in the EU as well as the percentage of food and feed samples with pesticide residues did not decline between 1996 and 2003. This has been recognised by the European Commission who in 2006 released a *Thematic strategy for a more sustainable use of pesticides* (Commission 2006a). The strategy aims to improve the quality and efficacy of pesticide application whilst minimising any adverse impact on human health and the environment. It recommends improvement of control and increasing knowledge about the use and distribution of pesticides by creating a system of training of professional pesticide users and developing national action plans to reduce dependence on chemical plant protection. It is to be expected that future pesticide application will be much more knowledge based and the requisites and limitations for application will further increase (Commission 2006b).

The practice of plant protection influencing the design of the service

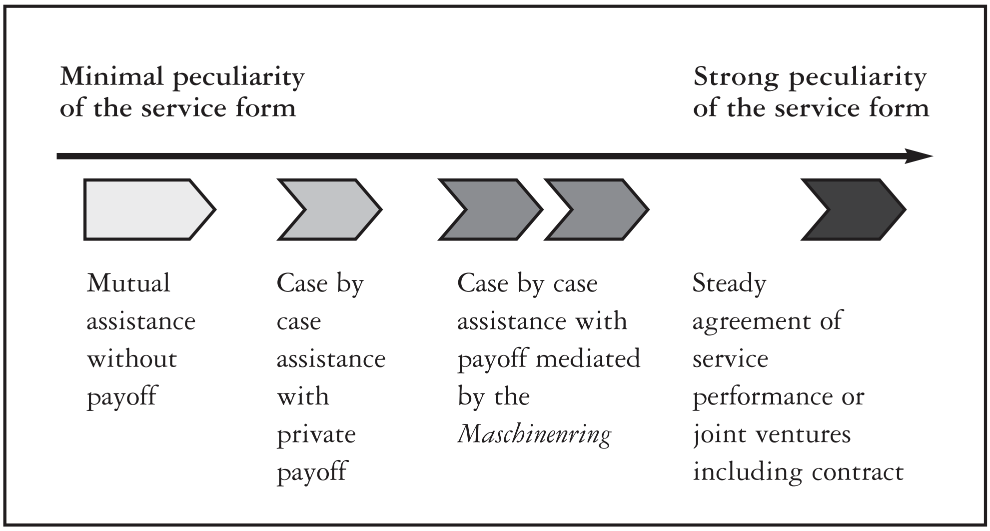
Successful and efficient pesticide application comprises a bundle of prerequisites and framework conditions. Pesticide spraying in the field or vineyard is an essential, but not the only criterion. First of all, appropriate equipment is needed. Since it must be regularly inspected, it should at least be state of the art. Pesticide application can either be a preventive measure or response to an acute pest infestation or a critical weather condition which facilitates infestation. In the former case pesticide application is a routine operation with a considerable tolerance in respect to the date of performance, e.g. herbicide application in corn growing. In the latter case pesticide application is a highly critical operation which must be performed with little tolerance in respect to time, e.g. fungicide application in viniculture.

The right choice of the date of application may thus be decisive to prevent damage and yield losses. It is evident – depending on the potential consequences of the plant protection measure – that there is a broad range of expectations and concerns on the customer's side and a need for commitment on the provider's side. At that point the relationship between the customer and the supplier as well as the capability of the supplier need to be seriously scrutinised: Is the service supplier ready and able to conduct the application within a certain timeframe? Who is responsible for the choice of the agent? What happens if damage occurs? What topics should a contract cover? What about insurance? Appropriate answers to these questions are a prerequisite to a close relationship between the customer and the supplier, thus forming a *strong peculiarity* of the service, which in turn is a prerequisite for exploiting the eco-efficiency potential of a plant protection service.

The peculiarity of the service

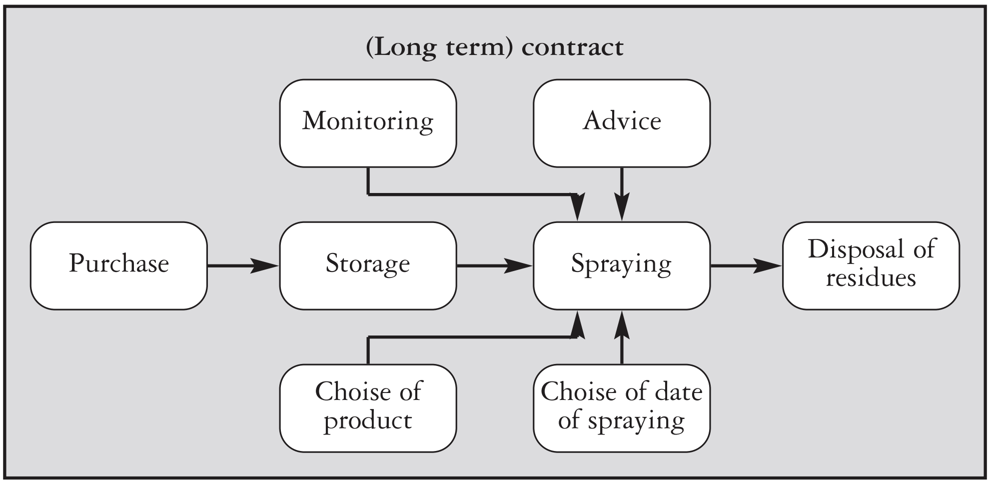
Based on the results of *Innovazid*, *Ser-Vino* and *Serplant Pro* the status quo of service performance can be summarised as follows: Plant protection services are offered and requested both in Austrian crop farming and viniculture and show either a *weak* or a *strong peculiarity*. The *weak peculiarity* is characterised by a mutual or case by case service, while the *strong peculiarity* requires a tight and perhaps long term cooperation between the customer and the service supplier. In crop farming for instance the costumers commonly retain their own machinery and the service often keeps the character of neighbourly help. In that case the service is frequently mediated by the *Maschinenring*, which is an Austrian-wide association to foster the inter-company use of agricultural machinery. The service only partly covers the income of the service suppliers, who are mostly farmers wishing to improve the capacity utilisation of their machinery and earn some extra money. In our investigations we use the term of *weak* or *minimal service peculiarity* (Figure 1). In viniculture however, the profit situation for service suppliers appears to be a lot better than in crop farming. This is partly due to the high impact of pesticide application on the crop yield, which correlates with the market value of the resulting (amount of) wine.

Figure 1. Different peculiarities of plant protection services



Consequently, a *strong service peculiarity* was most often found and described in viniculture. Typically, the service supplier is an entrepreneur equipped with high-tech equipment, his income and investments may be completely covered by the receipts from his service provision, his calculations are economically reasonable. The evidence suggests that the *strong service peculiarity* is the one with the greater eco-efficient potential. It enables renouncement of machinery and for the supplier the payback on investment in adequate machinery and training is more readily calculable (see also Table 1). It is further assumed that the *strong service peculiarity* is a necessary but not sufficient premise for eco-efficiency in terms of reduced and / or less harmful application of pesticides per area unit. Adequate data monitoring (i.e. amount of pesticide sprayed per area unit) and quality assurance are both necessary to document the economic and ecological benefits of the service.

Figure 2. Work packages of plant protection service which may form part of a service contract



From a life cycle perspective pesticide application is accompanied by and embedded within measures other than the mere spraying: e.g. purchase, storage and proper disposal of the pesticide (residues); monitoring of crop development, infestation and weather conditions; deciding on the date of application and choosing the appropriate pesticide (Figure 2). In the ideal case of a *strong service peculiarity* these measures are usually regulated by a commitment (contract) between the customer and the provider. In practice, from a few up to (nearly) all the measures are covered by the service supplier. Generally speaking the more measures are covered by the service supplier, the stronger the *service peculiarity* will be.

How eco-efficient can a plant protection service be from a theoretical point of view?

In practice, the environmental and occupational impact of pesticide application is interconnected with the (technical) efficiency of the application. To begin with, the amount of pesticide sprayed per unit of area should be kept to a minimum. This is facilitated by the employment of new innovative technologies. Tunnel spraying machines for instance avoid drift by recycling the spraying agent, which is filtered very finely back into the tank, thus reducing the amount of plant protection agent required by up to 40 % (Illustration 1). Since viniculture and fruit plantations demand a high level of plant protection with short intervals during the growing season, cost savings can be significant compared with conventional spraying techniques. It is obvious that such techniques may substantially boost service supply, since costumers equipped with conventional machinery and not willing or able to incur high investment costs for new technology may appreciate cost savings by utilising a service. On the other side, appropriate demand for the service may motivate potential providers to invest in technology and launch a start-up.

Secondly, reducing the environmental burden of pesticides may be achieved by substituting harmful pesticides with less toxic or less environmentally harmful ones (i.e. applying the substitution principle). This, however, requires comparative assessments of pesticides within the same application context. Unfortunately convenient tools for making such choices are widely lacking and it is evident that the substitution principle cannot be easily utilised to enhance the eco-efficiency of a plant protection service. This may change if incentives for choosing less harmful pesticides are implemented in pesticide regulations or assessment tools are available. Another option of reducing the environmental burden of pesticide application is to avoid exposure and improve occupational safety. This can be achieved either by technological measures (driver's cab equipped with filters and air-conditioning) or training of the supplier in appropriate dosage and cleaning techniques.

Illustration 1.

Source: Serplant Pro

Another alternative are ecological and performance improvements. A semi-quantitative access to determine the ecological efficiency of the service may be to calculate its *Material Input Per Service Unit* (MIPS). The MIPS concept was developed in the 1990s by the Wuppertal Institute. It is an approach to measure the material input (MI) needed per service rendered (Hinterberger, Luks et al. 1997). If agricultural equipment is applied more frequently, the utility or function that can be obtained from the machinery over its lifetime is enhanced. The MIPS approach perceives the product – in this case the agricultural equipment in combination with the sprayed pesticide – as a 'service delivery machine' (Wrisberg 2002). A decreasing MIPS indicates that less material input is needed to satisfy a constant need (i.e. plant protection) and therefore measures the progress of dematerialisation. A plant protection service might influence the MIPS in conjunction with the machinery used and the pesticide applied. A simple example may illustrate this: when one supplier uses one modern tunnel spraying machine to spray the vineyards of several customers, the others can abandon their own machines and do not need to buy new ones. Table 1 shows several elements influencing the eco-efficiency (impact) of a plant protection service.

Table 1. Criteria influencing the eco-efficiency of plant protection services

Criterion	Measure (service element)	Impact on eco-efficiency	Indicator
Reduced amount of pesticide sprayed per unit of area	Tunnel spraying (viniculture)	++	kg pesticide agent applied per ha
	Powerful pesticide application equipment	++	Material input per service unit (MIPS)
Less environmental impact on non-target organism and enhanced occupational safety	Spraying technique (fine spraying)	+	Environmental monitoring and surveillance data
	Driver's cab equipped with filters and air-conditioning	+	
	Training: appropriate dosage and cleaning techniques	+	
Less toxic and less environmentally harmful pesticides applied	Substitute with alternatives	(? → ++)*	Substance related indicators for human and eco-toxicity

**… possibly high, but actually difficult to implement because of lack of assessment tools.*

Practice examples for services with a medium and strong peculiarity

To illustrate the character and scope of a *medium* or *strong service peculiarity* and to give an impression of feasible variations in the service design, a few case studies are outlined in the following.

Case study 1: Cooperation between seven winegrowers in Burgenland (strong)

Seven winegrowers in Burgenland founded a legal association for the provision of essential operations in the vineyards during the growing season. The association owns and shares a multifunction carrier for a vineyard area of 100 hectares. As the term indicates, the carrier operates with accessory devices. The purchase is financed by each partner on a pro-rata basis. The partners delegate their workloads (spraying, harvesting, pruning and wire lifting) to the association, which employs an operator and acts as an agricultural service supply agency. The partners have favoured access to the service, but the carrier along with the operator can also be hired by other winegrowers. The benefit for the winegrowers include shared investment costs, reduced operating costs and release of time for core activities such as marketing.

Case study 2: Service supplier for winegrowers (medium)

Operations in the vineyards are offered on a commercial basis from an agricultural service supply agency. Instead of tunnel spraying they use a fine spraying technique with less pressure. The technique has been chosen because, in contrast to tunnel spraying, the fine pesticide spray is considered to protect useful creatures and prevents them from being washed off the grapevine. Additionally pruning and wire lifting services are offered. The entrepreneur currently manages eight clients and plans to compile a written contract.

Case study 3: Plant protection in crop farming (strong)

The plant protection service was founded in the early 1990s aiming at task sharing between two farmers. The service was broadened to others later and contracts with ten clients are currently maintained. The service comprises weed and pest control in agriculture (mostly cereals) on an area of 500 hectares. According to the service supplier the foremost motivation was always cost saving. This is achieved by jointly purchasing the pesticides and efficient administration including application of modern techniques. The machinery for example is equipped with charcoal filters and circulating air conditioning thus enhancing occupational health safety. Expert knowledge enables the service supplier to choose the optimal application date, appropriate documentation certifies the client is in compliance with the legal requirements. A contract based agreement over several years enables or at least facilitates planning and investment appraisal. In an interview the service supplier proposed to enhance similar joint ventures coordinated by the *Maschinenring* – a large-scale agricultural service supplier association – as well as appropriate training courses. His position was to provide such a service with a certificate on a legal basis.

A critical retrospective view on the results of 'Innovazid', 'Ser-Vino' and 'Serplant Pro'

The projects successfully investigated and analysed plant protection as a service in crop farming and viniculture in Austria. The results provide an impressive survey of good practice examples covering all stakeholders involved and the key issues in the particular service design. But from a retrospective view several originally envisaged targets could not be reached: a consistent and unified model for a plant protection service together with economic calculation, a long term and sustaining dissemination concept, an ecological assessment of the active ingredients of plant protection products within service application and an overall ecological impact assessment – for example by means of MIPS – is still lacking. The reasons for this are as follows: despite the fact that the projects cover a period of four years, this was altogether too short to launch implementations and calculate their impacts within such a complex and diverse issue. There was benign communication and exchange with stakeholders (i.e. *Maschinenring*) on a regional basis, but no support was provided on the national level. For example a national action plan for pesticide management is lacking, a pro-active engagement on a national basis was not apparent. Academic concepts scarcely match with the mindscape of the rural stakeholders and they are not really helpful in communicating the pros of the service concept. The social environment and the infrastructure in which such a service is embedded is complex and has an insisting tendency *per se*, comparable with private transport. An exchange forum where long term supply and demand offers for such services can be lodged on a regional level would be helpful, but is still widely lacking. However it is of utmost importance for a farmer to perceive a service support as being guaranteed in the long term, before he considers abandoning his own activities (including machinery). This aspect of secure service provision should be considered when promoting service dissemination. It is the opinion of the author that ecological aspects are generally disregarded in plant protection. Incentives and funding encouraging farmers to apply less harmful pesticides are largely lacking. Last but not least, some reservations against the service concept seem to derive from the mentality of the farmer's social community. The abandonment of machinery in particular appears to run against the social reputation of farmers, which is based on their 'farm-allocated' equipment.

Note

1 *Pflanzenschutzmittelregister*, published by the Austrian Agency for Health and Food Safety, http://www.ages.at

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