BENCHMARKING FARMER PERFORMANCE AS AN INCENTIVE FOR SUSTAINABLE FARMING: ENVIRONMENTAL IMPACTS OF PESTICIDES

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SUMMARY

Pesticide use in the Netherlands is very high, and pesticides are found across all environmental compartments. Among individual farmers, though, there is wide variation in both pesticide use and the potential environmental impact of that use, providing policy leverage for environmental protection. This paper reports on a benchmarking tool with which farmers can compare their environmental and economic performance with that of other farmers, thereby serving as an incentive for them to adopt more sustainable methods of food production methods. The tool is also designed to provide farmers with a more detailed picture of the environmental impacts of their methods of pest management. It is interactive and available on the internet: www.agriwijzer.nl. The present version has been developed specifically for arable farmers, but it is to be extended to encompass other agricultural sectors, in particular horticulture (bulb flowers, stem fruits), as well as various other aspects of sustainability (nutrient inputs, 'on-farm' biodiversity, etc.).

The benchmarking methodology was tested on a pilot group of 20 arable farmers, whose general response was positive. They proved to be more interested in comparative performance in terms of economic rather than environmental indicators. In their judgment the benchmarking tool can serve a useful purpose in steering them towards more sustainable forms of agricultural production. The benchmarking results can also be used by other actors in the agro-production chain, such as food retailers and the food industry.

INTRODUCTION

In the Netherlands environmental pesticide levels are a serious problem. Pesticides are to be found in every compartment of the environment, with standards regularly being exceeded (De Snoo, 1999). As part of wider government policy to improve environmental quality, Dutch pesticide policy seeks to reduce pesticide use as well as emissions to the environment (e.g., Multi Year Crop Protection Plan, 1991). With the exception of soil disinfectants, however, over the past decade there has been scarcely any decline in national pesticide use (De Jong et al., 2001). To achieve the envisaged reduction in pesticide use, Dutch policy-makers have to date focused on entire agricultural sectors, setting targets for arable farmers, bulb growers and other specific groups. At the level of individual farmers there is wide variation in pesticide use, though (De Snoo, 2002). It is now clear, moreover, that 5% of farmers account for about 25% of the overall potential environmental impact of pesticide use in the Netherlands. With this degree of variation among farmers, it should in principle be feasible to achieve a more dedicated reduction in pesticide use and associated environmental impact. The benchmarking scheme presented here uses the variation among individual farmers rather than entire sectors as a lever for enhancing inter-farm competition with respect to the environmental dimension of sustainability (in terms of the 'Three Ps', Planet), in this case related specifically to crop protection. Because this environmental dimension is inherently tied to the costs of the pesticides used and the crop protection benefits accruing, the economic dimension of sustainability (Profit) is also duly accounted for. Although the social dimension (People) might also be incorporated in a benchmarking system, it is not discussed in the present paper.

The key aim in developing this benchmarking tool was that it should allow farmers to compare their performance with that of fellow farmers on several aspects of sustainability. Many farmers currently have no idea of their own performance in this respect relative to other farmers engaged in similar activities in their locality or region. Do I use more or less pesticides on the same crop? Am I having a similar (potential) impact on the natural environment? Do I rate among the best 5% of Dutch potato growers? If farmers have a more transparent picture of the various sustainability issues associated with their own farm, they may become far more motivated to improve their score on both environmental and economic yardsticks. Moreover, other actors in the agro-production chain (food retailers and the food industry) will be interested in a system that can potentially provide them with more detailed information on suppliers, or help steer the latter in a more sustainable direction, in the context of company certification for example (*cf.* Udo de Haes & De Snoo, 1997). A benchmarking tool that can act as an incentive for sustainable farming gains considerable added value if farmers can compare their own performance anonymously with a large sample of other farmers engaged in similar food production operations. The benchmarking tool was therefore developed as an internet tool.

To successfully induce farmers to make their farming more sustainable, a benchmark incentive must satisfy a number of basic conditions. It must be *relevant to the farmer*, *scientifically sound*, *easy to determine*, *universally applicable* and *attractive for the farmers using it*. To assess the *relevance* of particular indicators to farmers, the degree to which the sustainability issues in question apply in the agricultural setting must first be established. The benchmarking tool must also be *scientifically sound*. Indicators can be defined at different levels of sophistication. Pesticide use, for example, can be measured in kilograms of active ingredient(s), in kilogram-equivalents accounting for the toxicity of the ingredients or in kilogram-equivalents based on fate, exposure and toxicity (*cf.* Reus et al., 1999; Udo de Haes et al., 1999). Including fate and exposure implies a need for data on local and regional environmental conditions (soil type, soil organic matter, etc.). To make the tool user-friendly for farmers and readily verifiable by other actors in the food chain such as retailers, the chosen indicators must also be *easy to determine*. Here a balance must obviously be struck between scientific accuracy and ease of measurement (*cf.* De Snoo, 2002). The tool should also be *universally applicable*, so it can be used to measure the performance of any farm in the Netherlands or even the EU. This means that the chosen indicators must be suitable for use across a wide range of conditions (different agricultural sectors with their different products, different environmental conditions, etc.). Finally, the benchmarking tool must be *attractive* for the farmers using it. Although the prime concern here is overall design and presentation, this criterion also has a bearing on indicator definitions, which must epitomise issues and kinds of measurement with sufficient appeal for farmers, too.

In this paper we first provide a general description of the benchmarking methodology employed (selected indicators, scale level, data input, reference data, data output). In the Results section we run through an example of how an individual farmer might use the benchmarking tool and report on the perceptions and preferences of a pilot group of farmers who subjected the system to initial testing. This paper is one of the results of a project being carried out at the Leiden University Centre of Environmental Science to develop a benchmarking tool for arable farmers growing eight of the Netherlands' principal crops (such as winter wheat, spring barley, sugar beet, onions and ware potatoes, seed potatoes etc). The tool is freely available on the internet: www.agriwijzer.nl.

MATERIALS AND METHODS

Design of the benchmarking tool

Indicators

The benchmarking tool incorporates both environmental and economic indicators. With respect to the environment, farmers can assess their performance on two indicators: the amounts of pesticides used (kg active ingredient/ha) and the potential environmental impact of that use (expressed in Environmental Impact Points: EIP/ha *cf.* Reus *et al.*, 1991). Both indicators were deemed sufficiently relevant to farmers, being already used in several certification schemes (e.g. Stichting Milieukeur, 2003). With respect to economic performance, farmers can opt for an input-related indicator: the cost of their pesticide use (euro/ha), or two output-related indicators: crop yield (kg crop/ha) and financial profit (euro/ha), the latter also duly allowing for harvest quality. All the indicators can be used at the crop level, while total pesticide use and costs can also be used at the farm level.

Allied farmers

Farmers can compare their scores with those of allied farmers engaged in similar operations at both the national and regional level. Regional comparisons are deemed the more relevant though, since several key factors differing across regions (e.g. soil type, affecting pest presence) may prompt different pest management strategies. To divide the Netherlands into regions relevant to farmers, we adopted the 'ecodistrict' classification (Klijn, 1988), based on factors like geology, relief, groundwater and soil type. The Netherlands comprises a total of 26 ecodistricts, but the distinctions are not all equally relevant from an agricultural perspective. For our present purposes we therefore clustered these ecodistricts into 14 regions (see figure 1).

Data input

To calculate their 'sustainability score', farmers need to provide information about farm pesticide use (type, dosage), application methods (equipment, nozzle type, buffer zone width, month of application), percentage soil organic matter, crop yields and financial profit. Most of this information is already familiar to Dutch farmers, many of whom register pesticide use for retailers or certification purposes. To relieve farmers of the burden of recalculating their pesticide use specifically for benchmarking, they should be able to readily import already registered data into the benchmarking tool.

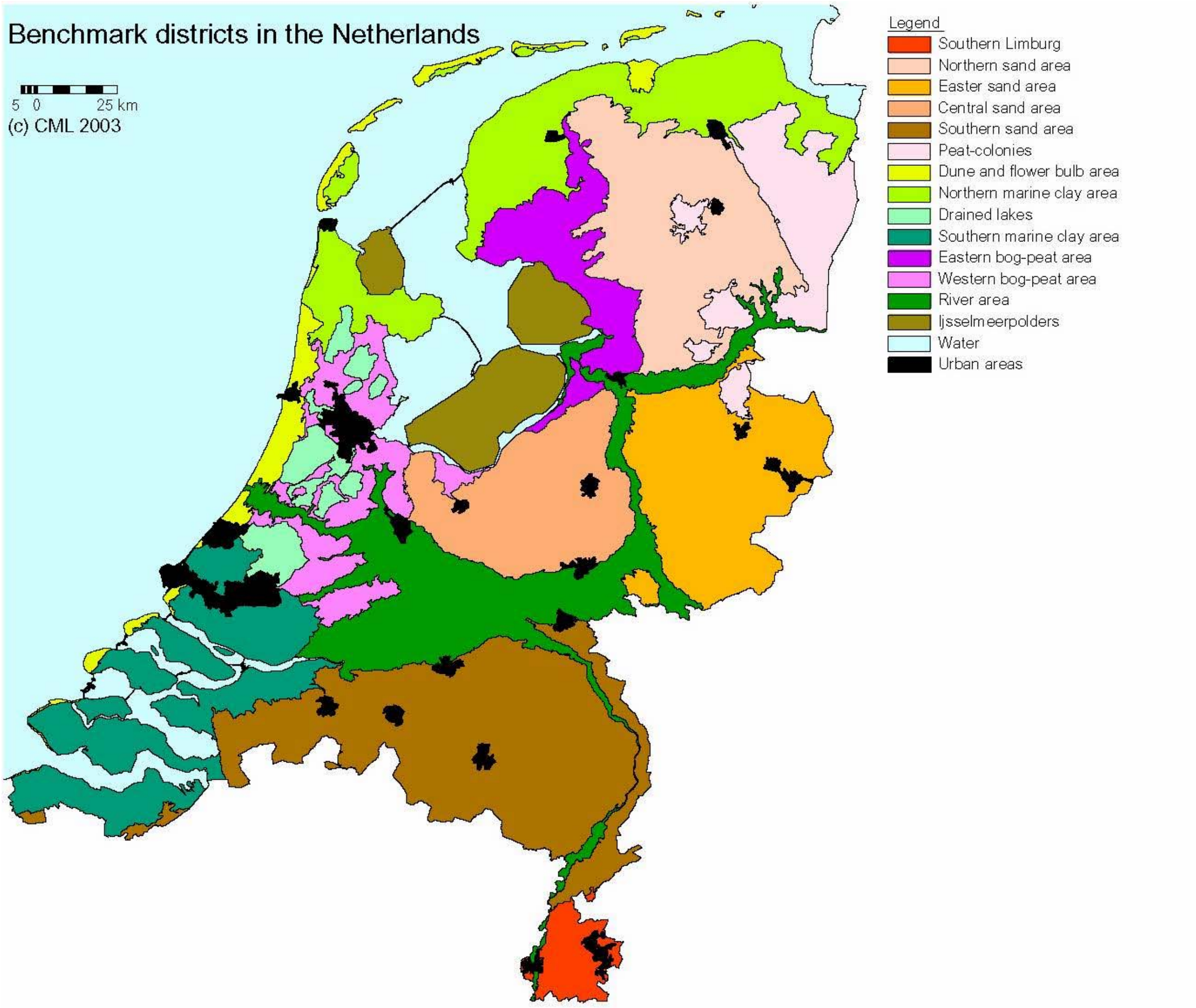

Figure 1: The Netherlands divided into 14 regions, allowing farmers to compare performance with others in the same region.

Reference data

Initial benchmarking data for individual farmers to compare their performance with those of others had to be taken from existing data sources. These reference data were drawn from Statistics Netherlands (CBS), the sugar industry (CSM, SuikerUnie) and other actors in the agro-production chain. All the data were checked by experts and are assumed to be reliable. In regions with sufficient data in the initial database, individual farmer performance could be compared with a regional benchmark; elsewhere, where the sample size was too small, comparison was with national reference data.

Data output

User output for farmers is in the form of text and graphics reporting individual environmental and economic scores in relation to those of other, allied farmers. The set-up is designed to give the farmers detailed insight into their performance on the various indicators. On the environmental side, farmers are also informed as to which three pesticides contribute most to their score (greatest environmental impact, etc.). The farmer's responses as to individual pesticide use (for what weed, pest, disease?) allow tailor-made advice to be given about more sustainable forms of pest management. This advice may relate to use of less toxic pesticides as well as to such issues as (changes in) crop rotation schemes and use of tolerant crop varieties. There is also an opportunity for farmers to consult a 'knowledge database'. The advisory tool and the database have been developed as separate modules within the same internet environment.

Farmers' perceptions of the benchmarking tool

The tool was tested on a pilot group of 20 arable farmers, selected to represent the present structure of Dutch farming (modern and traditional farmers). This had two main goals: to obtain information about the relevance to the farmers of the chosen indicators (via questionnaires, on a ten-point scale) and to find out how much time farmers spent on data entry. Farmers were also asked to give their opinion about the web lay-out of the benchmarking tool.

To find out how much time farmers spent on data entry, the pilot group was asked to fill out all the data required for benchmarking. The pilot group consisted of three sub-groups of farmers. First, there were farmers already registering data on farm pesticide use with a company specialised in 'chain ICT services' like crop registration, tracking & tracing and benchmarking (Group 1). These farmers' data could be easily retrieved from this company's database and transferred directly to our system. Secondly, there were farmers who recorded such information using other management systems (Group 2). Although these systems did not permit direct data transfer to our system, these farmers had rapid access to basic statistics on their pesticide use, reducing the time needed for data entry. Finally, some farmers recorded their pesticide data solely for their own use (Group 3). This group was expected to spend most time on data entry.

RESULTS

The benchmarking tool in practice: an example

To get a realistic view of how the benchmarking works in practice, as an example we shall run through the procedure adopted by an individual farmer, based on real data. The crop selected for this exercise is sugar beet, the chosen indicator environmental impact (Environmental Impact Points).

First the farmer is asked to give the four numbers of his postal code. In the future the farmer can indicate the area on the map (see figure 1) where his farm is located. He is also asked for which crop and which indicator he wants to do carry out the benchmarking. In this example it will be sugar beet and EIP. He is then shown regional performance on the EIP yardstick for sugar beet, based on the reference data available (but not including his own performance). The screen presented is reproduced here in figure 2.

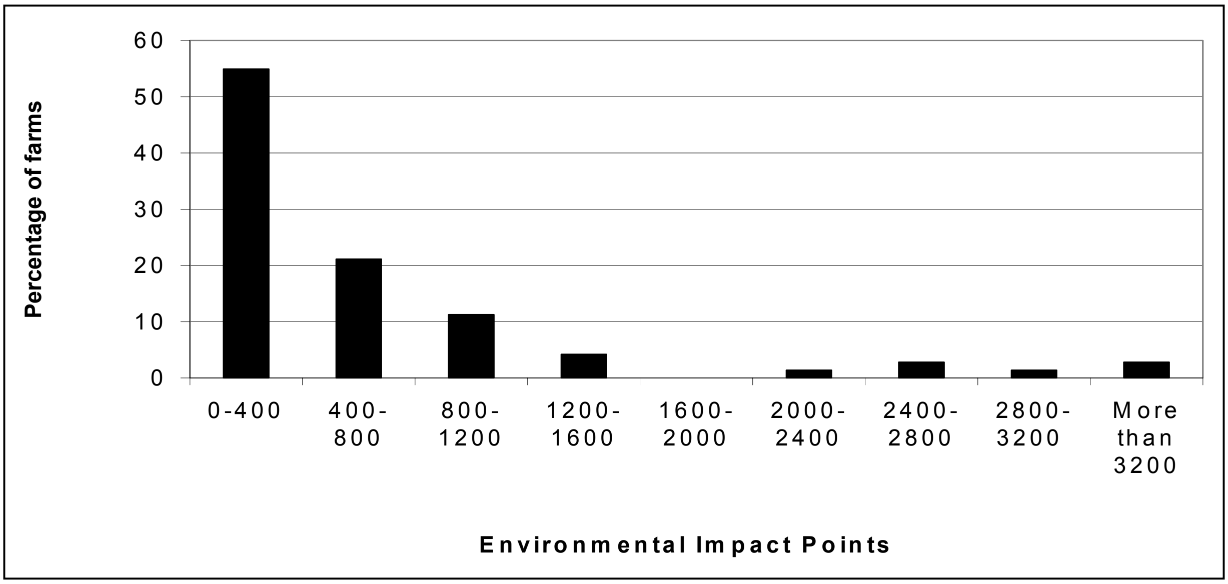

Figure 2: Screen showing regional sugar beet performance in Environmental Impact Points.

At this point the farmer is asked to enter relevant data on his own pesticide use, equipment, etc. Figure 3 shows the screen for data input on herbicide use; there are similar screens for insecticides, fungicides, seed treatments and other pesticide applications.

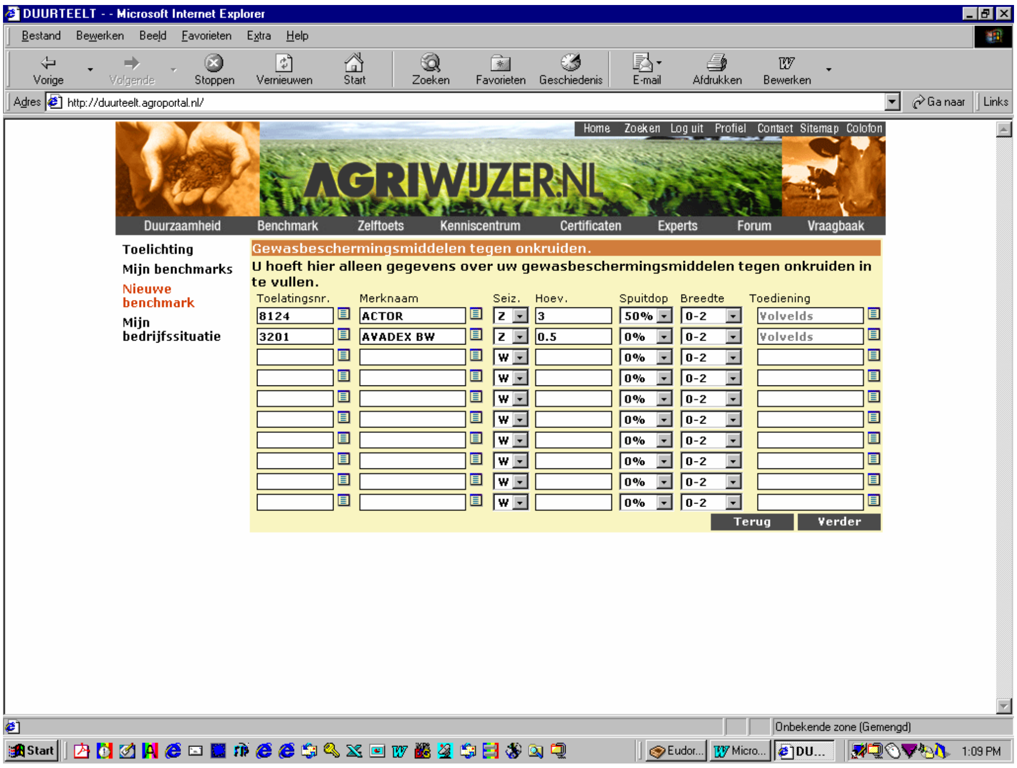

Figure 3: Data entry screen for herbicide use on sugar beet.

Having entered his own data, the farmer is presented graphics showing his own score relative to that of allied farmers (figure 4) and providing a more detailed picture of the potential environmental impact of his pesticide use. In a second release of the website this impact will be specified according to type of pesticide (herbicides, etc.) and environmental compartment (surface water, etc.); see figure 5. The farmer is also informed which three pesticides are responsible for the greatest environmental impact.

Finally, the farmer is asked to specify the purposes for which these pesticides are used. As mentioned above, his responses to these questions permits advice to be given on how to manage these problems more sustainably. The benchmarking results can be printed, saved and so on. Next time the farmer accesses the system he can use the earlier data to identify any changes in his performance.

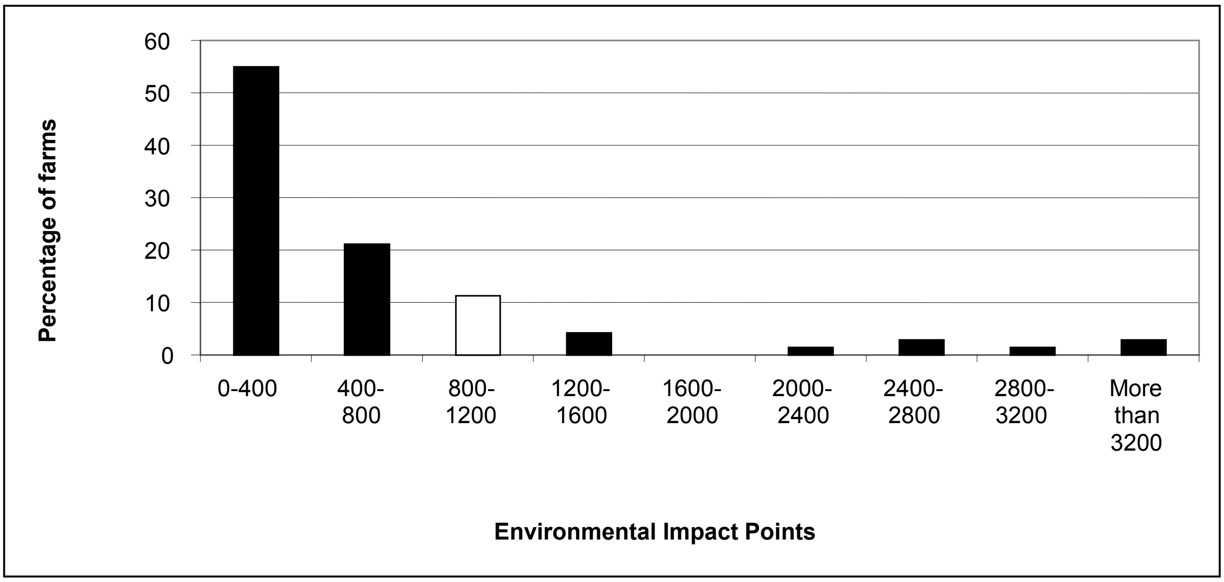

Figure 4: Farmer's score (white bar) relative to other farmers.

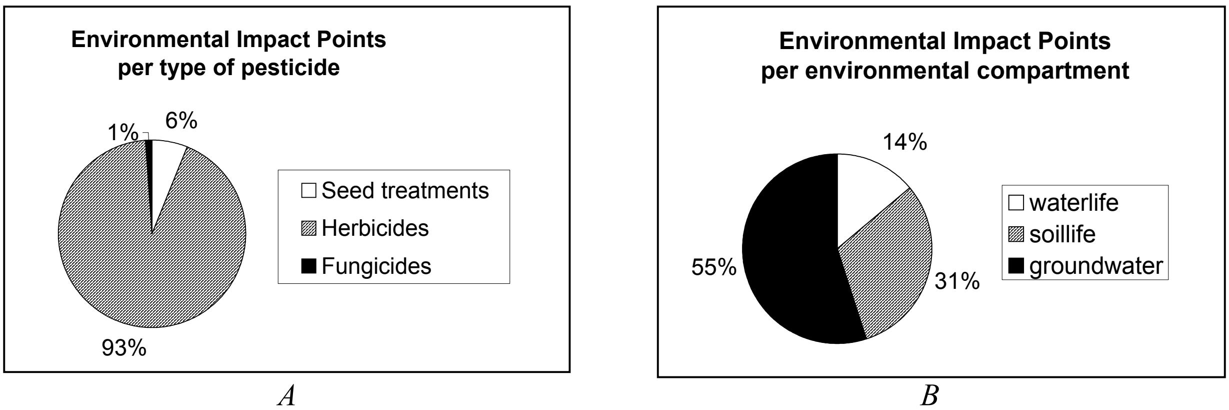

Figure 5: Environmental Impact Points (A) per type of pesticide and (B) per environmental compartment for sugar beet.

Testing the benchmarking tool: farmers' perceptions

Relevance of indicators

Table 1 shows how relevant the selected indicators were deemed to be by the pilot group of farmers. It became clear that farmers are more interested in benchmarking at the crop level than at the farm level. Moreover, they are most interested in the economic indicators rather than environmental indicators.

Indicators	Farm level	Crop level
Environmental indicators:		
Amount of active ingredients	5.9	6.8
Environmental impact (EIP)	-	7.0
Economic indicators:		
Costs of pesticides	6.1	7.8
Crop yield (euro/ha)	-	7.8
Crop yield (kg/ha)	-	7.9

Table 1: Relevance of benchmark indicators according to pilot group of 20 arable farmers (ten-point scale: 10 = best, - = not tested).

Lay-out and data entry

Farmers were also asked to give their opinion about the lay-out of the benchmarking tool and the time required for data entry. The lay-out was generally judged to be good. However, some farmers reported that data entry was too time-consuming, especially farmers of group 3. This was not the case for farmers already registering or recording data on their pesticide use. Table 2 shows the time spent by farmers testing the benchmarking tool. The average time spent on entry of farm level data by farmers of group 1 was 22 minutes. However, this average was due mainly to one farmer; if his time is ignored, the average time spent on data entry was 3 minutes.

	Farm level	Crop level
Group 1	22 minutes	12 minutes
Group 2	45 minutes	24 minutes
Group 3	48 minutes	25 minutes

Table 2: Time spent by farmers on data entry.

Data output

Farmers of the pilot group considered the data output to be clear and meaningful. The presented diagrams, specially the bar plots were easy to understand by most of the farmers. Furthermore, the farmers were very satisfied about the way of linking the results of the benchmarking tool with the other Agriwijzer sites: the farm advisory tool and the 'knowledge database'. The farmers do think this can help them finding more information to enhance sustainable farming.

DISCUSSION

Internet use among farmers is currently soaring. Increasingly, farmers are using the internet for the everyday business of sales and so on, as an advisory tool for pest management and fertiliser regimes and for registering their pesticide use. Using the internet environment to develop a benchmarking tool is more novel, though. Inclusion of an element of inter-farm competition in the tool allows farmers to compare their environmental and economic performance anonymously and securely in a large-scale, open-access environment. Ultimately, it is hoped, this approach can serve as an incentive for farmers to adopt more sustainable methods of food production.

A pilot group of farmers responded positively to the benchmarking tool, indicating that most farmers are interested in comparing their own performance with that of farmers engaged in similar agricultural operations. They proved to be particularly interested in their economic rather than environmental performance, as well as in crop-level comparisons with farmers in their own region. An important factor in this success is the ease and speed with which data can be entered. If relevant data can be transferred directly from existing registration systems (government, food industry, retailers, management and bookkeeping systems) this is a major advantage.

During the first year or so of operation the benchmarking tool will use only reference data from external sources. By the second year, though, this initial database can be extended to include the data collected during the first year. On subsequent visits to the website, moreover, individual farmers will need to enter less information, as many of their agricultural activities will remain unchanged. Over time, furthermore, benchmarking results will be of increasing value to farmers, enabling them to compare their performance over a longer period and assess their progress.

The benchmarking tool will also be made available to other actors in the agro-food chain such as the food industry and food retailers. Although they will not have the same, direct access to the system as individual farmers, they can use the tool to help steer agricultural producers towards more sustainable production methods, by setting standards for suppliers: for example, no procurement from farmers scoring at the bottom end (25%). This will provide a strong incentive for individual farmers to improve their environmental performance.

To date the focus of the benchmarking tool has been on arable farming. However, the indicators it comprises are also suitable for application in other branches of agriculture, in particular horticulture (bulb flowers, stem fruits). We also intend to provide an internet interface for farmers articulating other aspects of sustainability such as nutrient use and on-farm biodiversity. The ultimate aim is to have about ten sustainability issues available on the internet for benchmarking farm performance with respect to the three dimensions of Planet, Profit and People (*cf.* Unilever: Growing for the Future). Although our methodology has been developed for the Dutch situation, it can be readily upgraded to a higher scale level, the EU, for instance.

ACKNOWLEDGEMENTS

We thank Hein Antonissen (CSM), Sjaak Kolff (SuikerUnie) and Tom Loorij (Statistics Netherlands) for their help in obtaining the required reference data and Nigel Harle for his critical editing of the English text. The study was commissioned by Duurteelt.nl, a foundation representing several actors in the agro-production chain (food industry such as Unilever and Heineken, retailers such as Albert Heijn), governments and farmers' organisations. More information is on the website: www.agriwijzer.nl

REFERENCES

De Jong, F.M.W., De Snoo, G.R. & Loorij, T.P.J. (2001). Trends of pesticide use in The Netherlands. Med. Fac. Landbouww. Univ. Gent, **66/2b**: 823-834.

Klijn F. (1988). Milieubeheergebieden. CML mededelingen 37, Centrum voor Milieukunde Leiden, Leiden.

Multi Year Crop Protection Plan (1991). Tweede Kamer, Vergaderjaar 1990-1991, 21677, nrs3-4, SDU Uitgeverij, 's-Gravenhage.

Reus J.A.W.A. (1991). Milieumeetlat voor bestrijdingsmiddelen – Ontwikkeling en plan voor toetsing. Centrum voor Landbouw en Milieu, Utrecht.

Reus, J., Leendertse, P., Bockstaller, C., Fomsgaard, I., Gitsche, V., Lewis, K., Nilsson, C., Pussemier, L., Trevisan, M., Van der Werf, H., Alfarroba, F., Blümel, S., Isart, J., McGrath, D. & Seppälä, T. (1999). Comparing environmental risk indicators for pesticides in the EU. Centrum voor Landbouw en Milieu, Utrecht.

De Snoo, G.R. (1999). In: De Snoo, G.R. & De Jong F.M.W. (Eds.), Bestrijdingsmiddelen en milieu, Jan van Arkel, Utrecht. pp.53-70.

De Snoo, G.R. (2002). In: Den Hond, F., Groenewegen, P. & Van Straalen, N.M. (Eds.), Pesticides: Problems, Improvements, Alternatives, Blackwell Science, Sustainable Pest Management Series.

Stichting Milieukeur (2003). Milieukeur akkerbouwgewassen en vollegrondgroenten.

Udo de Haes, H.A. & De Snoo, G.R. (1997). Int. J. LCA, **2 (1)**: 33-38.

Udo de Haes, H.A., Jolliet, O., Finnveden, G., Hauschild, M., Krewitt, W. & Müller-Wenk, R. (1999). Int. J. LCA, **4 (2/3)**: 1-15.