Energy Saving in Greenhouse Horticulture as a Response to Changing Societal Demands: Findings from a Behavioural Study among 95 Growers in The Netherlands

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Abstract

In response to societal demands, the Dutch government implemented policy measures to reduce the use of fossil energy in greenhouse horticulture. A survey study was conducted to analyse behavioural aspects of horticultural growers to see 1) if they know about the policy measures and know what they mean for their own firm; 2) if they are willing to behave accordingly, and 3) whether we can explain different behavioural responses to the policy measures. Semi-structured interviews were conducted on 95 specialised greenhouse firms and the interview data was combined with existing firm records on technical and economic results, energy-saving investments and energy use. A cluster analysis was executed to reveal differences between growers with respect to the policy measures. Five clusters were identified that could be distinguished by the gap between their current energy use and the required energy-use level as determined by the policy measures. Perception, attitude and behaviour with respect to energy saving varied considerably among the different clusters. Limited knowledge of policy measures appeared to be no explanatory factor: firms that have to make large adjustments to comply with policy measures were quite well aware of the policy measures. Either a 'wait-and-see' strategy or a strict focus on consumer demands has kept them from changing their energy-related behaviour so far. Fine-tuning policy measures taking into account the different perceptions and attitudes per cluster offers possibilities to effectively change growers' behaviour.

INTRODUCTION

In response to societal demands, the Dutch government implemented policy measures to reduce the use of fossil energy in greenhouse horticulture. Horticultural firms are assigned a maximum amount of fossil energy use per square meter, depending on their crop type and production system. These so-called energy-use standards are implemented this year and will become more strict each year until the year 2010. Horticultural growers can comply with these standards by refining their energy management, by investing in energy-saving technology, or by using energy from renewable sources (e.g., wind energy).

The Dutch Ministry of Agriculture, Nature and Food Quality and the Dutch Branch Organisation of Horticultural Growers asked for a behavioural study:

1) To find out whether growers know about the policy measures in general and about their firm-specific energy-use standard in particular.
2) To find out what the attitude of growers is with respect to the policy measures (Are they motivated to comply with the standards? If so, when and how will they take the necessary steps? If not, what are the perceived barriers?).
3) To find out whether growers react differently on the policy measures. If so, how can these differences be explained?

MATERIALS AND METHODS

To answer above questions, semi-structured interviews were conducted on 95 specialised greenhouse firms: 29 cut-flower firms, 34 vegetable firms, and 32 potted-plants firms. These firms were selected from the Farm Accountancy Data Network (FADN) of the Agricultural Economics Research Institute in the Netherlands. The advantage of this selection procedure was that the interview data could be combined with the technical, economic and energy (usage and investment) data in the FADN.

The interviewers made use of a questionnaire that was developed in a way that answers could be linked to key theoretical concepts from decision-making literature, more specifically the 'motivation-of-change' literature (Ajzen, 1991; De Heer et al., 1998; Fishbein, 1967; Vlek et al., 1997). Table 1 shows the links between the topics in the questionnaire and the decision-theoretical concepts.

Data was analysed by cluster analysis techniques to reveal different responses between growers with respect to the policy measures. Using a set of variables on perception, attitude and behaviour with respect to energy saving, five clusters were identified that could be distinguished by the gap between their current energy use and their firm-specific energy-use standard. Two clusters consisted of firms that had energy usages either "far below the standard" or "just below the standard", meaning that firms in these clusters already complied with the year-2010 standards. The other three clusters were labelled "just above the standard", "above the standard" and "far above the standard". Rose firms with assimilation lighting were typically assigned to the last two clusters, whereas most vegetable firms were found in the clusters "just above the standard" and "just below the standard". Potted-plants firms were assigned to several clusters, ranging from "far below the standard" to "far above the standard" (Table 2).

RESULTS

The cluster analysis gave a good insight into the differences between growers on perception, attitude and behaviour with respect to energy saving. In Table 3, these differences are summarized.

Besides the above differences between clusters, the study also generated more general results:

The Higher a Firm's Energy Use Per Square Meter, the Bigger the Gap with the Energy-Use Standard (despite the adjustments for crop type and production system in the standards). This finding is remarkable because "the gap with the energy-use standard" was expressed in relative terms instead of absolute reductions in cubic metres of natural gas. Statistical analysis cannot reveal whether this finding results from ill-defined energy-use standard or from firm developments after defining the energy-use standards.

Growers Who Use More Energy than the Energy-Use Standards (clusters 3, 4 and 5 in Table 3) have More Knowledge of the Energy-use Standards than Growers Below the Energy-Use Standards (clusters 1 and 2). This finding suggest that lack of knowledge of growers with respect to the policy measures plays an unimportant role in explaining why growers have not yet complied to these measures. The relation between "gap with the energy-use standard" and knowledge of the policy measures is not linear: growers in the cluster "far above standard" appear to have less knowledge of the policy measures and their consequences for the firm than growers in the cluster "above standard". This finding can be explained by the differences in growers' interests between those clusters. Growers in the cluster "above standard" show interest in energy reduction mainly from a cost-reduction perspective. Growers in the cluster "far above standard" are not really focused on energy reduction but on market demands and output prices instead.

The Bigger the Gap with the Energy-Use Standard, the More Energy-Saving

Technology is Available on the Firms. This finding seems to contradict the explanation at the previous result because growers in the cluster "far above standard" actually do invest in all kinds of energy-saving technologies. However these high investment levels can be explained by the fact that more energy-saving technologies are profitable at higher energy-use levels (and also allow more intensive production systems or higher-quality production with relatively small increases in energy inputs). The attitude of the growers in this cluster on energy reduction cannot be judged from the investment levels.

Investments in Renewable Energy Sources are Not Popular because they Typically Do Not Serve a Production Goal. Growers perceive that there are not many interesting renewable energy options available. Unless these options are very profitable, growers are not very motivated to invest in them. Most of the renewable energy sources only serve an ecological goal and do not contribute to other goals such as higher production levels or improved product quality. On the other hand, if policy measures force the growers to choose between "lowering energy use, lowering production levels and/or lowering product quality" or "maintaining the energy use with renewable sources and maintaining production levels and product quality as well", growers will without any doubt choose for the latter option.

Timing is Important for Policy Intervention because Growers Prefer to Include Investments Energy-Saving Technologies in their Expansion Plans. Besides the cluster analysis presented in Table 3, another cluster analysis was conducted using variables that relate to the family-firm life cycle. Consistent with the theory, the cluster analysis revealed four clusters defining the "starting phase", "growth phase", "consolidation phase" and "withdraw phase" of the family-firm life cycle. As expected, investment levels were highest in the growth phase because of the firm expansion. In this phase, new energy-saving technologies could be adopted by the growers at relatively low cost. However, it appeared that growers in this phase of the family-firm life cycle are quite risk averse. They cannot yet rely on many years of experience as a grower and are facing high debt rates because of the firm expansion. Therefore, they are inclined to invest in proven technologies although they can adopt new technologies at relatively low cost. This means that it takes longer for new technologies to become "proven technologies". Applied research and advisory services have an important role in breaking this vicious circle by providing growers with "prove" just before or at the beginning of the growth phase.

Growers Prefer to Change their Energy Management, Based on Familiar Practices and Technologies that Can be Gradually Implemented on their Firms and Involve Little Risk. In the survey, growers were asked for the most import criteria to invest in energy-saving technology or changes in the energy management. "Profitability" ranked highest followed by "proven technology". The third and fourth rank were "should not have a negative impact on production levels" and "should save energy". In all, research on energy-saving technology or changes in the energy management should focus on profitable options that are based on proven technology, can be gradually implemented at the firm, and include low risks for production levels and product quality.

CONCLUSION

This study has shown that cluster analysis, based on a combination of record-keeping data and survey data, is a powerful instrument to gain insight into perception, attitude and behaviour of horticultural growers. This insight can be used to guide policy interventions. For instance, this study has shown that growers in the clusters '(far) above standard', with the biggest gap between current energy use and the standard also appear to have the best knowledge of the policy measures and their firm-specific standard. This suggests that a campaign to make these growers aware of the policy measures is not likely to be successful. In the 'just above standard' cluster, most growers feel the urge to further reduce their energy

use. However, they indicate that they that they do not have the financial resources to do so. Financial policy instruments could be useful for these growers.

The Dutch Ministry of Agriculture, Nature and Food Quality and the Dutch Branch Organisation of Horticultural Growers have expressed that, with the results of this study, they could now focus their policy interventions on the 'problem' clusters 'above standard' and 'far above standard'. In the near future, a research project will be conducted to have growers in these cluster develop energy-saving plans and to discuss the feasibility of different policy instruments with them, individually and in a workshop setting.

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Tables

Table 1. Links between topics in the questionnaire and decision-theoretical concepts

Questions on:	Decision-theoretical concept
Firm lay-out	Past behaviour
Energy use	Past behaviour
Opportunities: technical perspective	MOA/NOA: opportunities [1]
Opportunities: financial perspective	MOA/NOA: opportunities
Developments in legislation	MOA/NOA: opportunities
Developments in consumer markets	MOA/NOA: opportunities
Developments in labour markets	MOA/NOA: opportunities
Spatial developments	MOA/NOA: opportunities
Technological progress	MOA/NOA: opportunities
Age, availability of a successor	MOA/NOA: abilities
Physical capabilities	MOA/NOA: abilities
Mental capacity	MOA/NOA: abilities
Ambition, goals, strategies, preferences	MOA/NOA: needs
risk attitude	MOA/NOA: needs
family-firm life cycle	MOA/NOA: needs
Opportunities and threats	TPB: perceived behavioural control
Perception of risks	TPB: beliefs
Awareness of strong and weak points	MOA/NOA: motivation
Opportunities to tackle weak points	TPB: evaluation of behavioural outcome
Plans for the future	TPB: perceived behavioural control
Incentives from the market	MOA/NOA: needs, from external factors
Incentives from policy instruments	MOA/NOA: needs, from external factors
Incentives from social norms	TPB: subjective norms

1) MOA (Triade model): motivation, objectives, abilities (De Heer and Poiesz, 1998); NOA: needs, objectives, abilities (Vlek et al. 1997); TPB: theory of planned behaviour (Fishbein, 1967; Ajzen, 1991).

Table 2. Firm types per cluster

Firm type	Far below standard	Just below standard	Just above standard	Above standard	Far above standard
Rose w assimilation			1	4	6
Chrysanthemum w/o assim.		1	2	1	2
Chrysanthemum w assim.		1		2	
Other flowers w/o assim.	2	1			
Other flowers w assim.	1	1	1		
Tomato [1]		4	2	3	
Sweet Pepper		4	2	4	2
Cucumber		2	2	1	
Aubergine					1
Other vegetables	2	1	2		
Potted plants w/o assim.	8	6	1	3	5
Potted plants w assim.		1		3	
Total no. of firms [2]	13	22	13	21	16

1) none of the vegetable firms had assimilation lighting; 2) because of missing values cluster analysis was conducted on 85 instead of 95 firms.

Table 3. Perception, attitude and behaviour with respect to energy use

Cluster	Perception of growers	Attitude of growers	Behaviour of growers
Far below standard	Know that they have no problem	Market oriented Experience no incentive to save (more) energy	Avg. energy usage: 20 m^3 natural gas per m^2 No reduction needed to comply with year-2010 standard: -4,8% per year
Just below standard	Know that they act in the right way with respect to energy Consider energy as an input cost. Believe that cost reduction is very important	Risk averse: earn first; spend later Are cautious not to use too much energy	Avg. energy usage: 38 m3 natural gas per m2 No reduction needed to comply with year-2010 standard: -1,0% per year
Just above standard	Feel that they should comply with societal demands Feel dependant of societal opinions Are provoked by government policy	Have the intention to further reduce energy use Want to save more energy but lack the money to do so Have a strong external orientation	Avg. energy usage: 45 m^3 natural gas per m^2 Reduction needed to comply with year-2010 standard: 1,1 % per year
Above standard	Consider energy saving as a future issue Believe that they do quite well in comparison with peers (w.r.t. energy efficiency) Believe that generally they may be compared with firms of colleagues	Keep close eye on policy developments and react if necessary Regard the energy-saving issue as an energy-efficiency issue No nonsense attitude	Avg. energy usage: 55 m^3 natural gas per m^2 Reduction needed to comply with year-2010 standard: 1,7% per year
Far above standard	Know what's going on. Have done many energy-related investments; consider the energy-use standards as unrealistic. Buyers do no request, i.e., are not willing to pay for further energy saving.	Are innovative growers (high scores on "market orientation" and "willingness to take risk" scales and act as pioneers Believe that the energy-use standards will soon be adjusted by policy makers Don't let this disturb the work pleasure	Avg. energy usage: 64 m^3 natural gas per m^2 Reduction needed to comply with year-2010 standard: 4,1% per year