Grower Summary

PC 278a

The development and commercial demonstration of ducted air systems for glasshouse environmental control

Final 2012

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Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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HDC is a division of the Agriculture and Horticulture Development Board.

Project Number:	PC 278a
Project Title:	The development and commercial demonstration of ducted air systems for glasshouse environmental control
Project Leader:	Tim Pratt
Contractor:	Farm Energy Centre
Industry Representative:	Ian Ball, Humber VHB Gary Taylor, Valley Grown Nursery John Overvoorde, Delfland Nurseries Philip Pearson, A. Pearson & Sons Rob Bezemer, Jan Bezemer & Sons Fay Richardson, Coletta & Tyson
Report:	Final Report 2012
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Project Cost (Total Project Cost):	£74,217 (£89,217)

Headline

Four years of testing and development of a ducted air heating and ventilation system in a commercial tomato greenhouse in East Yorkshire have resulted in crop yield improvements, and heat energy saving.

Background

The fans and ducts system offers an alternative to conventional heating and ventilation in, what has become known as, the 'closed greenhouse'. Pioneered in the Netherlands, the system gives better control of air mixing and air infiltration in the greenhouse. It also presents the opportunity to deliver heat in a much more responsive way compared with the use of pipe rail systems, which are relatively slow to respond. Fans and ducts also offer the opportunity to the grower to use low-grade heat (water temperatures below 60°C); a level which is commensurate with the low-grade heat delivery systems such as CHP, boiler condensers, ground source heat pumps or waste heat from other industries.

Project PC 256 reviewed the theoretical potential for the closed glasshouse concept for UK horticulture. This concluded that although the closed greenhouse concept as a whole was not viable, ducted air systems could offer significant advantages over conventional greenhouse design. These are:

- Reduced energy consumption.
- Improved crop yield.
- Reduced pest and disease problems.
- Increased opportunities to use alternative heat sources.

With little practical experience in the UK, HDC decided to initiate this project to look at costs, benefits and practicalities of such systems.

Figure 1 overleaf shows the basic schematic layout of the fans and ducts system.

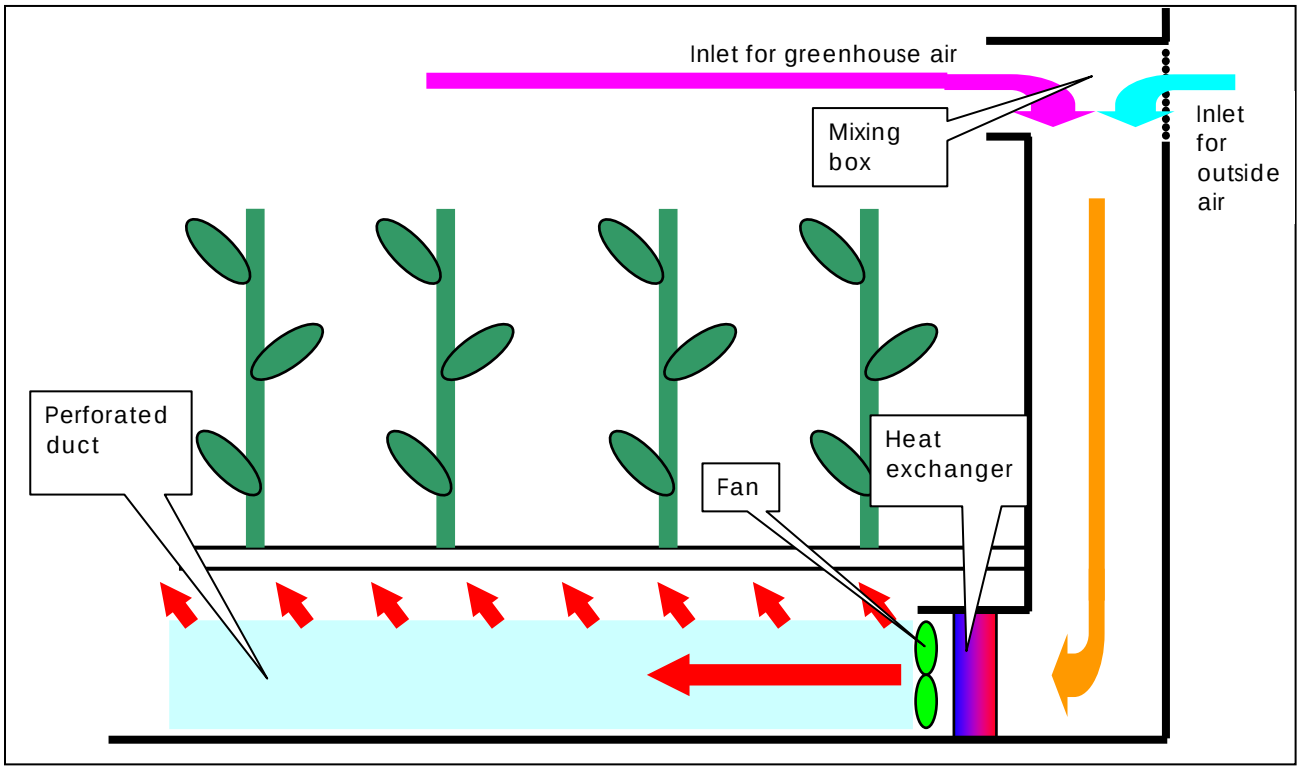

Figure 1 – Fans and ducts schematic (full system)

Summary of work over the four-year trial

The project started in 2008 with the design of a ducted air heating system to suit commercial conditions for a UK tomato grower. A supplier (Priva) was selected and an installation carried out at a commercial tomato grower in East Yorkshire over an area of 10,286 m^2 (two greenhouse compartments).

Initial trials began to characterise the system and allow the grower to become familiar with the operation of the new method of environmental control. For comparative purposes, control areas of a similar area were also monitored which used conventional heating, ventilation and environmental control.

Over the four years of the trial energy performance, crop yield, quality and disease were monitored. Refinements were made to reflect the practical and financial issues associated with the technique. Main modifications have been:

Refinement of air delivery system to give better temperature uniformity.

Alterations of air delivery rates and techniques to reduce the electrical running costs.

Figure 2 overleaf sets out the progress of the project over the last four years.

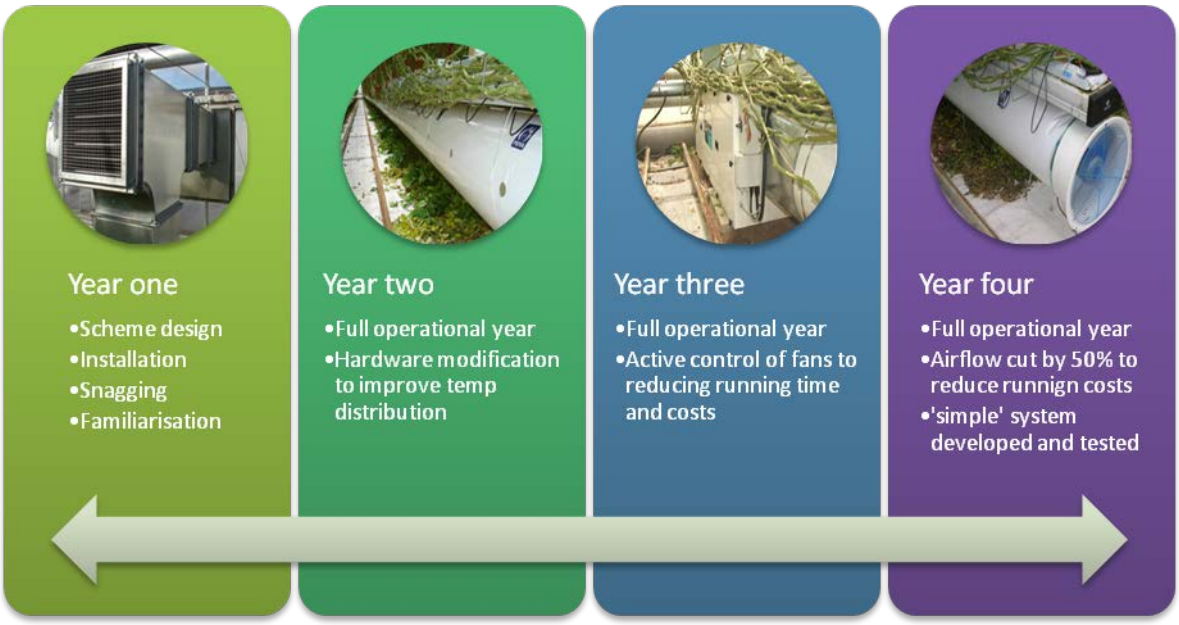

Figure 2 – Project timeline

In the final year (2011), a secondary ‘simple’ system was designed and tested in an effort to capture most of the practical benefits of the full fans and ducts system, but with lower capital and running costs. The simple system only employed the air recirculation element of the design. The heating function and ability to introduce outside air was forgone.

Financial benefits

Performance and financial results are set out in the following table. As the design, hardware, control and management of the system has been experimental and has continuously evolved – results may well be better for a more refined commercial system.

However, they do give a broad indication as to the potential of the system.

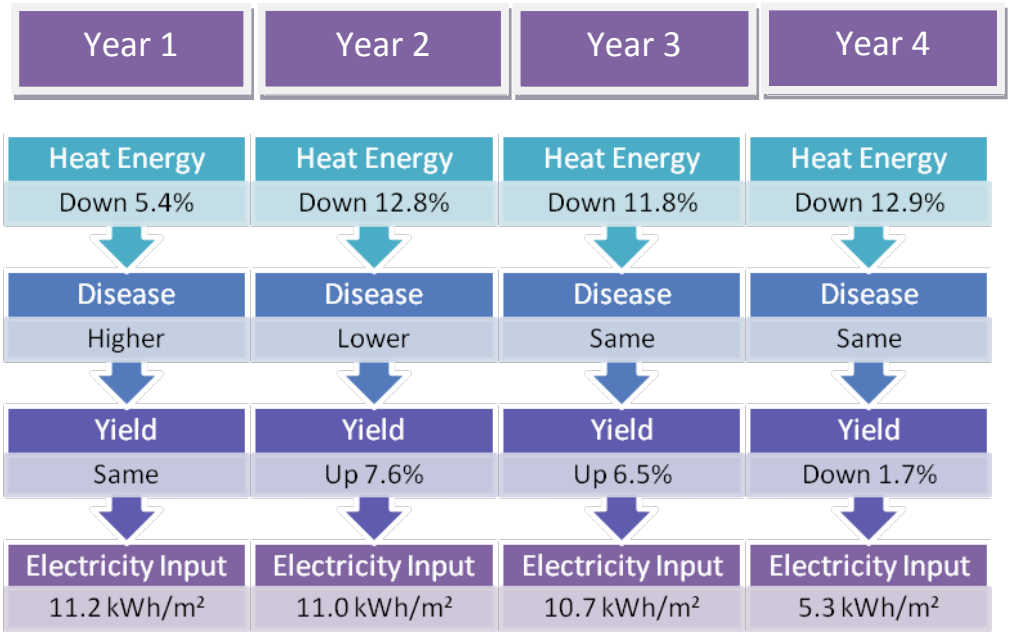

Figure 3 – Summary of results

The capital cost of the full system (as installed) was £15.90 per m^2. The value of additional yield, lower heating cost minus the cost of electricity used has averaged £2.06 per m^2 giving a simple payback of 7.7 years. The capital cost of a new, better-designed system is likely to be less – especially if it is integrated within a new-build greenhouse.

Simple system

Following two years of evaluation of a full fans and ducts system, it became clear that, as the major financial benefit came from enhancement in crop performance from better control of humidity and air mixing, then it might be possible to improve financial viability by forgoing some of the less critical features of the system.

A simple system was designed and installed with reduced capital and operation costs. Capital costs at £2 per m^2 were dramatically less than the full fans and ducts system (£15.90 per m^2).

Results showed modest heat energy savings of 16 kWh per m^2 using the simple system. This was in the face of some unexpected and un-associated management and disease difficulties, which, if put aside, might well have pushed heating energy saving to 22 kWh/m^2 or 5%. The simple system used 3 kWh/m^2 of electricity. However, savings in electricity from not having to run the normal roof fans should be allowed for (estimated to be 1.5 kWh/m^2).

Yield performance was disappointing with, in fact, a slight reduction (1.1%) over the control area.

On this evidence alone, payback would be over six years for on capital employed. It is however felt that, with more experience and fewer problems with extraneous disease events, this could be brought down dramatically.

Overall summary

On average, over the three years of full cropping trials the full fans and ducts system as opposed to traditional heating pipes and ventilation:

- Reduced energy costs by £0.39 per m^2.
- Increased average yield by 4.1%%.
- Enabled 95% of total greenhouse heat demand to be satisfied by water at 50°C or less (compared to 60% of heat demand with a conventional heating system).

However, experience from the project suggests that better performance than this can be achieved.

The one-year test (2011) of the 'simple' system was compromised by poor quality crop work in the trial area. However, indications were positive and experience with the full system suggests that a payback on investment should be possible within three years.

Action points for growers

The fans and ducts technique has greatest immediate potential where it can enable lower grade heat sources to be utilised.

Growers with a potential source of low-grade heat should:

- Determine the amount of heat that is available and the synergy between production and greenhouse heat demands.
- Explore the feasibility and cost of accessing the heat. This could be significant. For example, in the case of CHP, this may require additional heat exchangers, pumps and control systems.
- Identify potential suppliers of fans and ducts systems. There were at least six exhibiting at the Hortifair 2010.

Growers planning to build a new greenhouse without a low-grade heat source should:

- Investigate the ability to integrate the 'full system' concept using alternative (lower cost) designs that are only possible with a new-build greenhouse.

Growers with existing greenhouses who do not have access to lower cost heat sources should consider the benefits of a simple system.