Improving efficiency of potato store operation in Great Britain

AHDB Potato Council research project R439
and Storage 2020 knowledge transfer campaign

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Cost-effective storage

• Maximise return
  – Maintain quality
  – Market opportunity

• Control costs
  – Limit losses: moisture/disease
  – Optimise energy use: avoid unnecessary expense
Energy use: previous survey

[Bar chart showing energy use across different stores with corresponding kWh per tonne and kWh/tonne/day values.]
Aims

• To explore the detail behind these differences to explain them more precisely
• Identify areas where true savings are realistically achievable
• Calculate cost-benefit information
• Obtain data to assist the introduction of new, efficient technologies
Assessments

• Targeted a range of farms for each aspect
• Sampling approach or short-term logging
• Aim to quantify through direct measurement of store/crop condition or
• Make an assessment of equipment performance
Areas of interest

- Energy use measurement
- Air leakage
- Refrigeration efficiency
- Air distribution efficiency
- Temperature uniformity
- Insulation performance
- Changes in store hardware
- Humidification
- Carbon footprint
Potato store air leakage

Stable temperature and relative humidity

Boxes

Wind suction

Wind pressure
Potato store air leakage

Single hole equivalent for 1000/1500t stores  >
Responsible for c. 5% of energy use if well-sealed.
Responsible for 35-55% of a store’s energy use if not.
Storage refrigeration efficiency

Coefficient of Performance (COP): kW electricity > kW cooling
Refrigeration: condenser fans

- Condensers dissipate heat from fridge systems
- Traditionally used pressure switched fans where more units come on as load increases

ON/OFF DEPENDING ON HEAT LOAD

+1

+2
Upgrade: condenser fan replacement

- Removal of pressure switched units; replaced with continuously variable fan systems

ON/OFF DEPENDING ON HEAT LOAD

NEW FANS RUN CONTINUOUSLY BUT SPEED ADJUSTS ELECTRONICALLY TO LOAD
Condenser fans

OLD

NEW

- Sum of Sub cool total (K)
- Sum of COP Cool
- Sum of COP Heat
- Sum of Sub Cool Cond out (K)
- Sum of Super heat (K)
Fridge condenser fan upgrade

Coefficient of Performance (COP): kW electricity > kW cooling

POTATOES ➔ EVAPORATOR ➔ CONDENSER ➔ COP increased from 2.9 to 3.2 (10%)

1. Fan power use up by 3%
2. 83.7 > 92.2 kW +10%
3. 104.2 > 113.4 kW +9%
4. Power use down by 20%

The voice of storage

SUTTON BRIDGE Crop Storage Research

FARM ENERGY CENTRE
Refrigeration efficiency measurement
Fridge efficiency overall

Coefficient of Performance (COP): kW electricity > kW cooling

COP ranged from 1.6 to 3.9
Air distribution in overhead ventilated stores
Air distribution
Summary of project outcomes

• **Air distribution efficiency:**
  – Fans should be sized for worst case conditions and energy savings are then possible from inverters

• **Temperature uniformity:**
  – Air divider curtains can help to even out air flow in ‘overhead throw’ stores but not a complete solution. Other affordable upgrades being evaluated.
Summary of project outcomes

• **Leaky buildings:**
  – Between 30% and 50% energy savings possible

• **Refrigeration systems:**
  – Best to worst systems 2.5 times different
  – Condenser fan change can pay back in 5 years

• **Insulation:**
  – Upgrades offer energy savings of up to 10%
Summary of project outcomes

- Energy monitoring:
  - continues to highlight the difference between stores with over twice as much energy still used in some than others

<table>
<thead>
<tr>
<th>Market</th>
<th>2011 (kWh/tonne/day)</th>
<th>2012 (kWh/tonne/day)</th>
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<tbody>
<tr>
<td></td>
<td>Highest</td>
<td>Lowest</td>
</tr>
<tr>
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<td>0.43</td>
</tr>
<tr>
<td>Processing</td>
<td>0.10</td>
<td>0.20</td>
</tr>
</tbody>
</table>
Summary of project outcomes

- Store management survey
  - showed industry is moving to better storage systems but more change is still required

![Bar chart showing outcomes](image-url)
Actions

• Increase use of metering on potato stores
• Promote the uptake of modified and positively-ventilated box storage
• Encourage adoption of energy-saving technologies, eg inverters, adiabatic cooling
• Run Potato Council *Storage 2020* campaign to raise awareness of the need for better uniformity in stores across GB
**Storage 2020 campaign**

Main and Personnel Doors

Main doors are typically the leakiest aspect of a potato store and can contribute heavily to heat gain/cooling losses. Potato Council Project 4429 “Reducing the Energy Usage and Carbon Footprint of Potato Storage”, carried out this year, showed that air leakage can contribute up to 50% towards energy costs, of which the main door can contribute 30%.

A good example of typical cooling loss around the seals of an up-and-over door is shown in this thermal image.
Storage 2020 campaign

• Major international storage conference: 13 February 2014 at Peterborough

• StoreCheck nationwide audit service from 2014

• Open day: 50 years of storage research at Sutton Bridge 3 July 2014

• Much more to do!
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