

# Horticultural and Controlled Environment Department



ROTHAMSTED  
RESEARCH

## Controlled Environment and Glasshouse Facilities at Rothamsted Research

Aerial view of the site



## Introduction

Rothamsted Research is an internationally recognised facility. It is a primary source of world-class scientific research and new knowledge for policies, products and practices that underpin the economic, environmental and societal value of agricultural land

The Horticultural and Controlled Environment Department at Rothamsted Research is responsible for providing plants, for research, grown in glasshouses and controlled environments.

A team of 12 (11 FTE) staff are responsible for growing a wide range of plant material, mainly crop species such as oilseed rape, potatoes, wheat and barley. Over 500,000 plants are raised per annum for a variety of research purposes, including insect food, nutrition studies, plant physiological processes and genetic transformation studies. In addition, a wide variety of plants grown in the grounds are used for sourcing and rearing insects as well as experimental plant material.

## Glasshouses Facilities at Rothamsted

The glasshouse facilities presently (March 2017) consist of 42 glasshouses with 152 compartments and a total area of 3,515 m<sup>2</sup>, representing 1,452 m<sup>2</sup> of growing space. In addition there are 5 poly tunnels with 450 m<sup>2</sup> of growing space and 3 sand bed/hard standing areas with 405 m<sup>2</sup> of growing space.

### Glasshouse facilities

#### Glasshouse 25 (Cambridge, 1978/2003, 50 m<sup>2</sup>, 2 comp. each 10 m<sup>2</sup> bench area)

These compartments have automatic vents and fans, low-pressure hot-water heating, 400 watt SON-T lighting and manual blinds. The Envirocon control system is fitted to both compartments. Double-entry doors and insect-proofing is fitted for quarantine work. Fan ventilation is provided for Insect Behavioural studies.

#### Glasshouse 27 (Cambridge, 1982/2007, 450 m<sup>2</sup>, 5 comp. 28,50,32,32,16 m<sup>2</sup> bench area)

These compartments have automatic vents and blinds, low pressure hot water heating and 400 watt SON-T or 230 watt LED lighting. The glasshouse was reglazed in 2007 with polycarbonate cladding. Some compartments have flood bench irrigation systems. The Envirocon control system is fitted to all compartments.

#### Glasshouse28 (Cambridge,1982/2000/2007, 400 m<sup>2</sup>,8 comp 12, 3x15, 4x16 m<sup>2</sup> bench area)

These compartments have automatic vents, automatic blinds, low-pressure hot-water heating and 400 watt SON-T or 230 watt LED lighting. Four compartments have refrigeration (heat pumps) and are clad in polycarbonate, able to maintain 20°C in high ambient conditions. The Envirocon control system is fitted to all compartments. All eight

compartments are suitable for work on genetically-modified plants, having suitable screening and secured access. One of the refrigerated compartments is further compartmented with HEPA filtration fitted to ensure no pollen escapes.

**Glasshouse 29 (Cambridge, 1995, 248 m<sup>2</sup>, 15 comp. 14x5, 1x11.3 m<sup>2</sup> bench area)**

Thirteen compartments are automatically heated and cooled using heat pumps, with supplementary 420 watt LED lighting and fan ventilation through HEPA filters. Automatic blinds are fitted and the compartments are computer controlled using Envirocon controllers. The glasshouse is polycarbonate clad to provide good insulation and to minimise gaps and risk of breakage. This house is used as a C2 quarantine area.

**Glasshouse 30 (Cambridge, 2000, 174 m<sup>2</sup>, 8 comp. 8x8 m<sup>2</sup> bench area)**

**Glasshouse 31 (Cambridge, 2000, 248 m<sup>2</sup>, 12 comp. 4x11, 8x5 m<sup>2</sup> bench area)**

These compartments are computer controlled (Envirocon system) with automatic blinds, automatic irrigation, supplementary 230 watt LED lighting, fan ventilation through pollen filters (positive and negative pressure) and are fitted with heat pumps to provide cooling and heating. Carbon Dioxide monitoring is fitted with an option for control being available. The glasshouse is polycarbonate clad to provide good insulation and to minimise gaps and risk of breakage. These glasshouses are used for work on genetically-modified organisms and Class C2 work on plants requiring plant health licences.

**Glasshouse 32 (Cambridge, 2000, 248 m<sup>2</sup>, 14 comp 2x11, 12x5 m<sup>2</sup> bench area)**

These compartments are computer-controlled (Envirocon system), with automatic blinds, automatic irrigation, automatic side and top vents, low-pressure hot-water heating and supplementary 400 watt SON-T or 180watt LED lighting. Carbon Dioxide monitoring is fitted with an option for control being available.

**Glasshouse 33 (Cambridge, 2000, 174 m<sup>2</sup>, 7 comp 1x17, 6x8 m<sup>2</sup> bench area)**

Three compartments are computer-controlled (Envirocon system), with automatic blinds, automatic irrigation, automatic side and top vents, low-pressure hot-water heating, and supplementary 400 watt SON-T lighting. Four compartments are computer-controlled (Envirocon system), with automatic blinds, automatic irrigation, supplementary lighting, fan ventilation through pollen filters (positive and negative pressure) and are fitted with heat pumps to provide cooling and heating. The glasshouse is polycarbonate-clad to provide good insulation and to minimise gaps and risk of breakage. Carbon Dioxide monitoring is fitted with an option for control being available.

**Glasshouse 34 (Cambridge, 2000, 248 m<sup>2</sup>, 14 comp 2x11, 12x5 m<sup>2</sup> bench area)**

These compartments are computer-controlled (Envirocon system), with automatic blinds, automatic irrigation, automatic side and top vents, low-pressure hot-water heating and supplementary lighting. Carbon Dioxide monitoring is fitted with an option for control being available. One compartment is fitted with a computer-controlled misting system for propagation.



**Plan of Glasshouses, Polytunnels, Cages, Hard standing areas and Buildings containing Controlled Environments.  
March 2017**



G28. Polycarbonate clad, air conditioned.

Glasshouse 40 (Cambridge, 2001, 240 m<sup>2</sup>, 16 compartments each 5 m<sup>2</sup> bench area)

Twelve compartments are computer-controlled (Envirocon system), with automatic blinds, automatic irrigation, automatic side and top vents, low-pressure hot-water heating and supplementary lighting . Four compartments are computer-controlled (Envirocon system), with automatic blinds, automatic irrigation, supplementary lighting , fan ventilation through pollen filters (positive and negative pressure) and are fitted with heat pumps to provide cooling and heating. The glasshouse is polycarbonate clad to provide good insulation and to minimise gaps and risk of breakage. This glasshouse is rated at containment level 2.

Glasshouse 41 (Cambridge, 2001, 382 m<sup>2</sup>, 10 compartments each 21.5 m<sup>2</sup> bench area)

Glasshouse 42 (Cambridge, 2001, 288 m<sup>2</sup>, 8 compartments each 19 m<sup>2</sup> bench area)

Glasshouse 43 (Cambridge, 2001, 230 m<sup>2</sup>, 4 compartments each 33.5 m<sup>2</sup> bench area)

These compartments are computer-controlled (Envirocon system), with automatic blinds, automatic irrigation, automatic side and top vents, low-pressure hot-water heating and supplementary lighting . These compartments are extra high (4 metres) to accommodate taller crops.

Glasshouses 51-60 (Elite 2005 each 1.5m<sup>2</sup> . 10 glasshouses)

Glasshouses 61-64 (Elite 2005 each 8m<sup>2</sup> .4 glasshouses)

Glasshouses 65-79 (Elite 2007 each 1.5m<sup>2</sup> . 15 glasshouses)

Domestic glasshouses fitted with an auto vent. Glasshouses 65-79 fitted with polycarbonate and insect screening. Used for Insect studies and producing weed seeds in semi isolation.

## **Cage, Sandbed and Polytunnel facilities**

Glasshouse 35 (Clovis Lande, 2000, 137 m<sup>2</sup>, 39 sandbeds)

This cage area, with 39 sandbeds either 4.2 m<sup>2</sup> or 2.4 m<sup>2</sup>, is used primarily for weed studies and has an automatic irrigation system.

Glasshouse 38 (Clovis Lande, 1999, 70 m<sup>2</sup>, 1 compartment)

This polytunnel is used for pheromone work during the summer months and is fitted with fans to provide a uniform air flow.

Glasshouse 39 (Clovis Lande, 1999, 70 m<sup>2</sup>, 1 compartment)

This polytunnel is used for work during the summer months requiring higher than ambient temperatures but with no specific control requirement, and for overwintering temperate plants with a low temperature requirement. Power and gas heating are available.

Glasshouse 44 (Clovis Lande, 2001, 100 m<sup>2</sup>, 1 compartment)

This covered cage area is used for work requiring ambient temperatures, but also requiring cover from rain.

Compartment in G34, naturally ventilated, showing Phillips 400 watt SON-T lamps



Typical Glasshouse compartment with adjacent Envirocon controller.



Air conditioned compartment from G31. Note polycarbonate cladding and air conditioning unit



Corridor in G34



Covered cage G44



Cage area with sand beds (G35)



### Glasshouse 36 (CLM, 2000, 30 m<sup>2</sup>, 1 compartment)

This double-skinned polytunnel is used for drying and storing roots.

### Glasshouse 50 (Clovis Lande, 2005, 100 m<sup>2</sup>, 1 compartment)

This poly tunnel is fitted with fans to provide a uniform air flow

### Area 1 (RES 2003) 30 m<sup>2</sup> (Sand bed)

Sand bed "between G29 and G38"

### Area 2 (RES 2004) 168 m<sup>2</sup> (12 Beds)

Hard standing in compound adjacent to B37, automatic drip irrigation, used primarily for propagation and screening of willows and miscanthus.

## Glasshouse monitoring and control systems

Over 120 glasshouse compartments controlled by a glasshouse process control system. The Envirocon control system is currently manufactured at Rothamsted, and control software has been designed and developed to meet the current requirements of users. The Envirocon units are stand-alone microprocessor-based controllers, able to monitor and control temperature, lighting, CO<sub>2</sub>, humidity and watering. Over 200 control parameters allow quite complex control algorithms, limited only by the effectiveness of the various actuators. The controllers are fed from an independent power supply, which is battery-backed to ensure continuity of monitoring in the event of mains power interruptions. Units are linked via an RS 422 network back to a PC which is network accessible.

## Lighting

SON-T lighting is used throughout the facilities. The majority of the facilities (G32-40) use 400 watt Phillips SG140 luminaires. Hortilux Schreder HS2000/600 watt luminaires are used in G41 to G43. Plessey LED lighting is used in G27, G29, G30 and G31. Lighting levels of 300  $\mu\text{mol m}^{-2} \text{sec}^{-1}$  can be maintained at bench level in most compartments. Light levels are computer controlled to maintain daylength, as well as to switch off lighting when ambient light levels are high enough.

## Energy usage

The glasshouses are monitored for electricity, gas and water usage. Control strategies to minimise energy usage include light level control, shading (to reduce solar heat loads in summer as well as dead bands set to exploit high solar gain. Where specific temperatures are required as a research necessity these can be achieved  $\pm 1^\circ\text{C}$ . SON-T lighting is used throughout the facilities. Typically energy costs range between 15p (1 kWh) and £5.25. (35 kWh) per square metre of bench space used, per day, with an annual daily average of 75p (5 kWh).

# Glasshouse Support Areas

## B10 Soil Store

The soil store B10 has facilities for storing up to 120 cubic metres of soil or compost in 7 bins. Mixing facilities are available and loads of up to 1.5 tonnes can be transported using a forklift or Bobcat. A standard prescription mix, supplied by Petersfield Growing Mediums, is used for almost 70% of the 500,000 pots used every year and 2 bins are dedicated to storing this mix. A grit and loam mix is also stored. Various bagged loads of peat, John Innes mixes, various grades of sand, attapulgite clays, vemiculite and perlite are also stored in this area.

## B54 Glasshouse header area

This area provides support facilities and access for G29 to G34. The header area dedicated to G29 to G31 is a secure quarantine area and contains a vernalisation facility, as well potting, plant handling and autoclaving facilities. Additional security is provided in this area to meet the requirements for plant health safety. The header area supporting G32 to G34 contains a potting area as well as a temperature controlled low humidity seed storage room, small potato chitting cabinet and staff rest room facilities.

## B56 Glasshouse header area

This area supports work in G40 to G43. In addition to a laboratory support area and 2 potting areas, there is a dedicated soils washing area for soils, root and nematode work, -20°C seed storage room and a spray application facility.

There are a variety of sheds and containers and a locked compound available for storage of materials, machinery and various pieces of experimental equipment used in the glasshouses. A row of compost bins adjacent to B54 allow used soil and green waste from the glasshouses to be composted and recycled as topsoil and general soil improver on the laboratory grounds.



B54 Potting area



CE building (B57)



## Controlled Environment Facilities at Rothamsted

The Rothamsted Controlled Environment facilities are housed in 4 areas, B24, B25, B57 and B63. In total, there are 31 walk-in plant growth rooms and 65 plant growth cabinets. These facilities provide a wide range of environments of varying degrees of sophistication and quality. Anville 410, 420 and 625 loggers linked to a PC running a Tascomp 'Prodigy' software package monitors B63, B57, B24 and B25. The Sanyo Gallenkamp units in B57 are monitored and controlled via a Tascomp 'Prodigy' software package.

### Main Controlled Environment Building B57

Built in 2000/1, this building houses 16 Gallenkamp 228 cabinets, 4 Weiss HGC 1514 cabinets, 4 Gallenkamp Large rooms, 4 Gallenkamp Medium rooms, 1 'RES' Cereal production room, 1 Hotbox unit, 1 Vindon 111, 1 Gallenkamp 970, 1 Sanyo 254 MIR cabinets, 1 Vindon incubator and 3 Sanyo MLR cabinets. A cold room, laboratory area and monitoring room are located in the building.

#### Gallenkamp 228 cabinets (Sanyo, 2001, 1.68 m<sup>2</sup>, 16 units, C 1-16)

These cabinets have a growing area of 1.68 m<sup>2</sup> and growing height of 1.4 metres. Temperature control is provided in the range 5°C to 30 °C ± 0.3°C with lights off and 7°C to 35 °C ± 0.3°C with lights on. Humidity control is in the range 65% to 95% ± 5% in the range 15°C to 25°C. CO<sub>2</sub> monitoring (Vaisalla GMT 222) and control is fitted in 10 cabinets. Lighting is provided by T5 49 watt fluorescents providing up to 900 μmol m<sup>-2</sup> sec<sup>-1</sup> at 300 mm from the lights, dimmable from 100% to 10%. A 10% mix of tungsten lighting is provided. A Eurotherm 2704 controller, linked to a SCADA package, provides control.

#### Gallenkamp large growth rooms (Sanyo, 2001, 8 m<sup>2</sup>, 4 units, R 5-8)

These rooms have a total area of 16 m<sup>2</sup>, with a growing area of 8 m<sup>2</sup> spread over 8 trolleys and growing height of 3 metres. Temperature control is provided in the range 5°C to 30 °C ±



Gallenkamp 228 cabinets



Gallenkamp growth rooms

0.3°C with lights off and 7°C to 35 °C ± 0.3°C with lights on. Humidity control is in the range 65% to 95% ± 5% in the range 15°C to 25°C. CO<sub>2</sub> monitoring (Vaisalla GMT 222) and control is fitted. Lighting is provided by 400 watt HQI lamps, providing up to 900 μmol m<sup>-2</sup> sec<sup>-1</sup> at 1000 mm from the lights, dimmable, in 4 steps. A 10% mix of tungsten lighting is provided. A Eurotherm 2704 controller, linked to a SCADA package provides control.

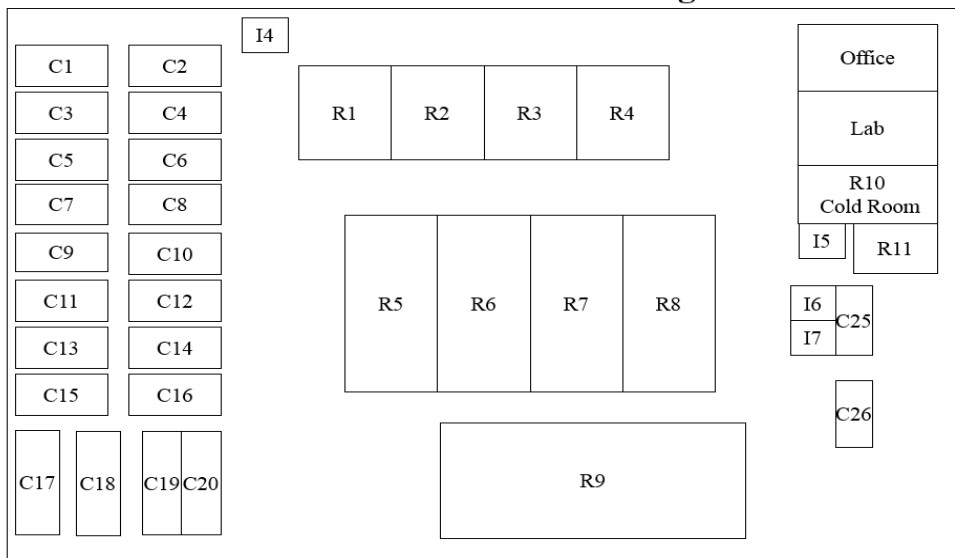
**Gallenkamp medium growth rooms (Sanyo, 2001, 6 m<sup>2</sup>, 4 units, R 1-4)**

These rooms have a total area of 12 m<sup>2</sup>, with a growing area of 6 m<sup>2</sup> spread over 6 trolleys and growing height of 2.5 metres. Temperature control is provided in the range 5°C to 30 °C ± 0.3°C with lights off and 7°C to 35 °C ± 0.3°C with lights on. Humidity control is in the range 65% to 95% ± 5% in the range 15°C to 25°C. Lighting is provided by 250 watt HQI lamps, providing up to 900 μmol m<sup>-2</sup> sec<sup>-1</sup> at 1000 mm from the lights, dimmable, in 4 stages, from 100% to 30%. A 10% mix of tungsten lighting is provided. A Eurotherm 2704 controller, linked to a SCADA package provides control.

**Cereal growth room (Watford Refrigeration, 2000, 25m<sup>2</sup>, 1 unit, R 9)**

This room has a total area of 32 m<sup>2</sup>, with a growing area of 25 m<sup>2</sup> on automatically-irrigated mobile benching. Temperature control is provided in the range 15°C to 30 °C ± 1.0°C with lights off and 15°C to 30 °C ± 1.0°C with lights on. Lighting is provided by 400 watt HQI lamps, providing up to 500 μmol m<sup>-2</sup> sec<sup>-1</sup> at 1000 mm from the lights. Air inlets and outlets are HEPA filtered. The room is optimised to produce Cereal Donor material for Genetic Transformation studies but has been used for bulking up GM cereal, linseed and Oilseed Rape seed.

**Controlled Environment Building B57**



#### Potato Chitting Room (Hotbox, 2001, 6m<sup>2</sup>, 1 unit, R 10)

This room has a total area of 2.56 m<sup>2</sup> with a growing area of up to 14 m<sup>2</sup> on trays in 2 removable Danish trolleys. Temperature control is provided in the range 8°C to 30 °C ± 2.0°C with lights off and 10°C to 30 °C ± 2.0°C with lights on. Lighting is provided by 58 watt fluorescent lamps, mounted vertically on the sides of the trolleys, providing up to 100 μmol m<sup>-2</sup> sec<sup>-1</sup> at the centre of the trolleys.

#### Sanyo MLR cabinets (Sanyo, 1993, 1996, 2009, 2011, 0.6 m<sup>2</sup>, 4 units, I 4-7)

These cabinets have a growing area of up to 1.0 m<sup>2</sup>, spread over 5 trays and growing height of 0.2 metres. Temperature control is provided in the range 7°C to 30 °C ± 1.0°C with lights off and 10°C to 35 °C ± 1.0°C with lights on. Vertically-mounted lighting is provided by T12 36 watt fluorescent lamps, providing up to 200 μmol m<sup>-2</sup> sec<sup>-1</sup> at the centre, dimmable in 5 steps from 100% to 20%.

#### Gallenkamp SGC 970 cabinet (Sanyo, 1997, 0.72 m<sup>2</sup>, 1 unit, C 25)

This cabinet has a growing area of 0.72 m<sup>2</sup> and growing height of 1.2 metres. Temperature control is in the range 0°C to 30 °C ± 0.2°C with lights off and 5°C to 35 °C ± 0.2°C with lights on. Humidity control is in the range 60% to 95% ± 5% in the range 15°C to 25°C. CO<sub>2</sub> monitoring (ADC) control is fitted. Lighting is provided by 55 watt PL fluorescent lamps, providing up to 1100 μmol m<sup>-2</sup> sec<sup>-1</sup> at 300 mm from the lights, dimmable from 100% to 30%. A 10% mix of tungsten lighting is provided.

#### Vindon 111 cabinet (Vindon, 1995, 0.72 m<sup>2</sup>, 1 unit, C 26)

This cabinet has a growing area of 0.72 m<sup>2</sup> and growing height of 0.8 metres. Temperature control is provided in the range 5°C to 30°C ± 0.5°C with lights off and 7°C to 35 °C ± 0.3°C with lights on. Lighting is provided by 36 watt fluorescent lamps, providing up to 250 μmol m<sup>-2</sup> sec<sup>-1</sup> at 300 mm from the lights. A 10% mix of tungsten lighting is provided.

#### Weiss HGC 1514 cabinets (Weiss 2017, 1.5 m<sup>2</sup>, 4 units, C 17-20)

These cabinets have a growing area of 1.5 m<sup>2</sup> and growing height of 1.9 metres. Temperature control is in the range -10°C to 30 °C ± 0.3°C with lights off and -10°C to 35 °C ± 0.3°C with lights on. Humidity control is in the range 65% to 95% ± 5% in the range 15°C to 25°C. CO<sub>2</sub> monitoring and control is fitted in 10 cabinets. Lighting is provided by Valoya B200 LED units providing up to 1000 μmol m<sup>-2</sup> sec<sup>-1</sup> at 300 mm from the lights, dimmable from 100% to 10%. A ProFace controller, linked to a SCADA package, provides control.

The 20 Weiss (Gallenkamp) cabinets and rooms are controlled using chilled water at 2 to 5°C from 3 York chiller units. The same units maintain the building at a constant 22°C ± 2°C with cold water or hot water (recovered from chiller units) as required. The remaining rooms and cabinets are temperature controlled with individual 'DX' units.

## Controlled Environment Service Building B25

Built in the early '70s, this building houses 7 'RES' Simple rooms, 1 RES Insect room 2 Arabidopsis rooms containing 10 CLF 'Grobanks' (24 cabinets), 4 Conviron Adaptis Cabinets, 4 Vindon 8194 cabinets, 5 Weiss SGC 110 Cabinets, and 4 Sanyo 600 (66)cabinet. The 7 simple rooms are chilled water cooled units whilst the remaining rooms and cabinets are on individual 'DX' chillers.

**Arabidopsis Rooms (Adcock's Refrigeration 2006 20 m<sup>2</sup>, 2 units, R 15-16)**

**'Grobank' cabinets (CLF 2006, 1.3 m<sup>2</sup> (shelf), 6 x 2 shelf and 4 x 3 shelf units, C60-83)**

Two rooms with air conditioning, lockable doors, and a negative filtered air extract. Temperature control is provided in the range 15°C to 30°C ± 1.5°C. The 'Grobank' cabinets are either 3 shelf units or 2 shelf units, each shelf with a growing area of 1.3 m<sup>2</sup> and growing height of 45 cm and 70 cm respectively on each shelf with separate day/night temperature control using ambient room air for cooling. Lighting provided by 58W dimmable fluorescent lamps, giving up to 250 μmol m<sup>-2</sup> sec<sup>-1</sup> at shelf level.

**RES simple rooms (RES, 2010, 2.4 & 4.8 m<sup>2</sup>, 7 units, R 60-66)**

These rooms have a total area of 5 m<sup>2</sup>, with a growing area of 2.4 m<sup>2</sup> or 4.8m<sup>2</sup> spread over 2 sets of single or two-tiered benching and growing height of 1.8 or 0.8 metre. Temperature control is provided in the range 10°C to 30 °C ± 1.0°C with lights off and 13°C to 35 °C ± 1.0°C with lights on. . Lighting is provided by 80 watt T5 fluorescent lamps, providing up to 500 μmol m<sup>-2</sup> sec<sup>-1</sup> at 800 mm from the lights.

**Vindon 8194 cabinets (Vindon, 1992, 0.7 m<sup>2</sup>, 4 units, C 21-24)**

These cabinets have a growing area of 0.7 m<sup>2</sup> and a growing height of 1.2 metres. Temperature control is provided in the range 5°C to 30 °C ± 0.5°C with lights off and 7°C to 35 °C ± 0.5°C with lights on. Humidity control in the range 65% to 95% ± 5% in the range 15°C to 25°C is available. Lighting is provided by 55 watt PL fluorescent lamps, providing up to 650 μmol m<sup>-2</sup> sec<sup>-1</sup> at 300 mm from the lights. Separate lamp housings are available using HQI lamps to provide 1050 μmol m<sup>-2</sup> sec<sup>-1</sup> at 300 mm from the lights. A 10% mix of tungsten lighting is provided.

**SGC 110 Cabinets (Weis Gallenkamp, 2008/10/13 0.9m<sup>2</sup> 5 units C 30-34 and 45)**

These cabinets have a growing area of 0.9m<sup>2</sup> and a growing height of 1.5 metres, with shelves the growing area is doubled to 1.8m<sup>2</sup> and growing height reduced to 0.7m. Temperature control is in the range 5 to 35°C ± 1% with lights off and 10 to 35°C ± 1% with lights on. Lighting with fluorescent lamps provide 400 μmol m<sup>-2</sup> sec<sup>-1</sup> at 300m from the lights.

**Fisons 600H cabinets (Fisons, 1970, 0.72 m<sup>2</sup>, 1 unit, C 47)**

These cabinets have a growing area of 0.72 m<sup>2</sup> and growing height of 0.8 metres. Temperature control is provided in the range 5°C to 30 °C ± 0.2°C with lights off and 7°C to 35 °C ± 0.2°C with lights on. Humidity control is in the range 60% to 95% ± 7% in the range 15°C to 25°C.. Lighting is provided by 55 watt fluorescents, providing up to 380

$\mu\text{mol m}^{-2}\text{sec}^{-1}$  at 300 mm from the lights. A 10% mix of tungsten lighting is provided.

**Conviron Adaptis cabinets (Conviron, 2010,2011, 0.6 m<sup>2</sup>, 4 units, C 50-53)**

The cabinets have a growing area of 0.6 m<sup>2</sup> and growing height of 1.1 metres. Temperature control is provided in the range 5°C to 30 °C  $\pm$  0.2°C with lights off and 5°C to 35 °C  $\pm$  0.2°C with lights on. Humidity control is in the range 60% to 90%  $\pm$  7% in the range 15°C to 25°C. Lighting is provided by 39W T5HO/840 fluorescent lamps providing up to 600  $\mu\text{mol m}^{-2}\text{sec}^{-1}$  at 300 mm from the lights.

**Culture Rooms (RES 1980 4 m<sup>2</sup>, 2 units, GR 2-3)**

Simple temperature control from 5°C to 28°C  $\pm$  2°C with shelving in one unit and either benches or shelving lighting can be installed in the other. Used for a variety of work, including controlled temperature storage and insect studies

**Seed Storage and Rooms (Weiss 2013, 25m<sup>2</sup>, 2 rooms, R67 A-B)**

Two humidity/temperature rooms for seed storage 100m<sup>2</sup> shelving per room. Set at 6°C/20% humidity and 15°C/15% humidity respectively. There is a small temperature controlled laboratory attached.

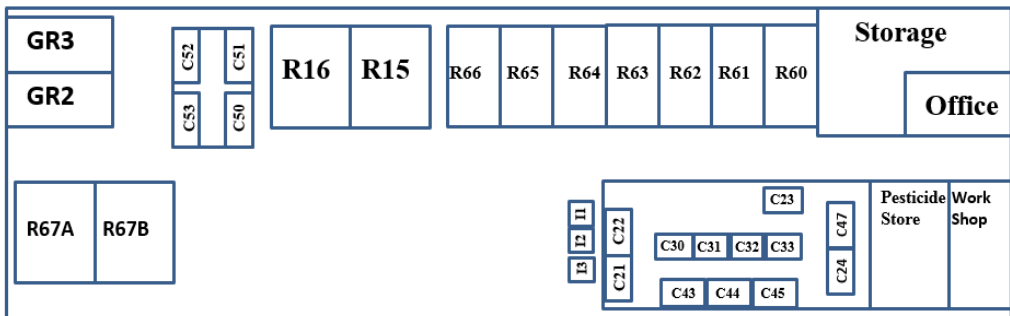
**Sanyo MLR cabinets (Sanyo, 1993, 1996, 2009, 2011, 0.6 m<sup>2</sup>, 3 units, I 1-3)**

These cabinets have a growing area of up to 1.0 m<sup>2</sup>, spread over 5 trays and growing height of 0.2 metres. Temperature control is provided in the range 7°C to 30 °C  $\pm$  1.0°C with lights off and 10°C to 35 °C  $\pm$  1.0°C with lights on. Vertically-mounted lighting is provided by T12 36 watt fluorescent lamps, providing up to 200  $\mu\text{mol m}^{-2}\text{sec}^{-1}$  at the centre, dimmable in 5 steps from 100% to 20%.

**SGC 110 Cabinets (Weiss, 2015 0.9m<sup>2</sup> 2 units C 43 and 44)**

These cabinets have a growing area of 0.9m<sup>2</sup> and a growing height of 1.5 metres, with shelves the growing area is doubled to 1.8m<sup>2</sup> and growing height reduced to 0.7m. Temperature control is in the range 5 to 35°C  $\pm$  1% with lights off and 10 to 35°C  $\pm$  1% with lights on. Lighting with Heliospectra R20 LED lights provide 400  $\mu\text{mol m}^{-2}\text{sec}^{-1}$  at 300mm from the lights.

## B25 Controlled Environment Service Building





CLF 3 tiered cabinets



Conviron Adaptis cabinets



Weiss SGC 110 Cabinet

## Cereal Transformation Building B24

This building as well as contains 6 large rooms dedicated to growing cereal plants for Cereal transformation studies and a vernalisation room. This building also contains 3 temperature controlled insect or invertebrate behaviour rooms. In addition there is a Containment facility (Level 2) with 2 plant growth rooms with a lobby and secure access

### Cereal growth rooms (Adcocks Refrig., 2007, 8.5m<sup>2</sup>, 6 units, R 18 a-c & 19 a-c)

These rooms have an area of 18 m<sup>2</sup> with a growing area of 8.5m<sup>2</sup> on automatically-irrigated mobile benching. Temperature control is provided in the range 15°C to 30 °C ± 1.0°C with lights off and 15°C to 30 °C ± 1.0°C with lights on. Lighting is provided by 400 watt HQI lamps providing up to 500 μmol m<sup>-2</sup> sec<sup>-1</sup> at 1000 mm from the lights. These rooms are optimised to produce cereal donor material for Genetic Transformation studies.

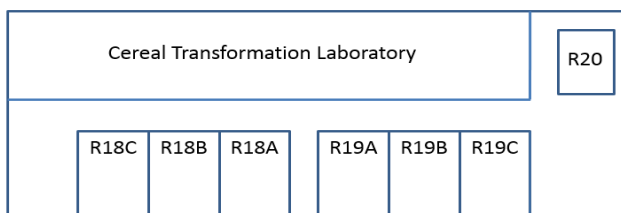
### Vernalisation room (Watford Refrig., 1998, 9.6m<sup>2</sup>, 1 unit, R 20)

This room has an area of 16 m<sup>2</sup>, with a growing area of 9.6 m<sup>2</sup>, split on two levels. Temperature control is provided in the range 4°C to 10 °C ± 2.0°C with lights off and 5°C to 10 °C ± 2.0°C with lights on. Lighting is provided by 70 watt fluorescent lamps, providing up to 150 μmol m<sup>-2</sup> sec<sup>-1</sup> at 300 mm from the lights.



Cereal Growth Room. (R19)  
Note automatic watering & HQI lamps in the room.

### B24 Cereal Transformation





## Jenkinson Building B63

The Jenkinson Building contains a range of Controlled Environment facilities.

### Containment rooms, tiered (Weiss Gallenkamp, 2008, 24.5 m<sup>2</sup>, 2 units, R 40 & 42)

These rooms have a growing area of 24.5 m<sup>2</sup> over 3 shelves and growing height of 0.6 metres. Temperature control is provided in the range 10°C to 30 °C ± 0.2°C with lights off and 10°C to 35 °C ± 0.2°C with lights on. Lighting is provided by 55 watt fluorescents, providing up to 380 μmol m<sup>-2</sup> sec<sup>-1</sup> at 300 mm from the lights. A 10% mix of tungsten lighting is provided. Positive humidity control in the range 60 to 90% ± 5% is provided. These rooms have a lobby, HEPA filtration and are negatively pressured to provide a level of containment to HSE CAT 3.

### Containment rooms (Weiss Gallenkamp, 2008, 9.8m<sup>2</sup>, 2 units, R 41 & 43)

These rooms have a growing area of 9.8 m<sup>2</sup> and growing height of 1.6 metres. Temperature control is provided in the range 10°C to 30 °C ± 0.2°C with lights off and 10°C to 35 °C ± 0.2°C with lights on. Lighting is provided by 55 watt fluorescents, providing up to 380 μmol m<sup>-2</sup> sec<sup>-1</sup> at 300 mm from the lights. Positive humidity control in the range 60 to 90% ± 5% is provided. These rooms have a lobby and HEPA filtration and are negatively pressured to provide a level of containment to HSE CAT 3.

### Rice rooms (Weiss Gallenkamp, 2008, 6m<sup>2</sup>, 2 units, R 50-51)

These rooms have a growing area of 6 m<sup>2</sup> and growing height of 2.2 metres. Temperature control is provided in the range 10°C to 35 °C ± 0.2°C with lights off and 10°C to 35 °C ± 0.2°C with lights on. Lighting is provided by 55 watt fluorescents, providing up to 480 μmol m<sup>-2</sup> sec<sup>-1</sup> at 300 mm from the lights. Positive humidity control in the range 60 to 90% ± 5% is provided. These rooms have reinforced floors to facilitate the study of columns of soil.

### Sanyo MLR cabinet (Sanyo, 2009, 1.0 m<sup>2</sup>, 2 units, I 8 & 9)

This cabinet has a growing area of up to 1.0 m<sup>2</sup>, spread over 5 trays and growing height of 0.2 metres. Temperature control is provided in the range 7°C to 30 °C ± 1.0°C with lights off and 10°C to 35 °C ± 1.0°C with lights on. Vertically-mounted lighting is provided by T12 36 watt fluorescent lamps, providing up to 200 μmol m<sup>-2</sup> sec<sup>-1</sup> at the centre, dimmable in 5 steps from 100% to 20%.

### Conviron Adaptis cabinets (Conviron, 2012, 0.5 m<sup>2</sup>, 1 units, C 54)

This cabinet has a growing area of 0.5 m<sup>2</sup> and growing height of 1.1 metres. Temperature control is provided in the range 5°C to 30 °C ± 0.2°C with lights off and 5°C to 35 °C ± 0.2°C with lights on. Humidity control is in the range 60% to 90% ± 7% in the range 15°C to 25°C. Lighting is provided by 39W T5HO/840 fluorescent lamps providing up to 600 μmol m<sup>-2</sup> sec<sup>-1</sup> at 300 mm from the lights.

### Cold rooms (Watford refrigeration, 2008, 5m<sup>2</sup>, 5 units, R102 a-d)

These rooms provide storage for field samples. Two units are kept at 5°C/20% humidity, one at -4°C and two at 4°C. Control is at ± 2°C and ± 5% where humidity is controlled.



B63



Containment rooms B63



Containment rooms tiered



Rice room

### Building 54

#### Sanyo MIR 154 cabinet (Sanyo 2009, 0.6m<sup>2</sup>, 1 unit, I124)

This cabinet has a growing area of up to 0.6 m<sup>2</sup>, spread over 3 trays and growing height of 0.2 metres. Temperature control is provided in the range 5°C to 30 °C ± 1.0°C with lights off and 5°C to 35 °C ± 1.0°C with lights on. Lighting is provided by T12 fluorescent lamps, providing up to 150 μmol m<sup>-2</sup> sec<sup>-1</sup> at the centre. This cabinet is used for chitting potatoes.

### Building 56

Cold Storage Rooms. There are 4 cold storage units, 3 small (5m<sup>2</sup>) and 1 large 25m<sup>2</sup> - 25°C room. In addition there is a vernalisation cabinet.

Cold Room Cambridge 2001 5m<sup>2</sup> 2 units 102,112. Room designed for sample storage at +4°C

Cold Room Adcock 2012 5m<sup>2</sup> 1 unit w 102.

Freezer Room Adcock 2012 155m<sup>2</sup> 1 unit 104.

Vernalisation cabinet, Williams 2010 1.5m<sup>2</sup> 1 unit.

Standard cold cabinet set at 4°C with IKEA grow LED lighting providing 100μmolm<sup>-2</sup>sec<sup>-1</sup>

## Rothamsted Growing medium supported

Here are the growing medium commonly supported by H&CE for plant growth and research. We supplied other type of medium that not listed here. Please contact one of our staff to discuss your needs.

### Weed Mix Details

Composition

- 80% Sterilised Screened Loam
- 20% Grit (3-6mm Screened, Lime Free)

Nutrients added - 2.0kg Osmocote Exact 5-6 month per m<sup>3</sup>

Nutrients	Osmocote Exact 5/6 months
N (total)	16%
NO <sub>3</sub> -N	8.4%
NH <sub>4</sub> -N	8%
P <sub>2</sub> O <sub>5</sub>	8%
K <sub>2</sub> O	11%
MgO	2%
Bo	0.02%
Mo	0.02%
Cu	0.05%
Mn	0.06%
Zn	0.015%
Fe (Total)	0.40%
Fe (Chelated)	0.20%

### Dried silica sand

Sieve size (mm)	Average % passing
3.35	100
2.80	99
2.36	84
2.00	55
1.70	23
1.40	3
1.18	1
1.00	0

**6/14 Sand**

Sieve size (mm)	Average % passing
1.00	100
0.71	96
0.50	47
0.355	10
0.25	1
0.18	0

**2EW Sand**

### **Rothamsted Standard Compost Mix**

#### Composition

- 75% Medium grade (L&P) peat.
- 12% Screened sterilised loam
- 3% Medium grade vermiculite
- 10% Grit (5mm screened, lime free)

Nutrients added - 3.5kg Osmocote Exact 3/4 month per m<sup>3</sup> or 0.5kg PG mix per m<sup>3</sup>

Nutrients	Osmocote Exact 3-4 months	PG Mix
N (Total)	16%	14%
NH <sub>4</sub> -N	8.4%	8.5%
NO <sub>3</sub> -N	7.6%	5.5%
P <sub>2</sub> O <sub>5</sub>	11%	16%
k <sub>2</sub> O	11%	18%
MgO	3%	0.80%
B <sub>o</sub>	0.02%	0.03%
Mo	0.02%	0.20%
Cu	0.047%	0.15%
Mn	0.06%	0.16%
Zn	0.015%	0.04%
Fe (Total)	0.40%	0.09%
Fe (Chelated)	0.20%	-

### **Seed and Modular + Sand (F2S)**

A fine grade growing media with added horticultural grade sand for seed sowing and direct rooting of cuttings in modules, trays or small pots up to 7cm. A medium Nitrogen growing media ideal for general seed sowing. Once established feeding is recommended.

### **Pot and Bedding: High Nutrient (M3)**

A medium structured high nutrient growing media designed for bedding and pot plants requiring high feed levels. Controlled release fertiliser is not recommended for use with this product.

### **Nematode Mix**

80% Sterilised Loam, 15% 2EW Sand, 5% Lime Free Grit (5mm).

## Rothamsted Pots Supplied

Here are the pots commonly supplied by H&CE for plant growth and research. We supplied other type of pots that not listed here. Please contact one of our staff to discuss your needs.

Reference	Type	Diameter (cm)	Height (cm)	Volume (ltr)
55L (Tiny Round)	Tiny 8° Tall Pots	5.5	5	0.08
VCC13 (Round)	5° Tall Pots	13	11.3	1.05
VCD14 (Round)	5° Dwarf Pots	14	9	0.95
VCC15 (Round)	5° Tall Pots	15	13.1	1.55
VCC21 (Round)	5° Tall Pots	21	18.3	4.5
VTD9 (Round)	8° Tall Pots	9	6.8	0.27
VTD105 (Round)	8° Tall Pots	10.5	8.1	0.44



Reference	Type	Pot Size (cm)	Volume (ltr)
V11PP (Square)	Square Pots	11 x 11 x 12	1
V91PP (Square)	Square Pots	9 x 9 x 10	0.59
V778PS (Square)	Square Pots	7 x 7 x 8	0.23
VQ22 (Large Square)	Square Pots	22 x 22 x 23	11

Reference	No. of Cells	Tray Size (cm)	Cell Size (cm)
C15 (Inserts)	15	36.2 x 22.7	6.5 x 6.3
C24 (Inserts)	24	36.2 x 22.7	5.0 x 4.8
C40 (Inserts)	40	36.2 x 22.7	4.0 x 3.8
C60 (Inserts)	60	36.2 x 22.7	3.2 x 3.0



Reference	External Size (cm)	Volume (ltr)
Half Seed Tray	22.7 x 17.3 x 5.5	1.7
Standard Seed Tray	37.3 x 24.5 x 5.5	3.85

Reference	No. of Cells	Cell Shape	Tray Size (cm)	Tray Depth (cm)	Cell Size (cm)	Cell Volume (ml)
P104 (Plug)	104	Round	53 x 31	5.3	3.5 x 3.5	38
P286 (Plug)	286	Square	53 x 31	3	2.0 x 2.0	9.5
P576 (Plug)	576	Square	53 x 31	3	1.45 x 1.45	3.5

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*Julian Franklin August 2017*