Genetically Modified Organisms in Controlled Environments

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"Working within the legislation"

Working within the legislation

- Context of GMs in UK
- Legislation
- Design of facilities
- Working practices
- Future

Plant Biotechnology

"The advent of the techniques of plant biotechnology in the last 20 years has widened the scope and increased the precision of crop plant improvement".

Discuss!

GM plants - history

During the 1970s many attempts were made to introduce foreign DNA into plants, but all failed.

Until…

GM plants - history

1983, a breakthrough in the science of crop improvement published, a tobacco plant was shown to have stably integrated a gene derived from a bacteria.

Herrera-Estrella et al., (1983)
***Nature* 303, 209-213**

GM plants - history

This was mediated using a "natural" genetic engineer, the soil bacterium *Agrobacterium*.

Current Methodologies

Other methods of gene transfer exist e.g. biolistics

Over 120 plant species have been transformed to date including potato, tobacco, oilseed rape and sugar beet.

Current Methodologies

The technology has moved very quickly since the first report.

First generation transgenics were a result of relatively unsophisticated technologies.

Current Methodologies

Recently, the methodology much more precise, and factors such as antibiotic resistance eliminated.

Introduced genes may also only be switched on at specific stages of the plants life cycle.

Historical perspective

1983 - First report published

1990 – 60+ species transformed

1992 – first field trials

1995 – first GM product on UK supermarket shelves.

Transgenic Plant Technology

Year 2000

- Worldwide area of GM crops reported as 34.8million ha .
- 16% of area for 4 crops is GM.

CANOLA **MAIZE** **SOYA** **COTTON**

Transgenic Plant Technology

Strategic changes in transgenic research in the UK:

- Away from the large scale commercial trials…..
- Towards small scale high value or proof of principle projects.

Working within the legislation

- It is clear that the technology moves very fast.
- Scientists/Legislators have to be reactive to developments.
- Design of new facilities must have eye on future!

The legislation

- Covered by previous speakers
- HSE Guide to the Genetically Modified Organisms (Contained Use) Regulations 2000.
- ACGM Compendium of Guidance (Notably Parts 2D, 3B).
- Plant Health Order (1993).
- Environmental Protection Act (1990).

Notifications: HSE, & SCRI has an extra administrative layer in that Scotland is covered by SERAD.

Containment and control measures for work with genetically modified plants

- ACGM

Level A – recommended for work with plants that are unlikely to cause environmental harm.

Level B – for work where harm could arise if the GM plant (including pollen) were able to enter the environment.

Containment and control measures for work with genetically modified plants

Level A – some examples

1. Plant is incapable of living outdoors in UK.
2. Plant has limited ability to transfer genetic material to UK species.
3. Plants transformed using a disarmed strain of *Agrobacterium* (unless conferring harmful phenotype).

Containment and control measures for work with genetically modified plants

Level B – some examples

1. Risk assessment identifies hazard to humans or environment e.g pollen escape.
2. GM plants with ability to transfer novel material to UK species.
3. GM plants that express hazardous substances.

Containment and control measures for work with plants infected with, or in association with, GMMS

Four levels – relevant sections

Level 2:

- spatial isolation of experiments with different GMMS in association with plants employed.
- Entrance lobby with interlocking doors.
- Prevention of run-off.
- Minimisation of dispersal of pollen.
- Protective clothing.

Containment and control measures for work with plants infected with, or in association with, GMMS

Four levels – relevant sections

Level 3:

- ”likely to be highly engineered and expensive greenhouses”.
- Sealed benches and floors.
- negative pressure.

Legislation – local procedures

- Genetic Modification Safety Committee
- Proposals submitted in advance .
- Risk assessments made.
- Committee considers each proposal and containment level.
- BSO Advises on licences etc.

Working within the legislation

- Containment measures are not only based on the use of physical barriers….
- but rely on rigorous procedural and management control.

Working within the legislation

Physical barriers

- Engineering control measures.
- Supplemented with protective clothing/equipment.
- Testing and maintaining.

Working within the legislation

Procedural and management

- Training of personnel.
- Local codes of practice.
- Signs, notices.
- Hygiene facilities.
- Record keeping.

Range of crops and conditions

- Diverse face of science these days necessitates flexibility in facilities e.g.
- *Arabidopsis*
- Viral vectors
- GM fungi

Range of crops and conditions

This also indicates requirements for:

- Precise control of conditions.
- Scope for handling a number of experiments simultaneously.
- Rapid throughput and analysis.

Range of crops and conditions

Consequently, there is an extremely high emphasis on management, training, and detailed planning and recording of experiments.

SCRI –

- Had been working with GMs since mid 1980s.
- Working within legislation.
- Facilities located at several sites across Institute.

SCRI –

- Plans for centralising facilities for GM research, (or building a custom-designed facility) had been around since early 1990s.
- However, a major funding opportunity arose, which with the assistance of SET, University of Dundee, ERDF.

SCRI –

- Came up with £1.6 million for a purpose built lab, growth room and containment glasshouse facility.
- Diverse sources of funding necessitated that teaching and business aspects featured.

SCRI – planning

- Consultation with scientists as to future needs (!).
- Legislative factors strongly featured.
- Visits to other sites/related facilities (GM containment learns from phytosanitary set-ups).

SCRI – planning

Finalised a flexible package: -

- Primary focus on protecting plants & protecting environment.
- Facility designed to deal with experiments ranging from single plant to pre-field scale.

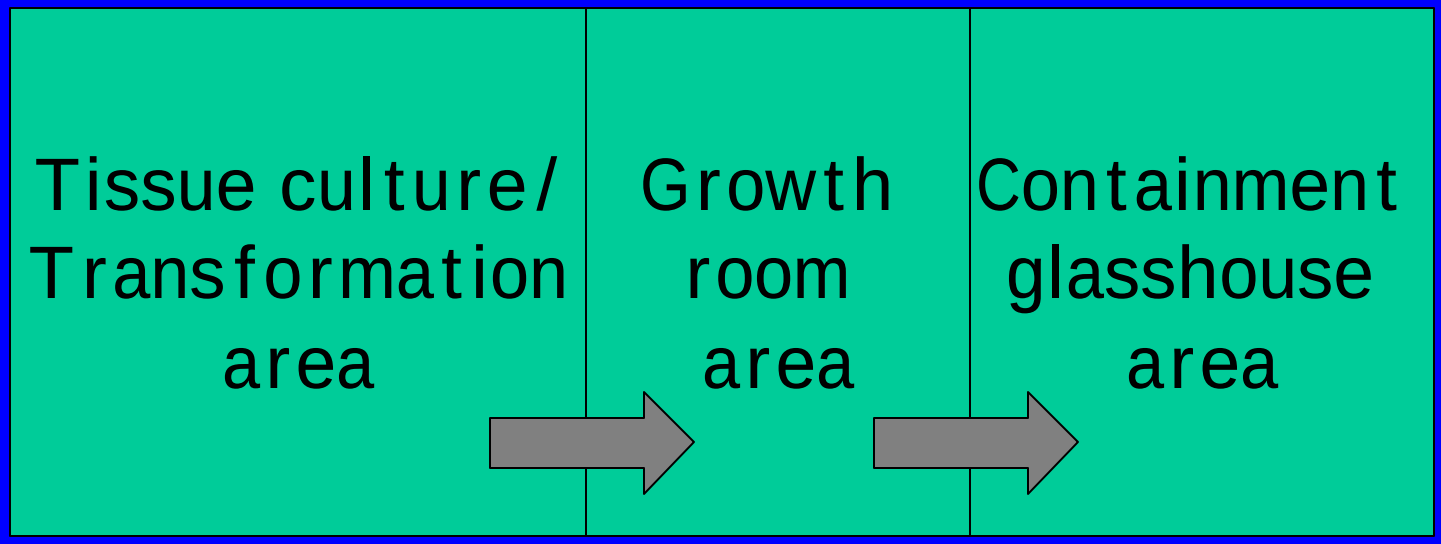
SCRI – planning

- Efficient ergonomic flow of work.
- Computer control & recording .
- Range of environments within.
- Distinctive.
- All within a “limited” budget!!

Working within the legislation

- SERAD consultation at early plan stages to ensure features for current and future legislation were incorporated.
- Run through worked examples of current GM projects.

Working within the legislation

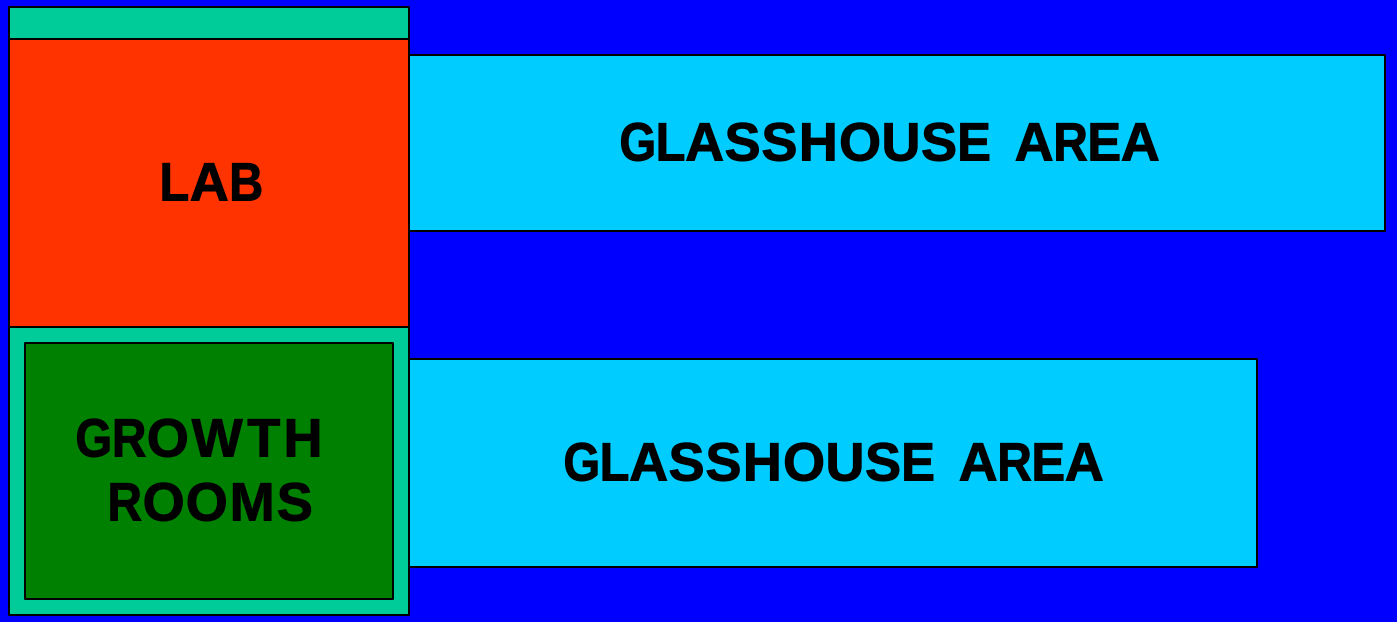


Working within the legislation

Lab/Plant room

South aspect

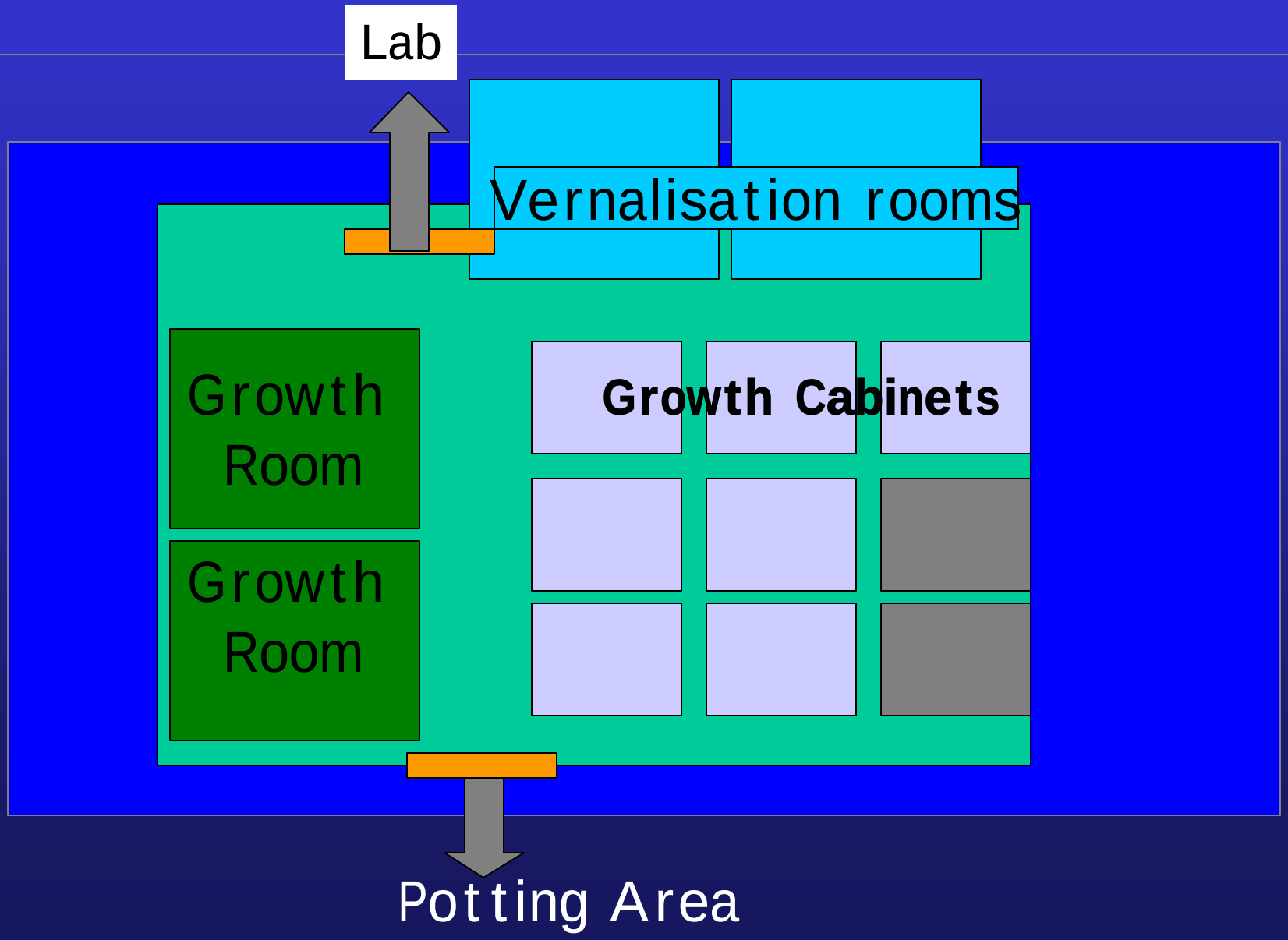
Working within the legislation



Working within the legislation: *lab area*

1. Access limited to key holders only
2. Logical throughput of work
3. *Agrobacterium* area isolated
4. Designated Growth rooms
5. Waste material disposal
6. Lab records

Growth Room Area



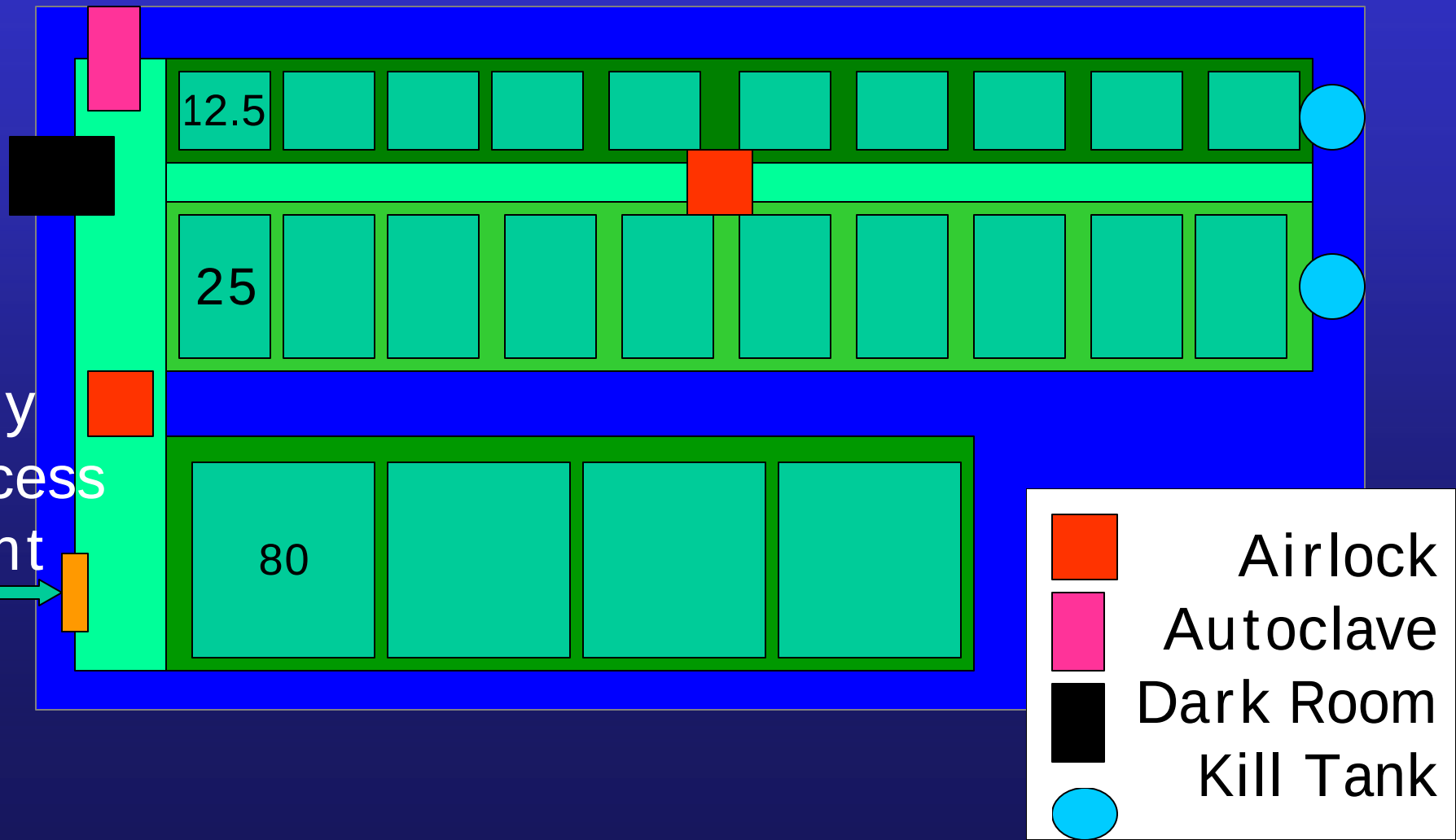
Working within the legislation: growth room area

- Access to key holders only
- All cabinets/rooms lockable
- All have experimental details (inc. contacts, licence number)
- Waste disposal procedures
- P&D programme

Working within the legislation: *growth rooms*

Range of species grown include *Arabidopsis*, Potato, *Ribes* and barley

Glasshouse Area



Working within the legislation: *glasshouse area*

- All drains sealed/sealable
- Appropriate filters on fan units
- All compartments fully sealed
- All compartments lockable
- Autoclaves in each designated area
- Protective clothing/hygiene
- SOPs

Working within the legislation: *glasshouse area*

low containment area

Autoclave in medium containment area

Working within the legislation: *glasshouse area*

Air lock between high and medium areas

Sealed containers for transport
"colour-coded" trolleys

Working within the legislation: *glasshouse area - features*

Changes since initial design

- Designated Glasshouse Staff
- Enhanced S.O. Procedures
- Wider range of projects
- Dark room facility added

Working within the legislation: Future prospects……..

- ISO9000
- Increase in viral vector work
- Increased range of species
- Special *Arabidopsis* provision
- High throughput systems
- *In situ* analytical systems

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