CIRC • CROP IMPROVEMENT RESEARCH CLUB

# New varieties by redesign or rapid steps

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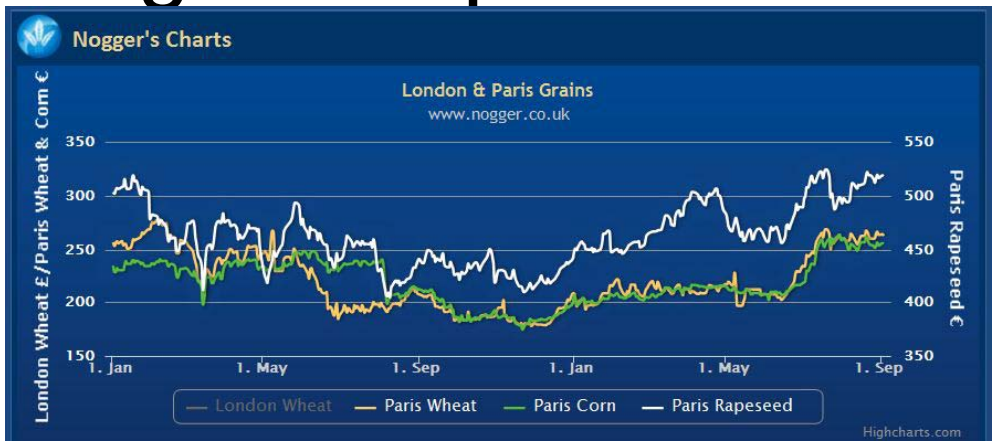
BBSRC & Biosciences KTN

BBSRC bioscience for the future

Knowledge Transfer Network Biosciences

# Outline

- Genetics is key to delivery of intensification
- Collaborative projects within the Crop Improvement Research Club provide exemplars of basic science application with industry
- Public funding underpins this research

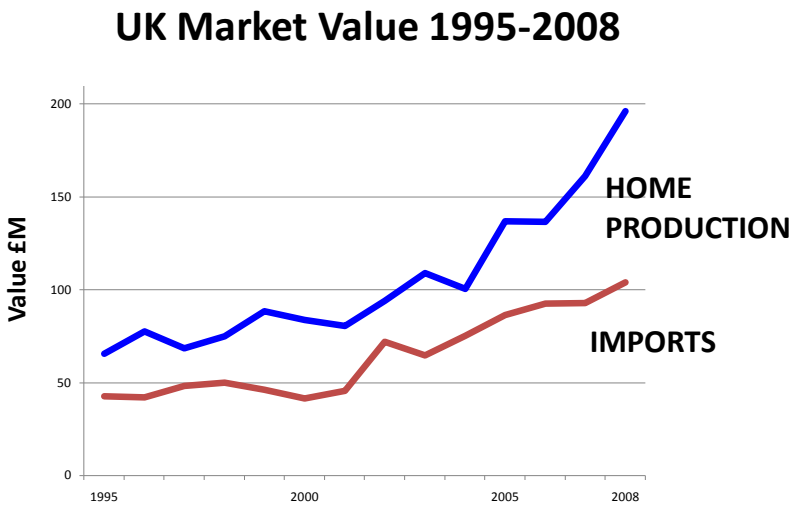


# Genetic Improvement is key

- Delivery of intensification will mostly come from genetics
  - Resource efficiency of crops
    - Carbon, energy, water, nutrients,
  - Adapting to new cropping systems
- Delivery by speeding up breeding and use of  biotechnology
- Systems approach has to integrate with chemistry, engineering, ecology....

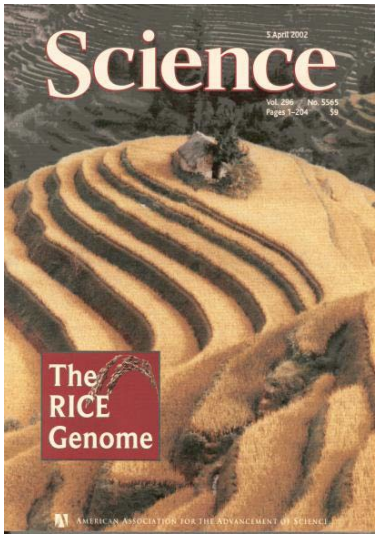
# Strawberry Intensification

- Buoyant market demand
  - Season extension
  - Keeping ahead of imports
- Technical innovation
  - 3x yields, similar area
    - Multi-span polytunnels
    - Production & scheduling
    - Crop Protection
    - Growing Systems
    - Genetics, somewhat



# Advances in basic science: Ready for application: 1

- Genomes galore
  - Plants, crops, microbes, pathogens, pests, beneficials…..
    - New low cost sequencing technologies
    - Potentially limitless supply of markers
  - Insights into domestication and re-domestication
- Understand the available genetic resources
  - Marker-driven breeding and selection
  - Access wild and exotic genetic materials



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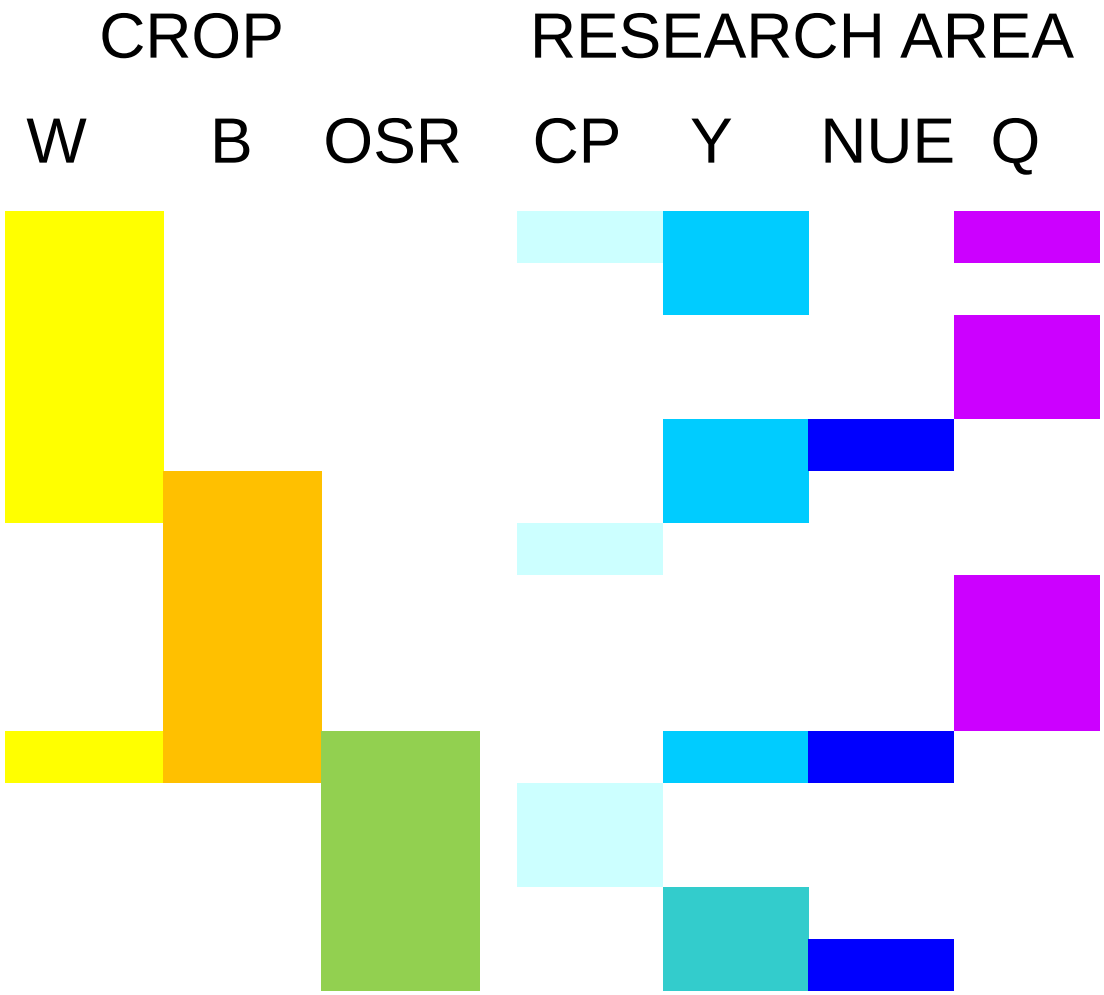
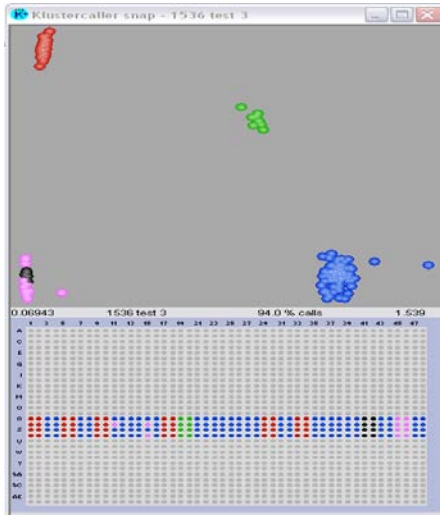
- BBSRC Industry Club
  - Members co-funding (10%)
  - 14 industry partners
- Joint selection of science projects after peer review of invited outlines
- 15 projects relating to wheat, barley and oilseed rape
  - Strong focus on traits with relevance
  - Underpinned by genetics and molecular markers

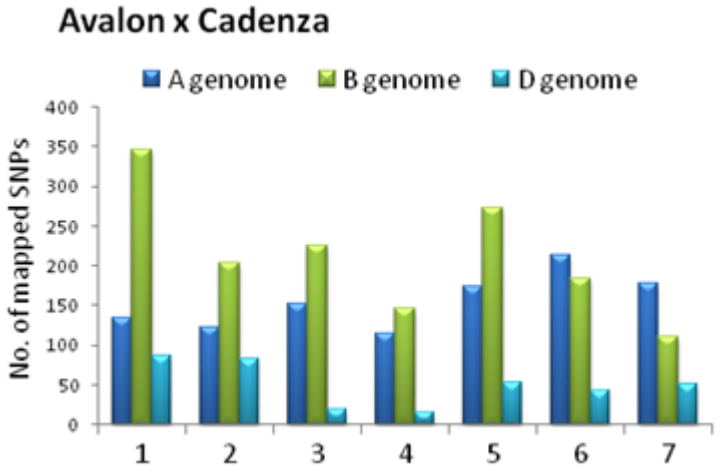
# Spread of Projects



# From wheat sequence to SNP's

- Over 90,000 SNPs between 8 cultivars by exome sequencing
  - Co-dominant SNPs in abundance for A& B genomes
  - 169 varieties genotyped; mapping populations
  - KASPar markers available ,validated, used





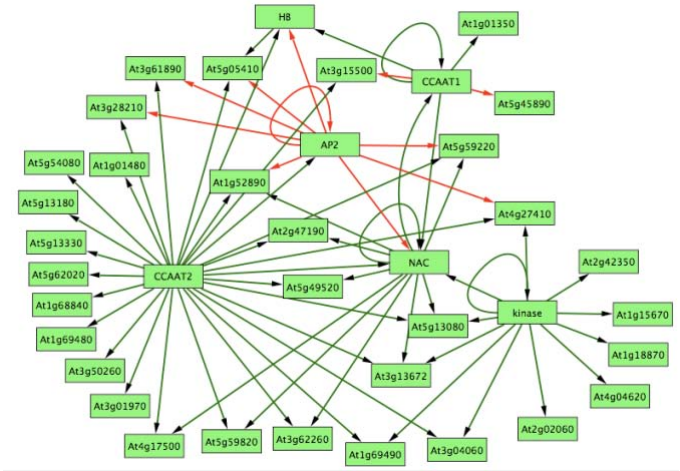

*Allen et al Plant Biotechnology Journal (2012) in press; www.cerealsdb.uk.net/*

# Crop Club Project

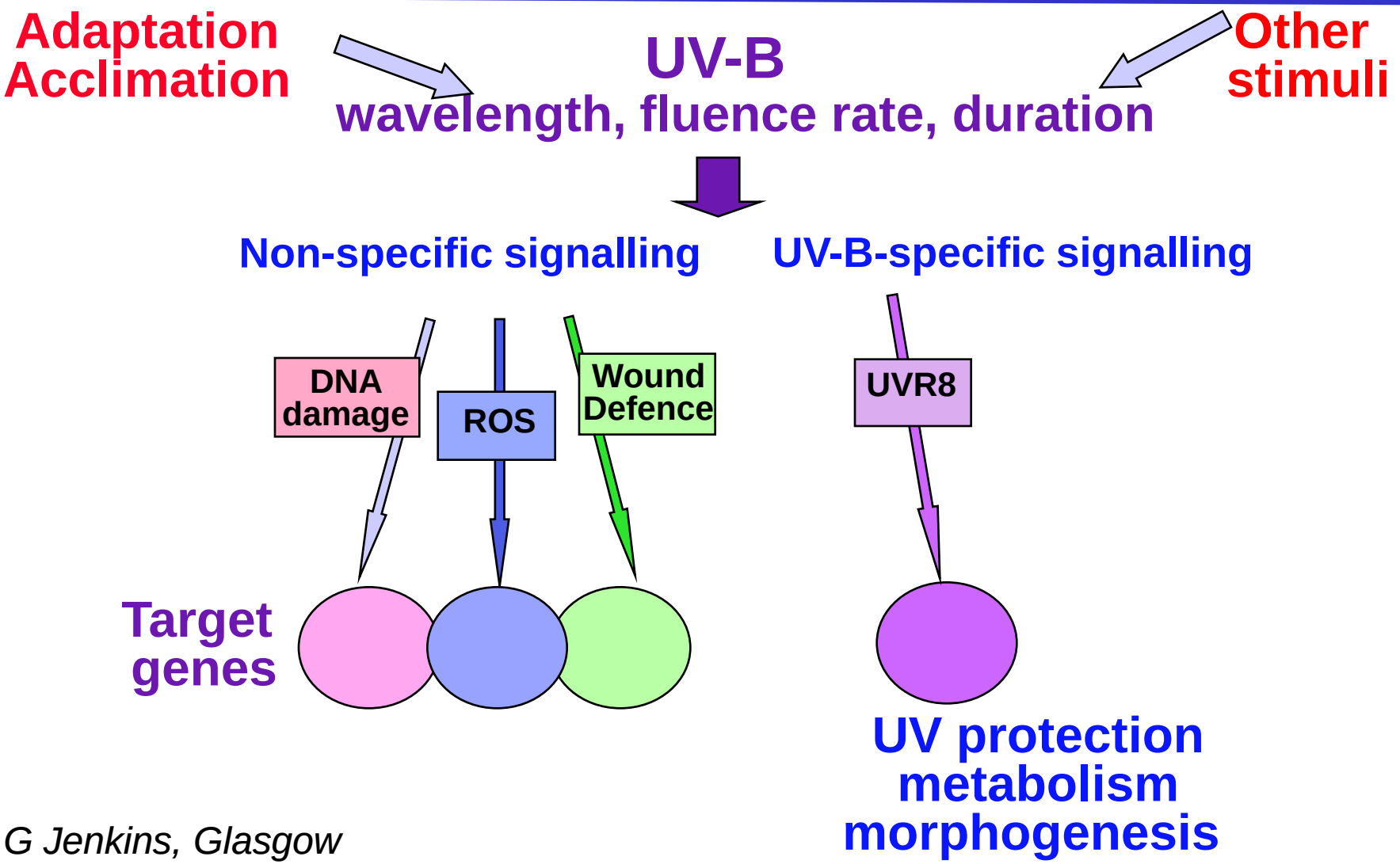
- Development and validation of wheat SNPs
  - Build on basic genome sequence work;2x SNPs
  - Robust validation on 46 elite varieties
  - Available for different SNP commercial platforms and levels of in house investment
    - KASPar from KBiosciences (now LGC Genomics)
- Partners: Bristol University, John Innes Centre, KBiosciences

# Advances in basic science: Ready for application: 2

- Systems Biology of Plants
  - Dissection of integrated processes
    - Development, disease, stress, yield
  - Predictive modelling of biological processes



# UV-B acts through multiple signalling pathways




*G Jenkins, Glasgow*

# CIRC Project

- Transfer knowledge of the regulatory networks around UVR8 from Arabidopsis to OSR
- Manipulate network to increase pest resistance in OSR
- Project Partners: Glasgow University, John Innes Centre

# Step changes from biotechnology

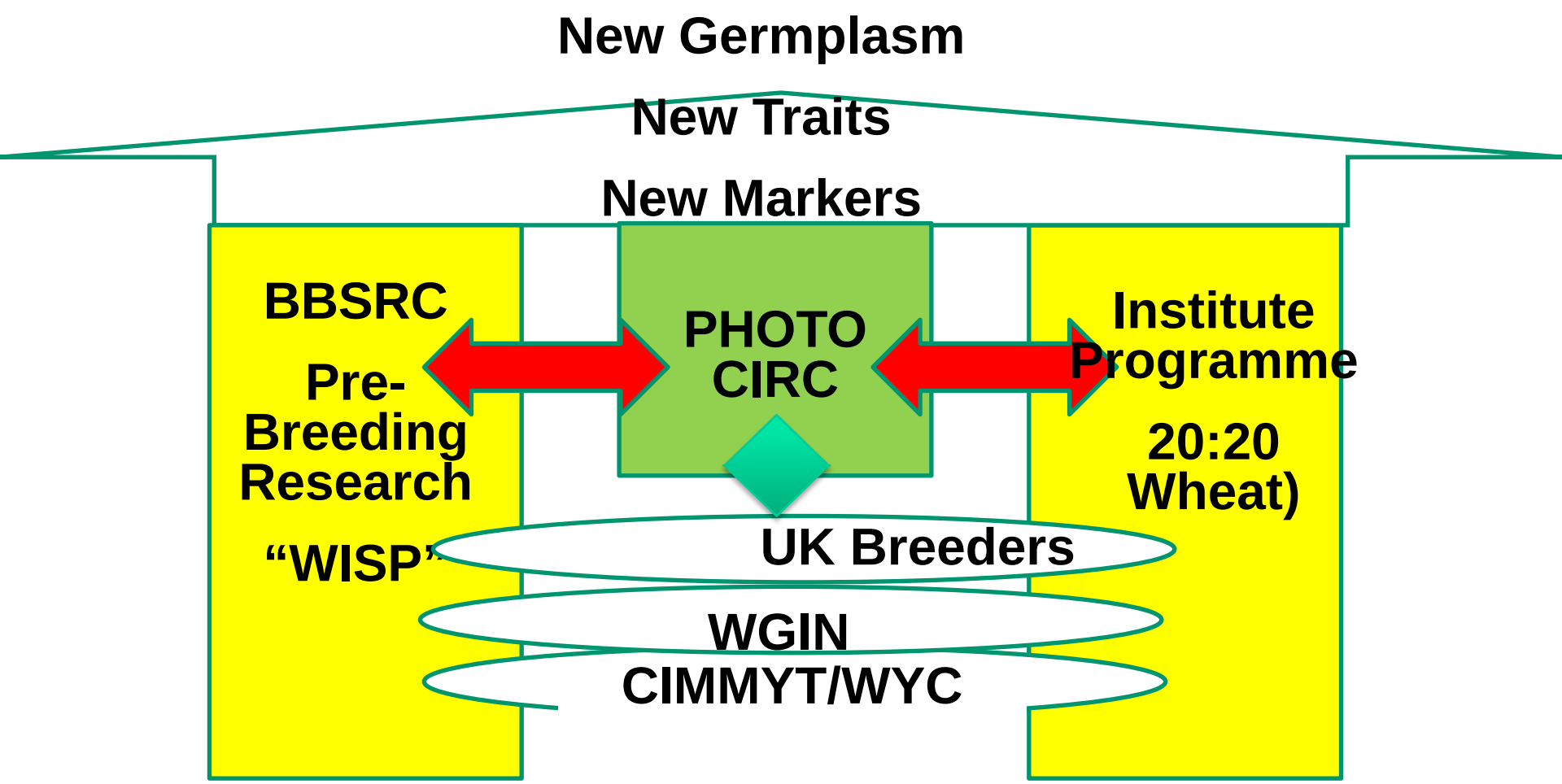
- All or nothing capability from genetic modification
  - Insect
  - Virus
  - Herbicide
  - Pathways

- Rapid “introgression” from wild species
  - S bulbocastanum into potato
  - Vegetative crops

# Stepwise re-design of crops

- Multi-gene manipulations in commercial use in US
  - Yield and water stress products in development
- Enough knowledge to attack major design challenges for the long term
  - Major global challenges with co-ordinated international efforts
    - Increase from carbon assimilation
    - Re-engineer symbiotic relationship leading to nitrogen fixation

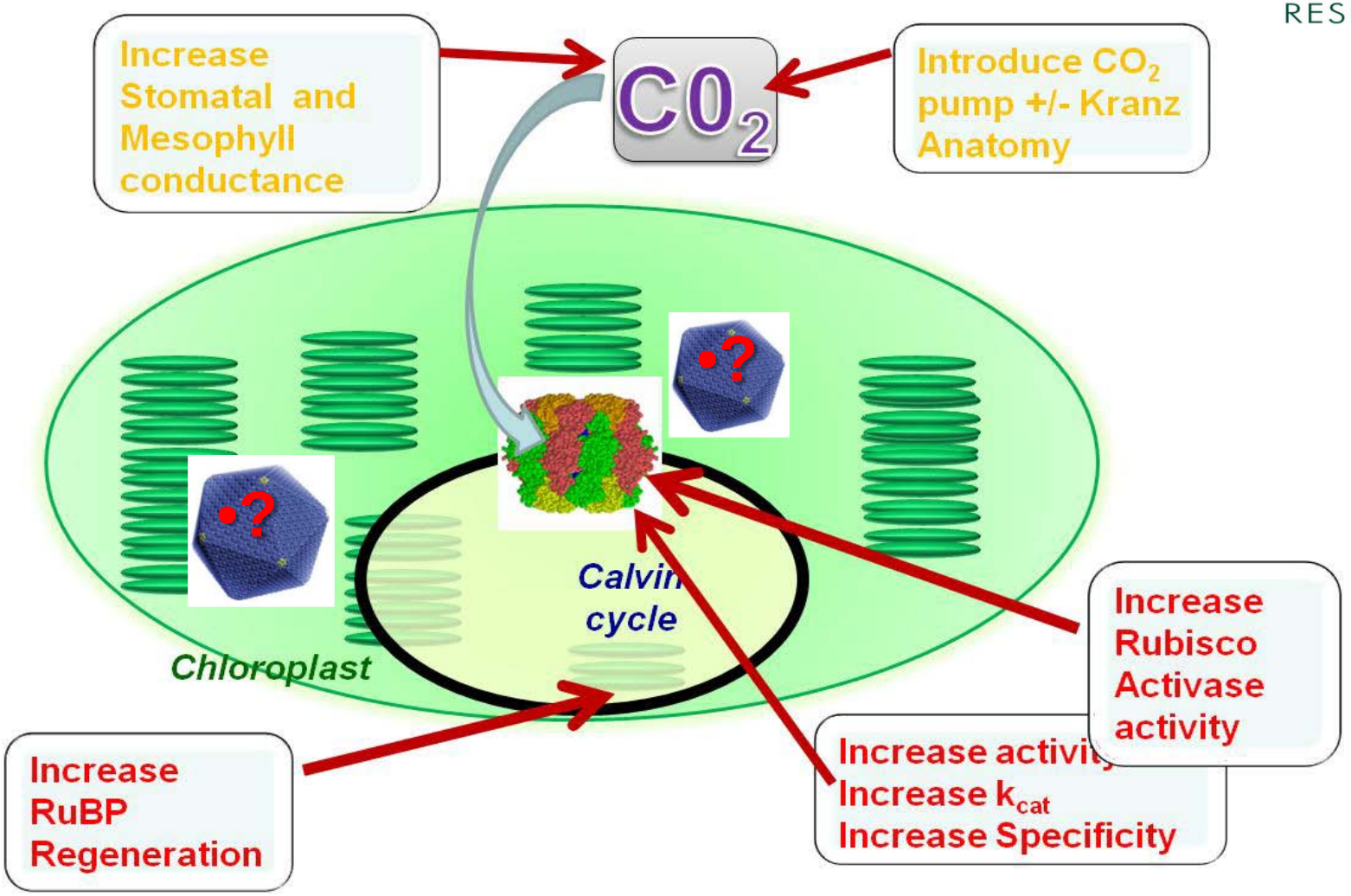
# Re-tuning the Calvin Cycle



University of Essex

# Crop improvement targets

ROTHAMSTED RESEARCH




*Project Partners Rothamsted Research , Essex University*

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# Increasing SBPase


Tobacco plants overexpressing SBPase

*C Raines, Essex University*

# Nitrogen-fixing cereals: A really grand challenge

- From impossible to extremely difficult!
  - Long term integration of metabolic partnership of plants and microbes
    - Signalling systems
    - Metabolic cooperation
  - Bill & Melinda Gates Foundation investing $9.8M over 5yr, focus on maize in Africa
    - Basic science offers a pathway to tackle the problem

# Conclusions

- Intensification will  rely on genetics as part of a whole systems approach to cropping
  - Carbon, energy, water, nutrients
- Delivery by speeding up breeding and use of biotechnology
  - Biotechnology is delivering multiple trait effects
  - Some step changes are applicable now, others can be forseen
- Public sector and private industry can work to apply the best basic science now. Examples such as the Crop Club can help rapid delivery