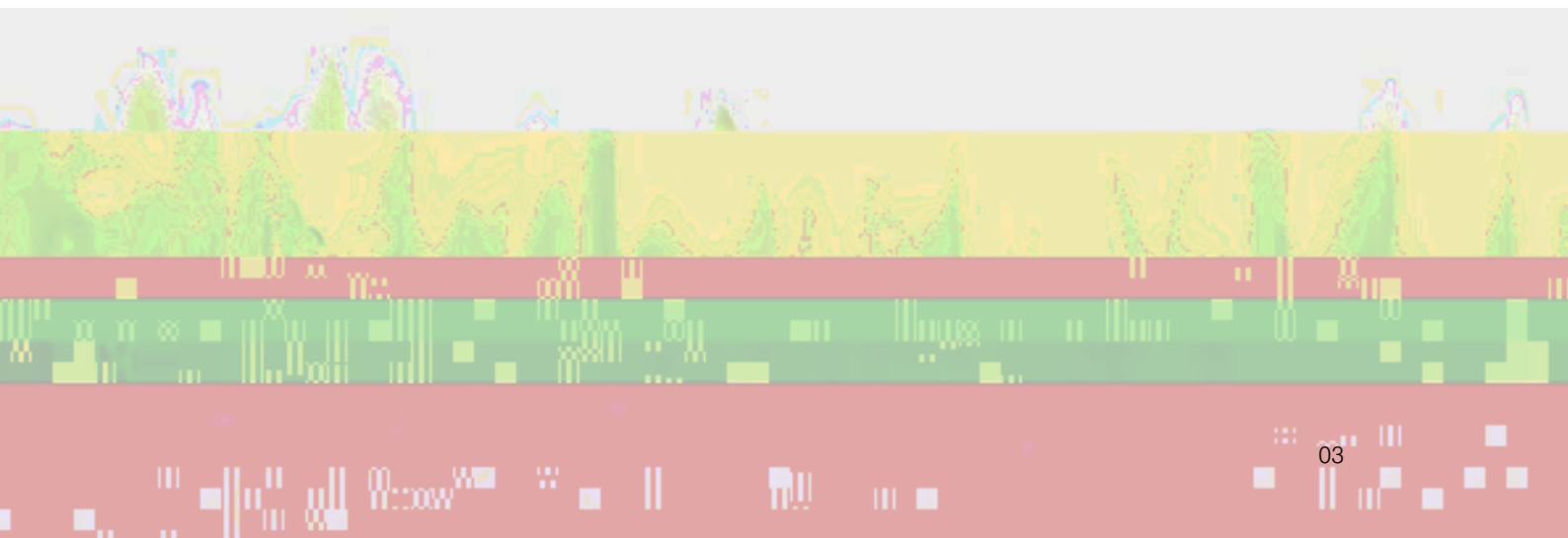
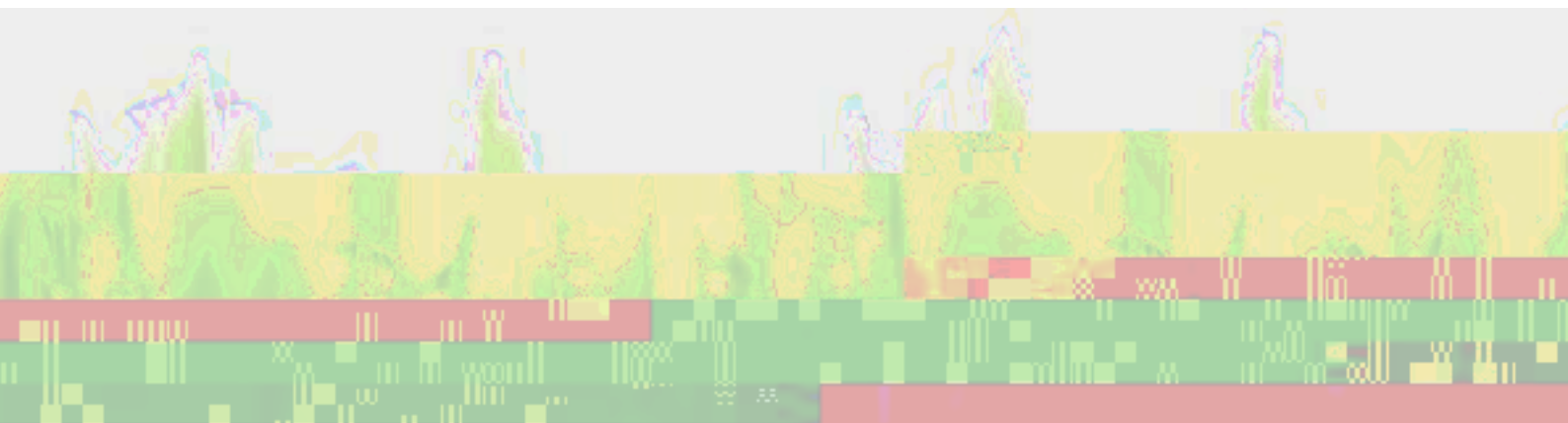
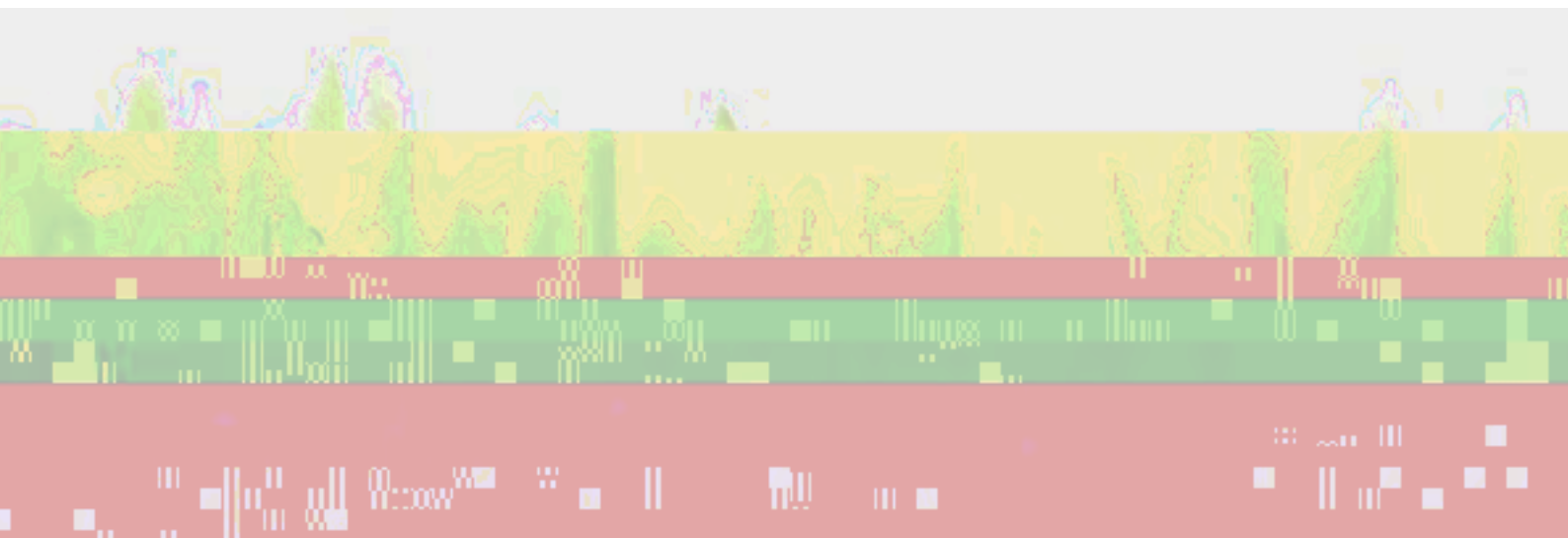


# Contents

Foreword	05
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**2 Apply modern genetic and breeding approaches to improve the quality, sustainability, resilience and yield-led profitability of crops and farm animals.**

- D... ..
- ... ..
- G... ..

**3 Use systems-based approaches to better understand and manage interactions between soil, water and crop/ animal processes.**

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**6 Develop evidence-based approaches to valuing ecosystem service delivery by land users, and incorporate these approaches into effective decision-support systems at the enterprise or grouped enterprise level.**

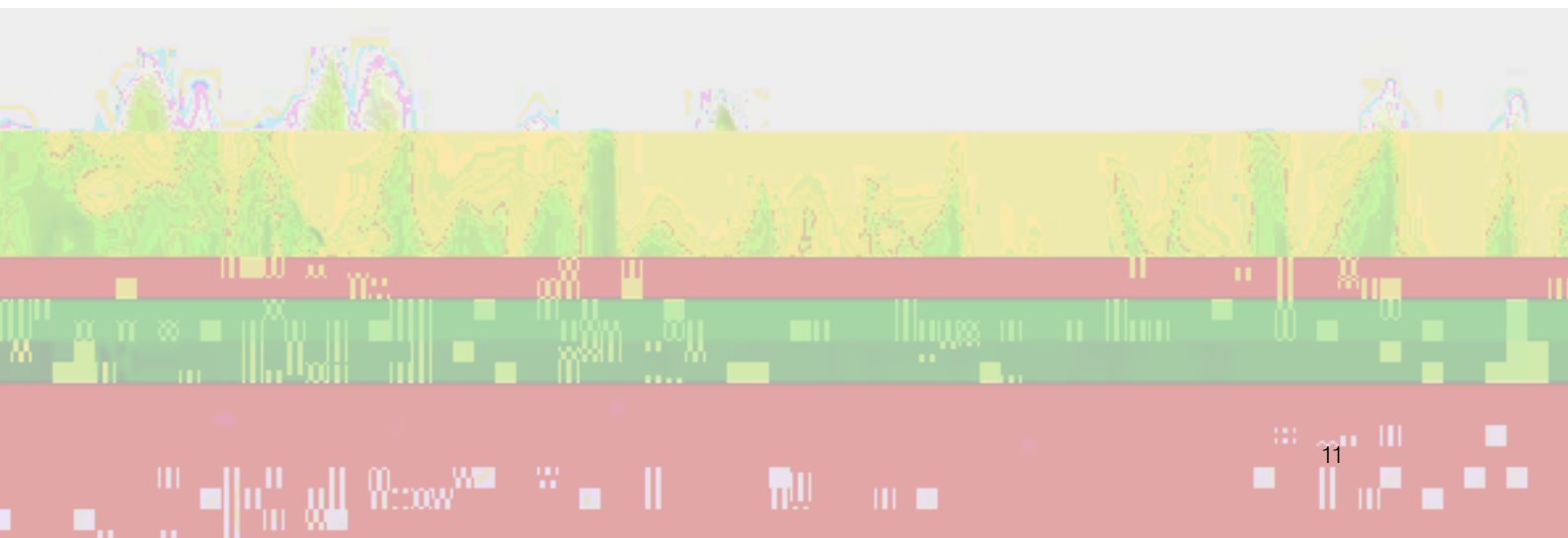
- Develop approaches to valuing ecosystem services that are based on evidence from land users, and incorporate these approaches into effective decision-support systems at the enterprise or grouped enterprise level.
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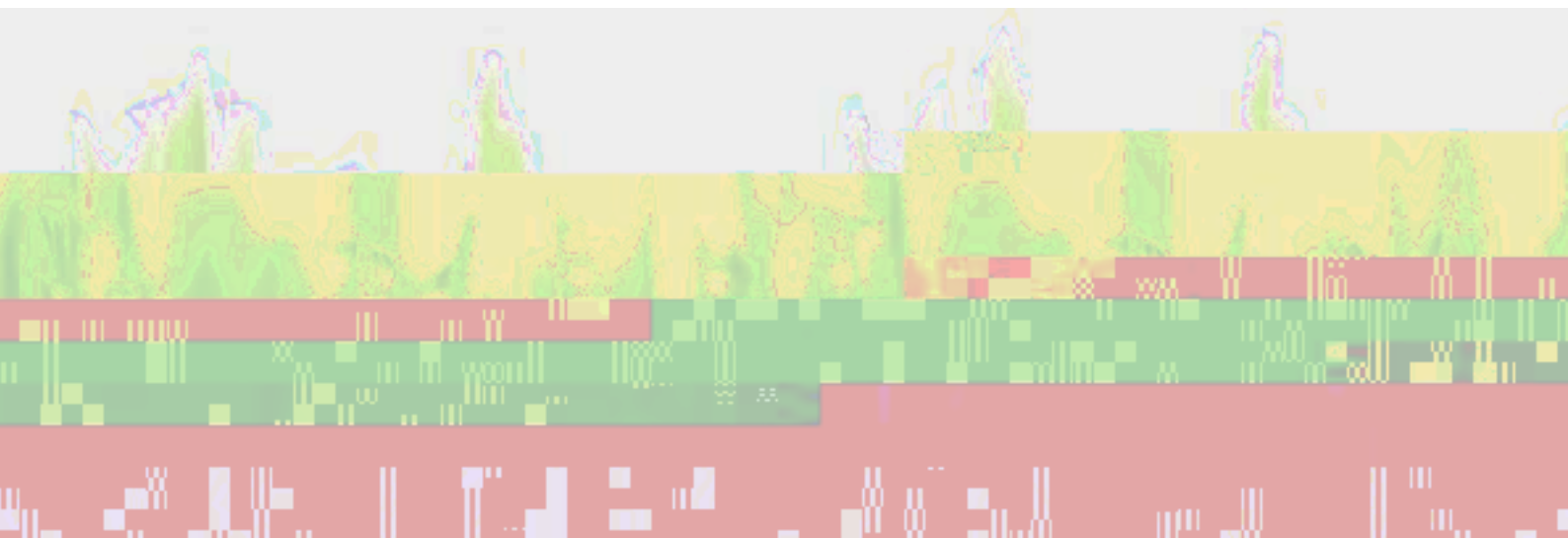


- Develop approaches to valuing ecosystem services that are based on evidence from land users, and incorporate these approaches into effective decision-support systems at the enterprise or grouped enterprise level.

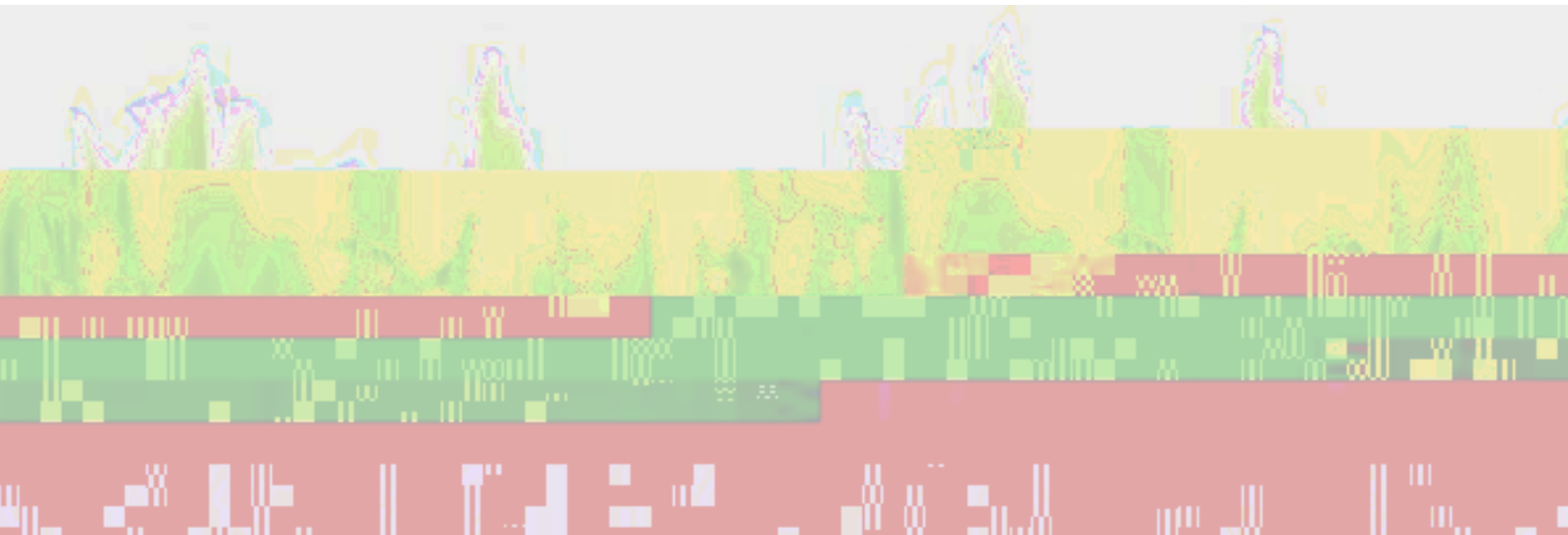
**7 Extend the training, professional development and communication channels of researchers, practitioners and advisors to promote delivery of the targets above.**

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# 1. Introduction

Europe's population is projected to increase by 10% by 2030, and the global population is projected to increase by 25% by 2030. This increase in population will lead to an increase in demand for food, and this demand will need to be met by a food system that is more sustainable and resilient than the current one.

The current food system is based on a model of intensive agriculture that has led to a number of environmental and social problems. These include the depletion of natural resources, the loss of biodiversity, and the degradation of soil and water quality. In addition, the current food system is also based on a model of production that is highly dependent on fossil fuels and synthetic fertilisers, which are both expensive and polluting.

In order to meet the demands of a growing population in a sustainable and resilient way, the global food chain needs to be transformed. This transformation will require a number of changes, including a shift towards more sustainable and resilient production systems, a reduction in food waste, and a change in the way that food is distributed and consumed.

**Table 1. Factors likely to constrain the ability of the global food chain to meet demands by mid-century (Royal Society, 2009)**

1	Land use change, particularly the conversion of agricultural land to urban and industrial uses, and the loss of agricultural land to other uses.
2	Water scarcity, particularly in arid and semi-arid regions, and the increasing demand for water for agriculture and other uses.
3	Climate change, particularly the increasing frequency and intensity of extreme weather events, and the resulting damage to agricultural infrastructure and crops.
4	Soil degradation, particularly the loss of soil fertility and the increasing incidence of soil erosion and desertification.
5	Loss of genetic diversity, particularly the loss of traditional crop varieties and the increasing reliance on a few high-yielding varieties.
6	Increasing demand for food, particularly in developing countries, and the resulting pressure on agricultural resources.
7	Increasing demand for food, particularly in developed countries, and the resulting pressure on agricultural resources.
8	Increasing demand for food, particularly in developed countries, and the resulting pressure on agricultural resources.

The Royal Society (2009) identified these factors as the most likely to constrain the ability of the global food chain to meet demands by mid-century. These factors are likely to have a significant impact on the ability of the global food chain to meet the demands of a growing population in a sustainable and resilient way.

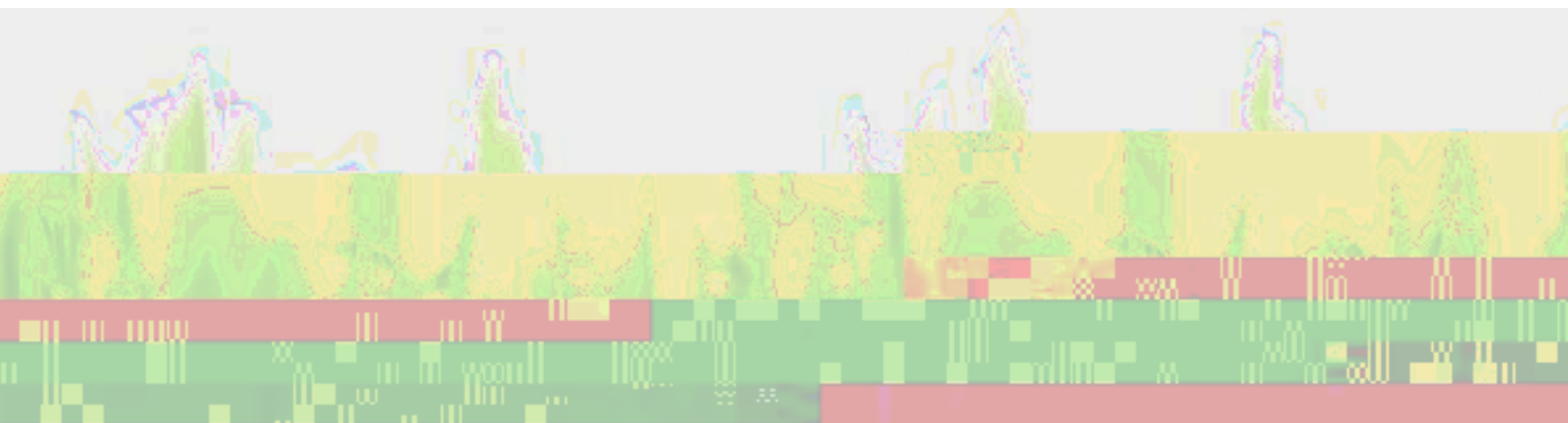
It is therefore essential that we take action to address these factors and to transform the global food chain in a way that is sustainable and resilient. This transformation will require a number of changes, including a shift towards more sustainable and resilient production systems, a reduction in food waste, and a change in the way that food is distributed and consumed.

The following sections of this report will discuss the impact of these factors on the global food chain and will propose a number of strategies to address these factors and to transform the global food chain in a way that is sustainable and resilient.

2 IAA D (2008). Agricultural and food systems in a changing world. A report for the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAA) D/E / Agricultural %20%20C%20and%20Food%20Systems%20%20D%20and%20%20(E%20).  
 3 B... J (2011). ...  
 4 ... (2009). ...







- $\text{Res}_k(\text{Gal}(\bar{K}/K))$  is a normal subgroup of  $\text{Gal}(\bar{K}/K)$
- $\text{Res}_k$  is a surjective homomorphism from  $\text{Gal}(\bar{K}/K)$  to  $\text{Gal}(\bar{k}/k)$
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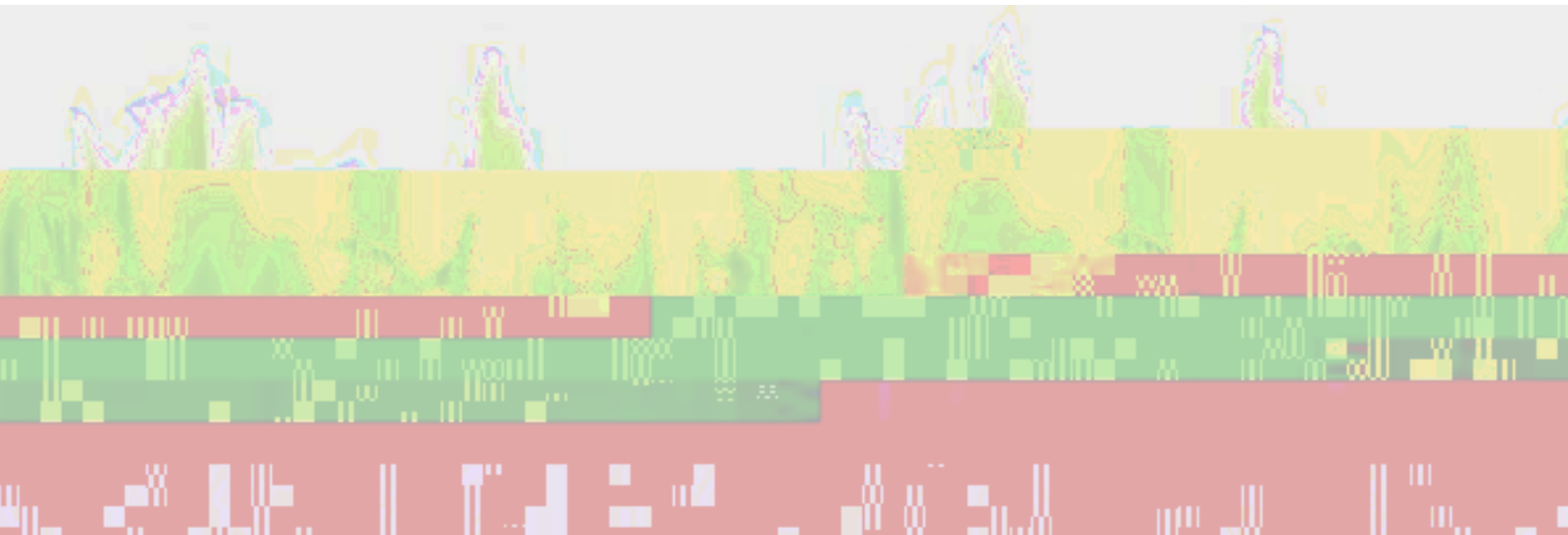
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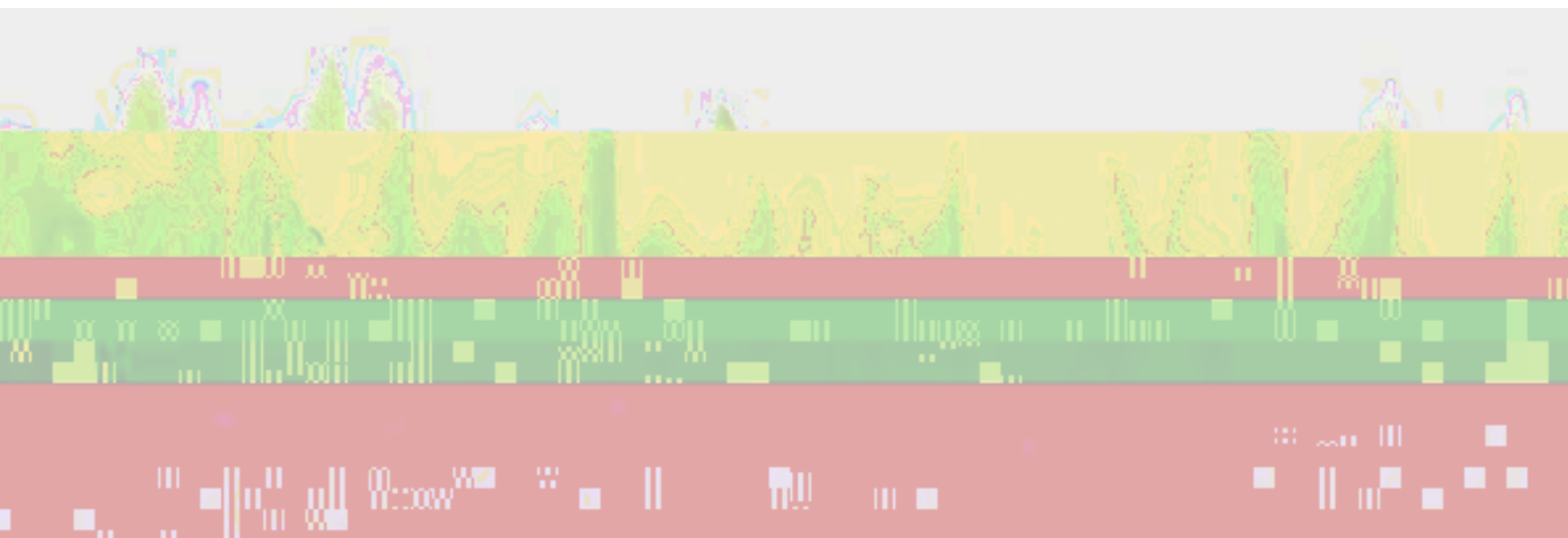
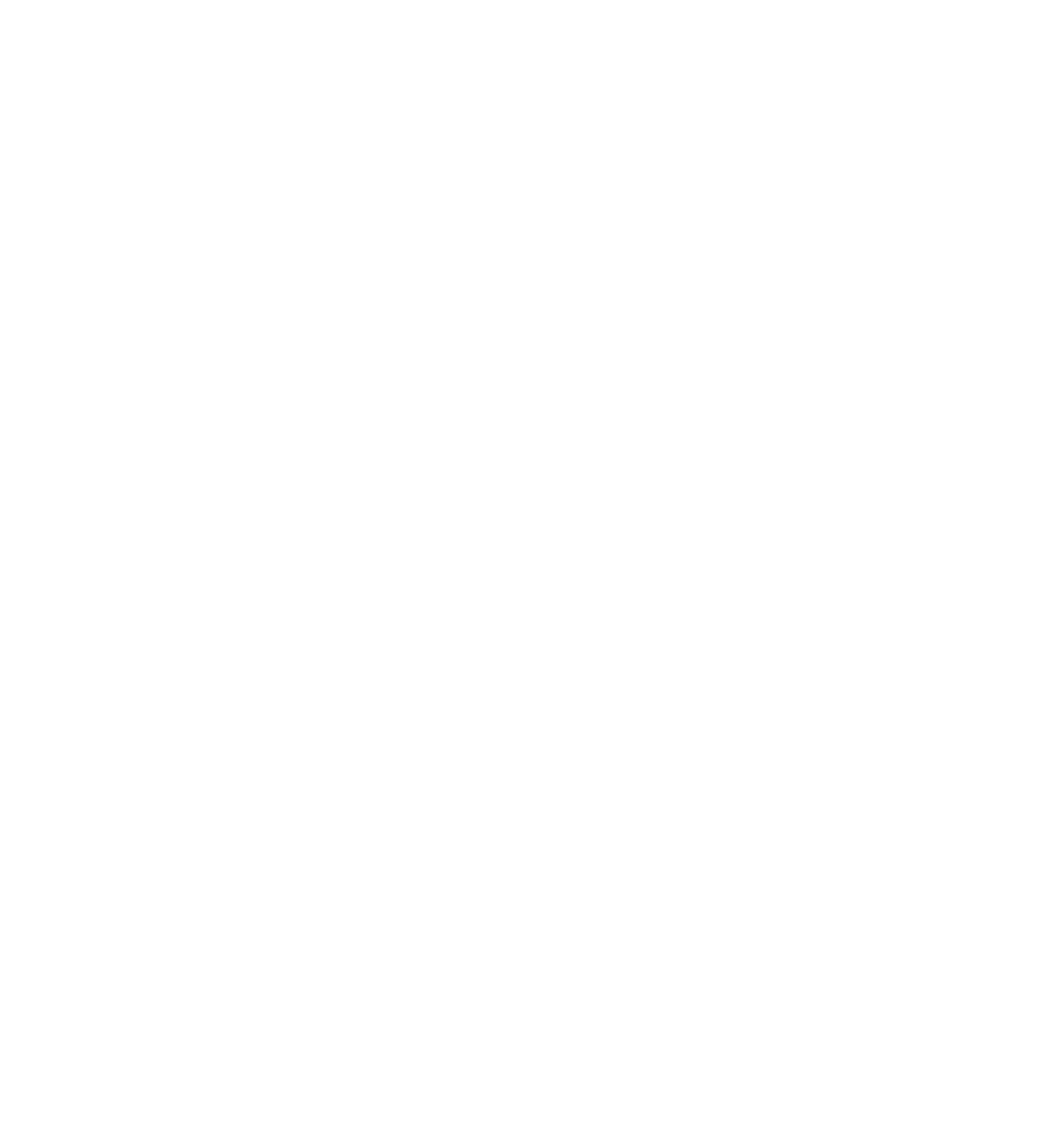
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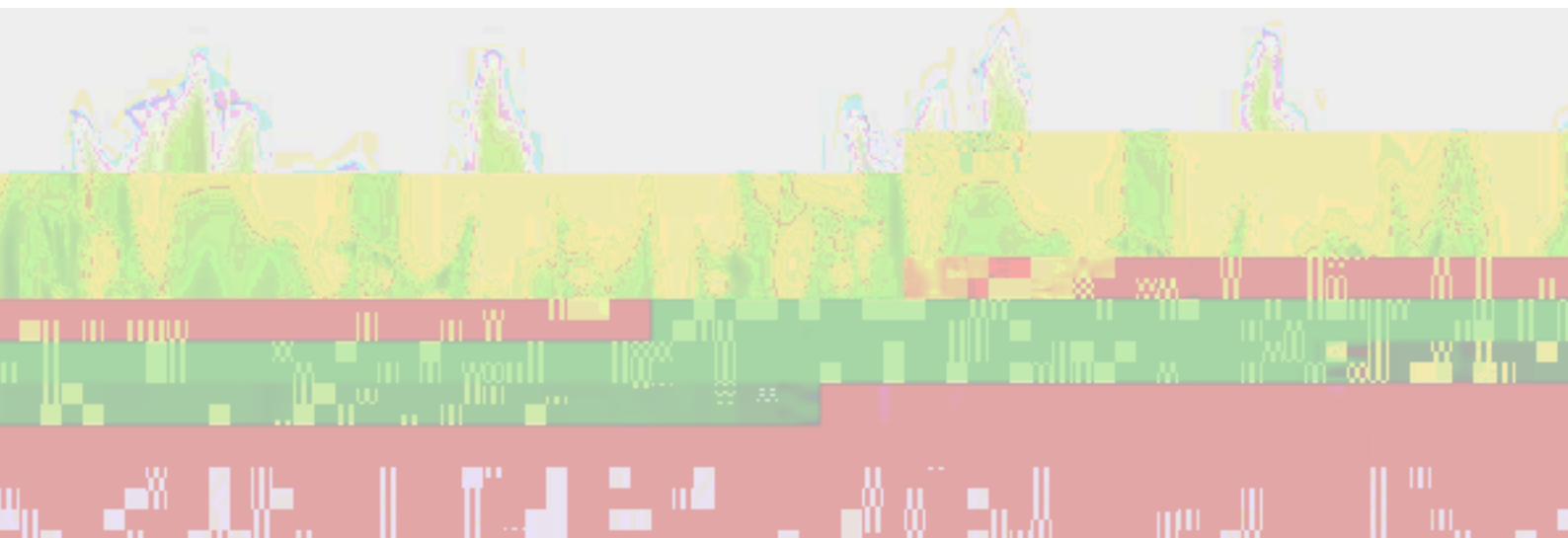
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 Felül 1. a... A... X2. a... R&D...  
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- A... X2... R&D...  
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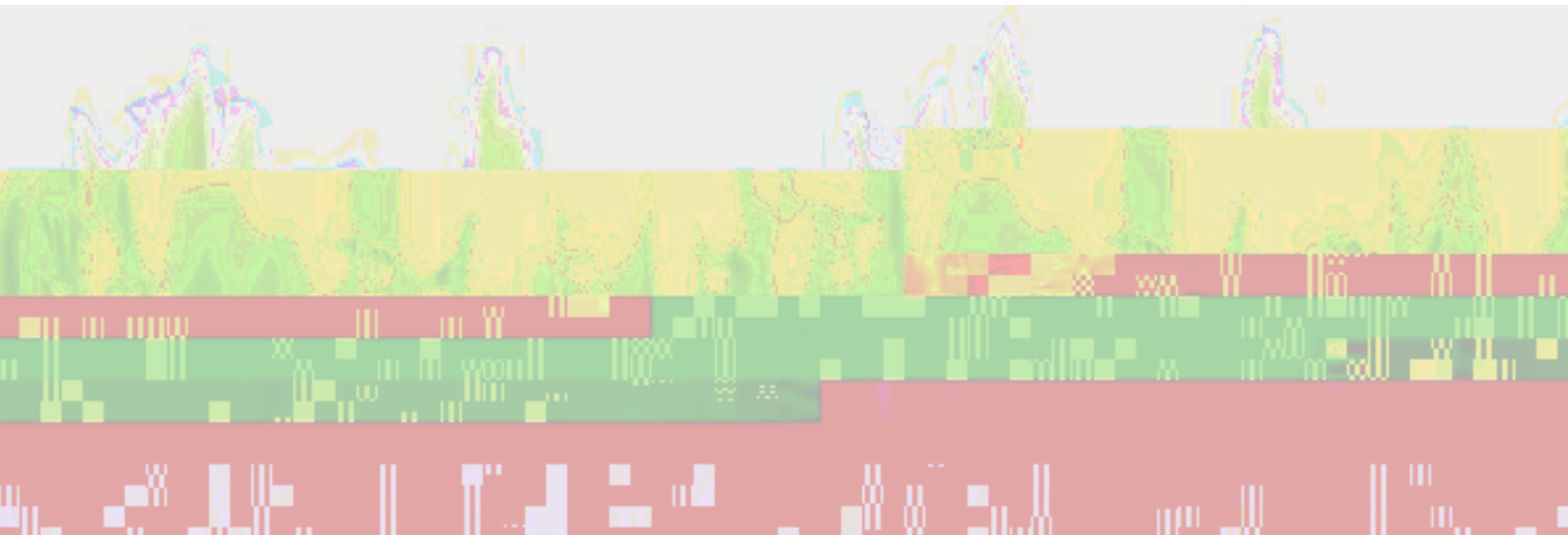


## 2 Apply modern genetic and breeding approaches to improve the quality, sustainability, resilience and yield-led profitability of crops and farm animals.

- Develop and apply modern genetic and breeding approaches to improve the quality, sustainability, resilience and yield-led profitability of crops and farm animals.
- Develop and apply modern genetic and breeding approaches to improve the quality, sustainability, resilience and yield-led profitability of crops and farm animals.

No-spray crops.



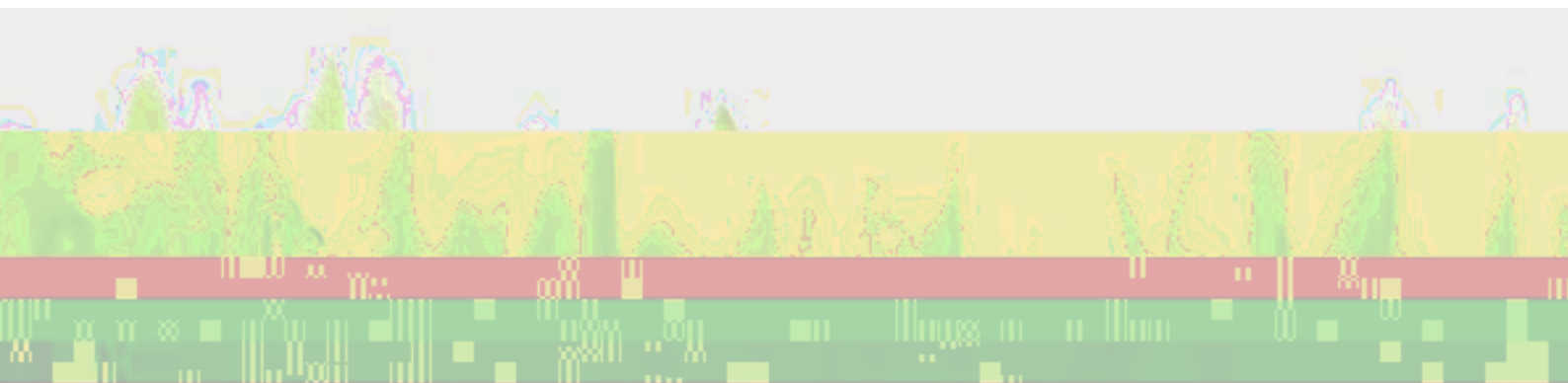


- D Իրականացնել և թերահավասարել արտադրողներին և արտադրանքի համարժեքներին ֆերմայի օժանդակում:

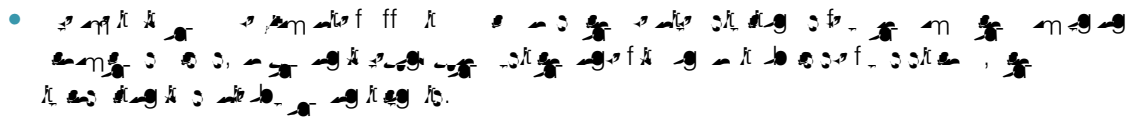
**Protein supply**, իրականացնել և թերահավասարել արտադրողներին և արտադրանքի համարժեքներին ֆերմայի օժանդակում:

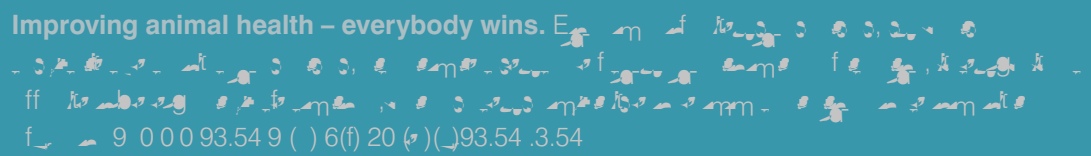
Միջինում արտադրողները օգտագործում են 25% ցածր պրոթեինով հարուստ կերակրամթերքներ, որոնք համարվում են արտադրողների և արտադրանքի համարժեքների օժանդակում:

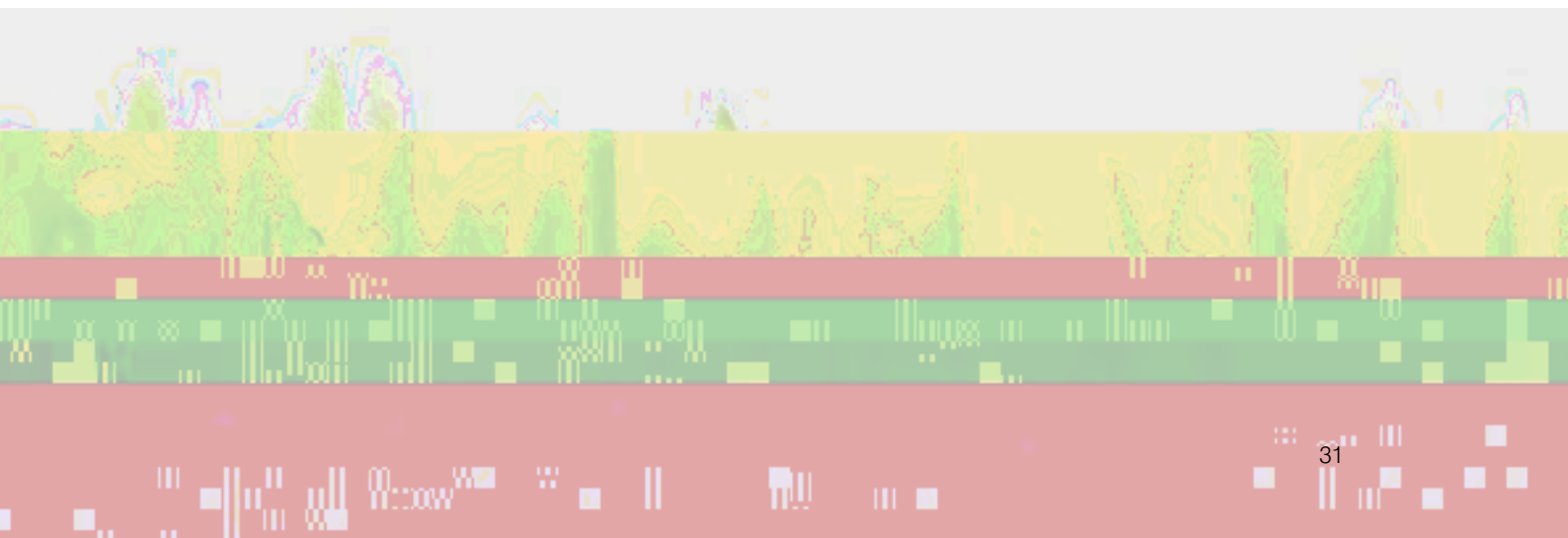
Սակայն, արտադրողները կարող են օգտագործել ավելի բարձր պրոթեինով հարուստ կերակրամթերքներ, որոնք համարվում են արտադրողների և արտադրանքի համարժեքների օժանդակում:



## 5 Develop integrated approaches to the management of animal disease within farming systems.

-  **Developing integrated approaches to the management of animal disease within farming systems.**

**Improving animal health – everybody wins.**  **Developing integrated approaches to the management of animal disease within farming systems.**





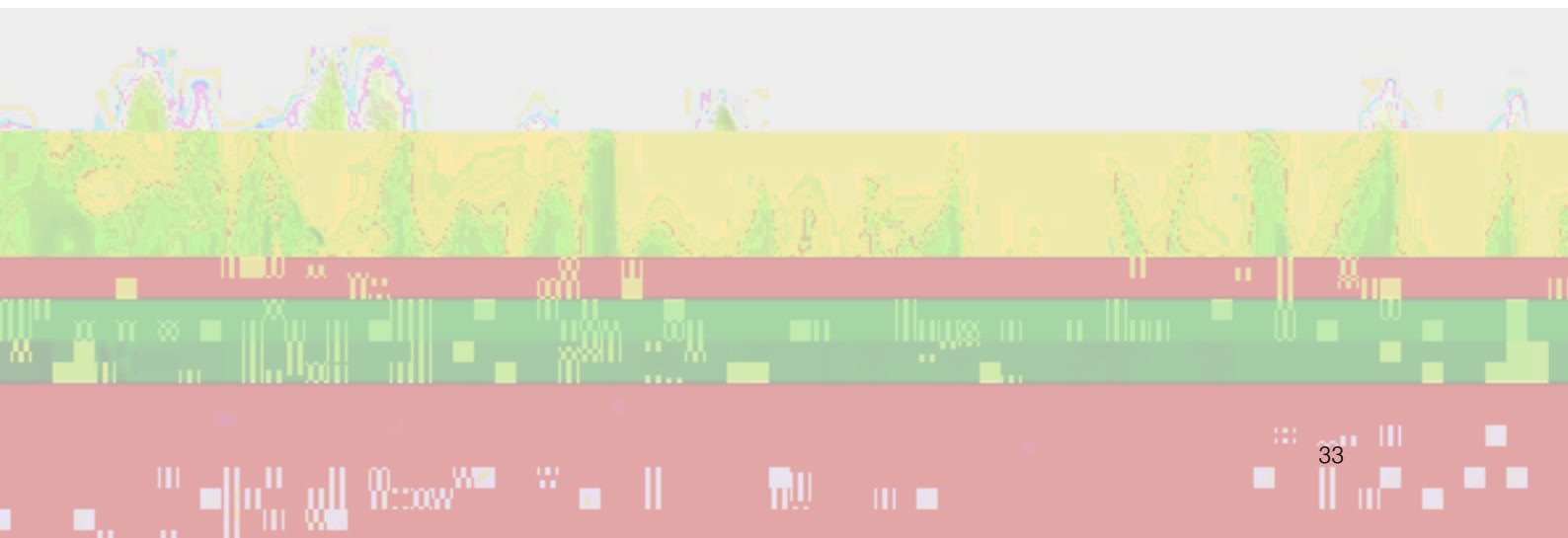


**7 Extend the training, professional development and communication channels of researchers, practitioners and advisors, to promote delivery of the targets above.**

**Up-skilling the industry.**

- The industry is a key partner in the delivery of the research and innovation agenda. It is essential to ensure that the industry is equipped with the skills and knowledge to deliver the research and innovation agenda.
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**8 Improve the use of social and economic science to promote the development, uptake and use of sustainable, resilient and profitable agricultural practice that can deliver affordable, safe and high-quality products.**

- Develop a self-sufficient, resilient and profitable agricultural practice that can deliver affordable, safe and high-quality products.
-

## ↓ R အကျဉ်းချုပ်

အောက်ဖော်ပြပါ အချက်များသည် အလုပ်အကိုင် ရှေ့တွင် အားသာချက် ရှိပြီး စီးပွားရေး ဖွံ့ဖြိုးရေး အတွက် အထောက်အကူ ပြုနိုင်စေမည့် အချက်များ ဖြစ်ပါသည်။

၁. R အကျဉ်းချုပ် - အလုပ်အကိုင် အဖွဲ့အစည်းများသည် အားသာချက် ရှိပြီး စီးပွားရေး ဖွံ့ဖြိုးရေး အတွက် အထောက်အကူ ပြုနိုင်စေမည့် အချက်များ ဖြစ်ပါသည်။

၂. အားသာချက် ရှိပြီး စီးပွားရေး ဖွံ့ဖြိုးရေး အတွက် အထောက်အကူ ပြုနိုင်စေမည့် အချက်များ - အလုပ်အကိုင် အဖွဲ့အစည်းများသည် အားသာချက် ရှိပြီး စီးပွားရေး ဖွံ့ဖြိုးရေး အတွက် အထောက်အကူ ပြုနိုင်စေမည့် အချက်များ ဖြစ်ပါသည်။

၃. အလုပ်အကိုင် အဖွဲ့အစည်းများသည် အားသာချက် ရှိပြီး စီးပွားရေး ဖွံ့ဖြိုးရေး အတွက် အထောက်အကူ ပြုနိုင်စေမည့် အချက်များ - အလုပ်အကိုင် အဖွဲ့အစည်းများသည် အားသာချက် ရှိပြီး စီးပွားရေး ဖွံ့ဖြိုးရေး အတွက် အထောက်အကူ ပြုနိုင်စေမည့် အချက်များ ဖြစ်ပါသည်။

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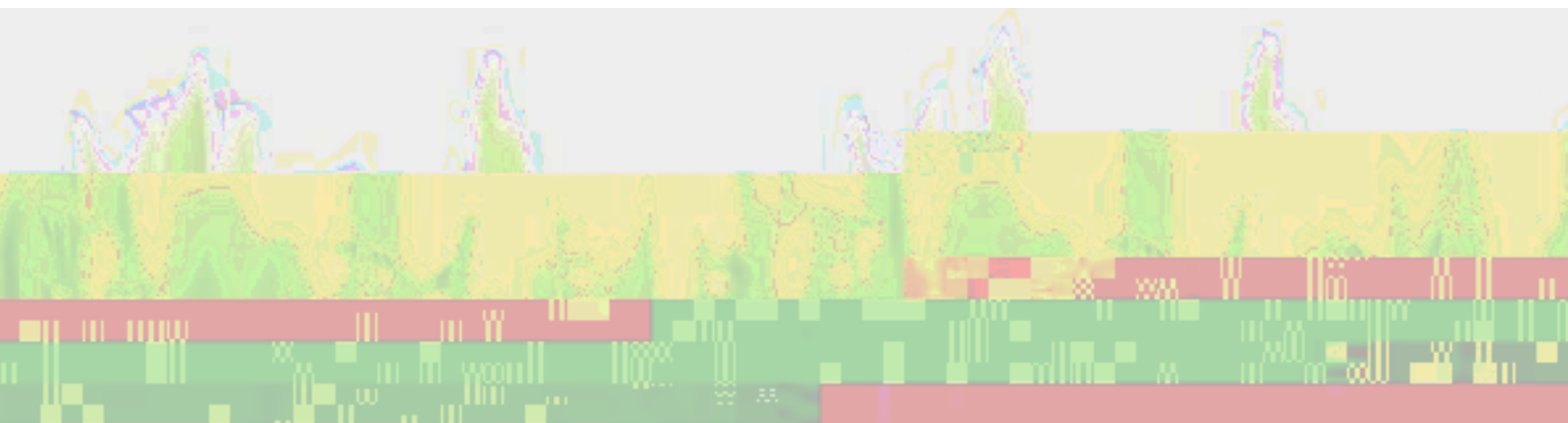
# 4. EXIT STRATEGIES: Affiliates

• **Exporting** - common method of exit for subsidiaries in emerging markets. First, it is the least costly method to exit, since it involves no physical assets to be sold. Second, it is the most flexible method, since it allows the parent company to adjust the level of exports in response to changes in the market.

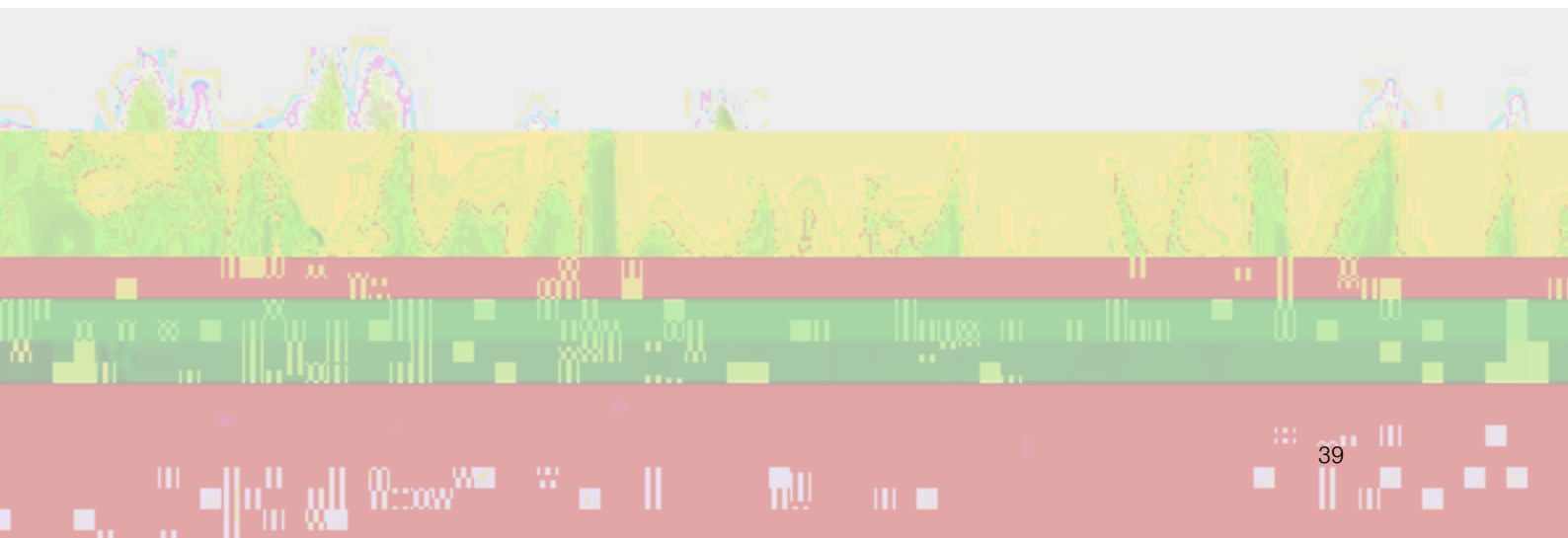
- **Royalties** - common method of exit.
- **Local distribution** - common method of exit for subsidiaries in emerging markets.
- **Local manufacturing** - common method of exit for subsidiaries in emerging markets.
- **Joint ventures** - common method of exit for subsidiaries in emerging markets.
- **Local manufacturing** - common method of exit for subsidiaries in emerging markets.
- **Local manufacturing** - common method of exit for subsidiaries in emerging markets.

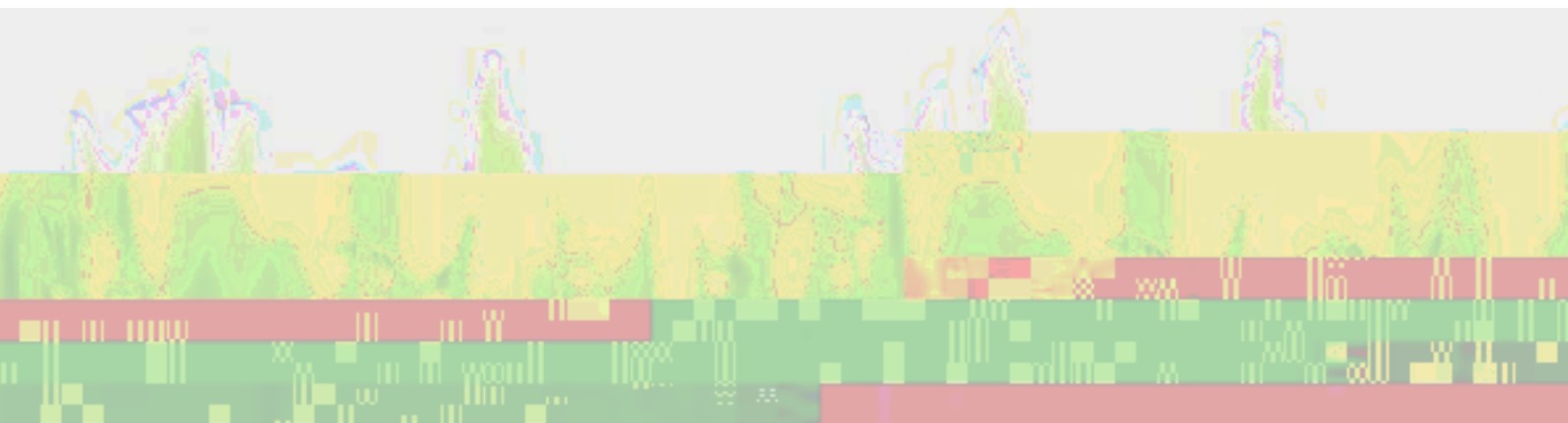
However, it is important to note that exit strategies are not always straightforward. For example, a company may have a subsidiary in a market that is highly competitive and has a high level of local manufacturing. In this case, the company may need to consider other exit strategies, such as selling the subsidiary or liquidating it.

- I am going to use the following - R&D, marketing, sales, production, distribution, service, support, etc.
- R - site: the research and development site.
- M - site: the manufacturing site.
- S - site: the sales and distribution site.
- P - site: the production site.
- D - site: the distribution site.
- A - site: the service and support site.



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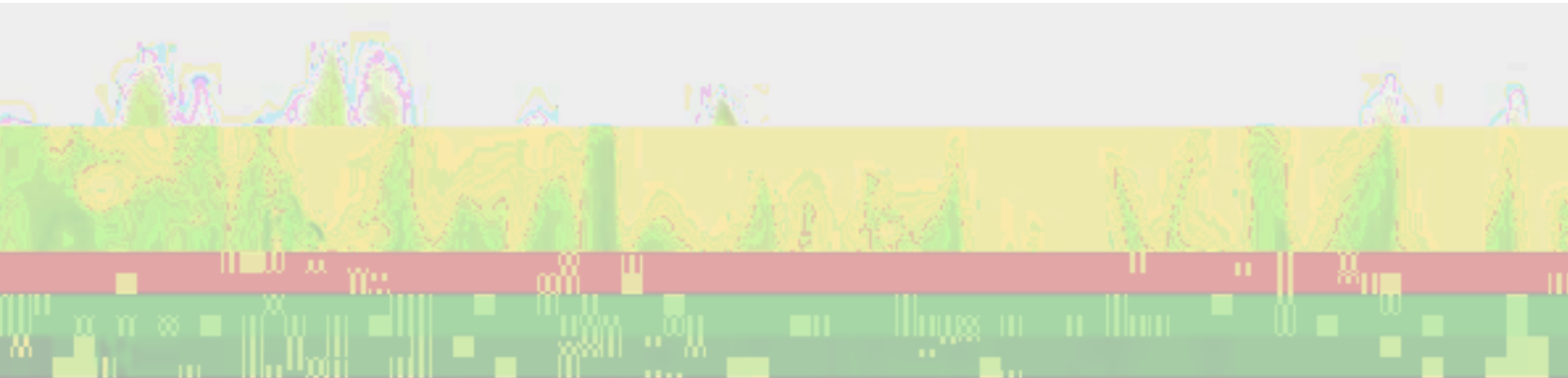




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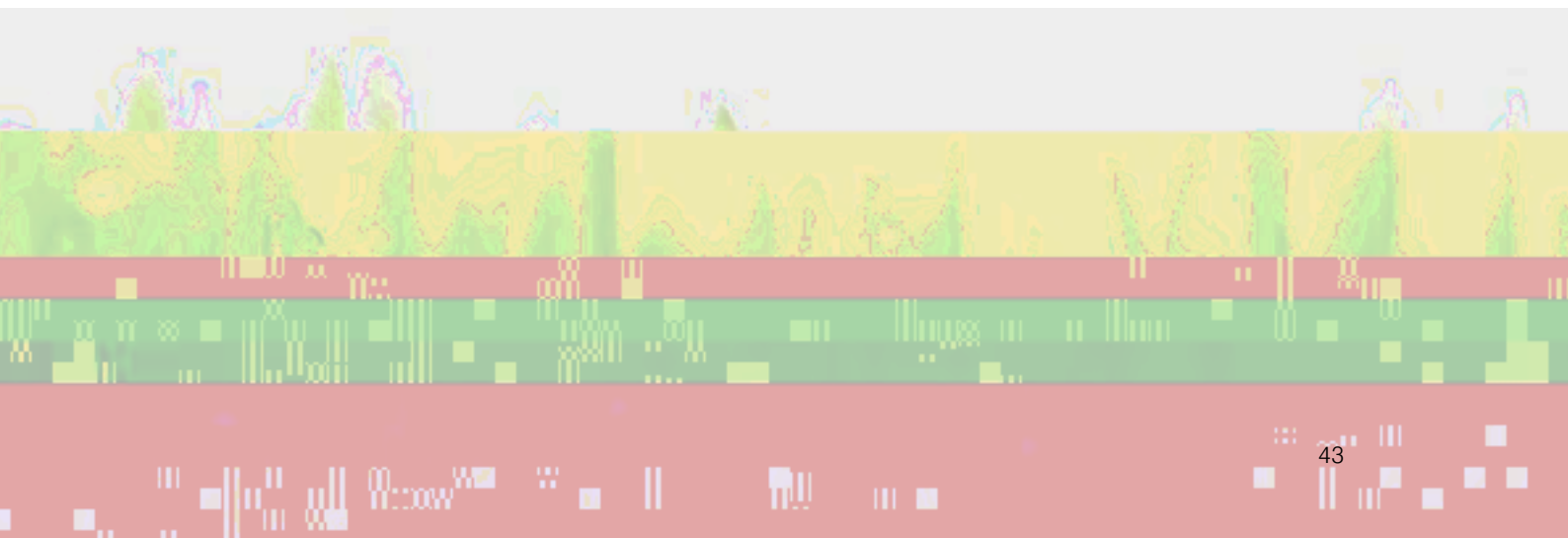
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Department, Government of Karnataka, Bangalore, 1999. It  
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of Karnataka, Bangalore, 2005. It is a Department of Horticulture  
Department, Government of Karnataka, Bangalore, 2005.



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X u t e f f e h e s e l e k t i f A g u l u B e i t e . ( I A B )  
R e s e r v i t i t e s e m e f e h e s e h e s e  
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\* B B C C e s e C e m m - F e m - G e r e h e f e F e m e

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## Campden BRI publications

'Scientific and technical needs of the food and drink industry – 2012-14'

[http://www.campdenbri.co.uk/~/media/Files/Publications/STN12-14.pdf](#)

## House of Lords

European Union Sub-Committee D 'Innovation in EU Agriculture' – 2011

(19th Report of Session 2010-12)

## HM Government

The Natural Choice – securing the value of nature. UK National Ecosystem Assessment

[http://www.naturalchoice.gov.uk/](#)

## Commercial Farmers Group (CFG)

Priorities for Agricultural and Horticultural R&D (2009)

## Environmental Sustainability KTN

'Environmentally Sustainable Agri-Food Production' (2012)

## Defra Green Food Project Report

[http://www.defra.gov.uk/~/media/Defra/2012/07/10/13794main.pdf](#)

## Hybu Cig Cymru (HCC) Welsh Meat Roadmap

[http://www.hybu.org.uk/~/media/HCC/2012/07/HCC%20Welsh%20Meat%20Roadmap%20English%201.pdf](#)

## Institute of Agricultural Engineers (IAgrE)

[http://www.iaagre.org.uk/~/media/IAgrE/EG/2012/07/IAgrE%20Food%20Security%20EB.pdf](#)

## Society for General Microbiology

[http://www.sgm.ac.uk/A\\_Forum/Food\\_Security.pdf](#)

## British Beet Research Organisation (BBRO)

[http://www.bbros.co.uk/](#)

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II

.....	Additives to improve FCE/ gut health	.....	Breeding for disease resistance	.....	Vaccine development (blue tongue, TB, Schmallenberg etc)	.....	Livestock benefits on arable farms	.....	Improved EID technology & portable systems of livestock record keeping
.....	Improving effectiveness of AI	.....	Rumen metagenomics	.....	Biosecurity & disease eradication	.....	Balancing production and environment (ecosystem)		

## Dairy Sector Workshop – Key Challenges & Priorities for Research

*****	Early embryonic death genetic, nutritional, health status	*****	Lameness/ pain detection	*****	Genotype links to treatment regime - stratified management	*****	Immune system function/ suppression
*****	Cow stress - measurement	*	New DD treatments formalin/ copper sulphate	***	In-line detection automated	*****	Johne's
*****	Submission rate vs conception rate (declining CR - why?)		KE adoption of current best practice	***	Multi-modal & interpretation	*****	Better diagnostics
**	Once-a-day milking		Digital dermatitis - pathology, resistance & vaccination	**	Alternatives to antibiotics	***	Anti-microbial resistance
**	Endemic & sub-clinical disease		Why do some cows not get lame	**	Diagnostics - real-time & stratified therapy	**	Social & behavioural requirement of cows - modelling building design
*	Physiological drivers of (in) fertility		Health economics	**	Biological control - cow, teat, environment	*	Persistent & multiple vaccines
*	Nutritional drivers of fertility & negative energy balance		Cow behaviour	*	Cow comfort & environmental		
					Neo-natal & pre-ruminant management		
					Liver damage & fatty liver		
					Calif & heifer rearing		
					FCE		
					Rumen modifiers		
					Synthetic amino acids		

Potatoes & Field Scale Vegetable Workshop – Key Challenges & Priorities for Research

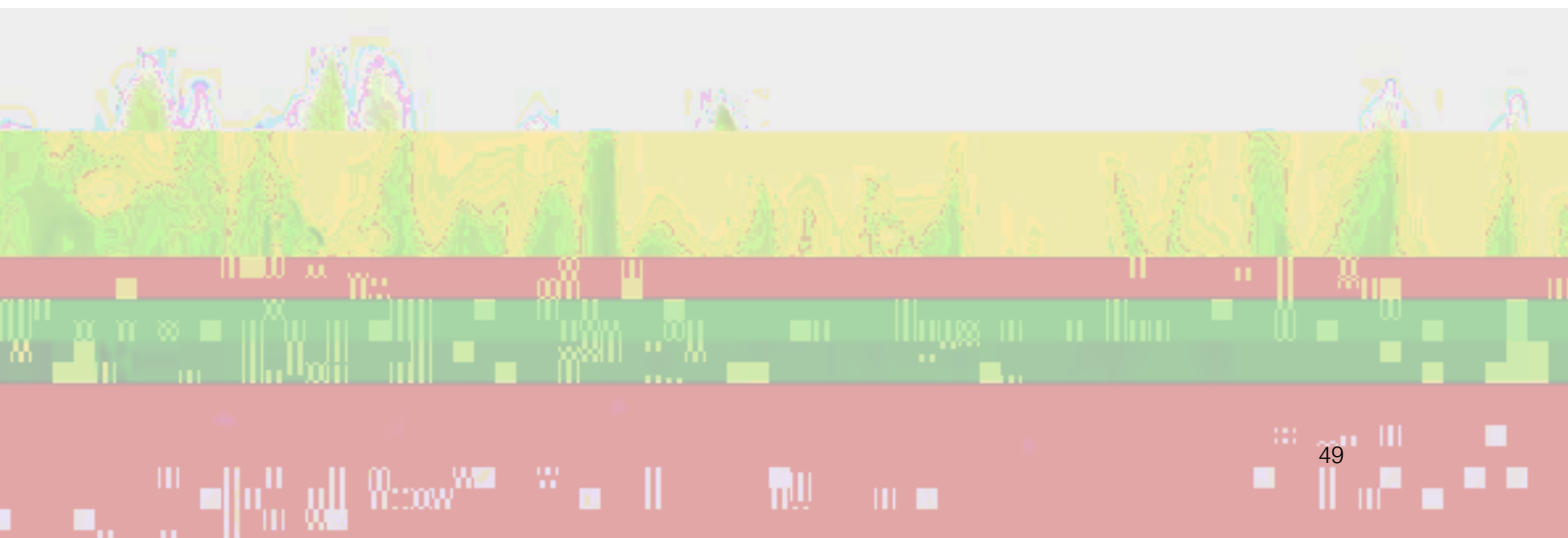
Crop Husbandry		Genetics		Environment & Social		Farming Systems		Engineering & IT	
Availability of crop protection products	****	Availability of marker-assisted breeding	****	Matching ecology with production	****	Rotational soil & nutrient management	****	Post-harvest detection of internal defects	****
Crop maturity control (brassicacs)	****	Introducing N-fixation in other crops	****	Managing effective biodiversity/beneficials	****	Rotational solutions to persistent issues	****	Robotics	****
Weed control	****	Potato blight	****	Sources of major nutrients	****	Alternative weed control barriers	****	Advanced storage & grading systems	****
Bruising	****	Drought resistance	****	Energy use/ climate change	****	New crops for the UK	****	IT to diagnose problems - remote sensing	****
Nutrients	****	Storage - sprout control	****	Efficient use of water	****	Crops to aid weed/ pest control	****	Mechanical harvesting of veg	****
New diseases/ invasive species	****	Yield	****	Meeting consumer requirements	****	Urban farming	****	Precision weeding	****
Light to propagate veg plants	****	Pest & disease resistance/ tolerance	****	Low GI potatoes	****	Legacy left by cereal farmer	****	Reducing management hours - MIS	****
Spear rot in brassicas	****	Nutritional quality (dial/ health)	****	Introducing predators into the field	****	Benefits of mixed farming systems	****	Better automated vision grading	****
Virus prevention	****	Improvements to enable mechanical harvesting	****	Non-water control of common scab	****	Risks to mixed farming	****	Educating next generation	****
Post-emergence herbicides	****	Shelf life	****	Targeting spray applications	****	Value of compost etc	****	Soil nutrient/ N analysis	****
Soil management	****	Gene identification in a broad range of plants	****	Waste utilisation for energy	****	Anaerobic digestion	****	Indicator plants to understand growth	****
Aphid control	****	Soil biology	****	Landscape level management of water	****	Vertical farming	****	Storage v transport	****
Water/ irrigation management	****	Resilience over range of environmental conditions	****	Pest horizon scanning	****	Companion/ perma-cropping	****	Plants & growing systems to make robots work	****
Alternative (non-peat) substrates for transplants	****	Adaptation to higher temps (climate change)	****	Social acceptability of new science	****	Short-term issues rented land	****	CTF for vegetable production	****
Crop desiccation	****	Smart plants	****	Phosphate utilisation	****	Green manures	****	Sensors for selective harvesting	****
Crop uniformity	****	What initiates what in plants (including weeds)	****	Energy use for protected production control	****		****	Automated phenotypic data collection	****
Crop establishment	****	Resistance to club root	****	Regulatory pressure for pollution	****		****	Contaminant removal/ reduction	****
Potato nematode control	****	Nutrient stress resistance	****	Keeping inputs/ run-off in the field	****		****	Atmosphere control by crops	****
N-optimisation	****	Flavour	****	Novel uses of by-products	****		****	Unknown unknowns	****
Constraints of RB209	****	Public acceptability of new varieties	****	Precision landscape planning	****		****	ID of pathogens (food poisoning)	****
Shalls in peas	****	Quicker integration of traits into commercial varieties	****	Headland management for biodiversity	****		****		****
Bio-fungicides	****	Bolting control	****	Efficacy of organic weed control in different conditions	****		****		****
Skin blemishes	****	Improving N-fixation in legumes	****		****		****		****
Sugar levels potato storage	****	Oxidisation post-harvest	****		****		****		****
Potato blight	****	Crop programming in a changing climate	****		****		****		****
Weed control - non chemical	****		****		****		****		****
Season extension	****		****		****		****		****
Downy mildew	****		****		****		****		****
Fusarium	****		****		****		****		****
Xanthomonas in brassicas/ leeks	****		****		****		****		****

Closing the yield gap - understanding why	N-fixing cereals	Overriding need for science/ evidence base regulation	Improved economics of pulses	Variable rate fert & manure application
Improved blackgrass control	GM traits for consumer benefits	Reducing N-use	Direct drilling in a maritime climate	In-crop testing of nitrogen/protein content
Micro-nutrients & trace element nutrition	Genetic disease resistance	Need for transparent & independent consistent research messaging	Benchmarking to integrate technical decisions with economics & sustainability	Smart GPS pesticide application
Soil-borne diseases and rotational effects (take all & club root)	Pest-repellent traits (slugs, pigeons, aphids etc)	Loss of chemistry	Science skill base & career retention	Soil nutrient mapping
Mycotoxin management	Drought tolerance & abiotic stress resistance	Efficacy of sterile strips to prevent weed ingress	New (to UK) crops for climate change adaptation	Remote sensing (pests, disease, nutrients)
Disease management and implications for development of resistance	Protein genetics	Soil biology & soil structure	Resource use efficiency	Low/ zero-tillage systems
Integrated weed control programmes	Improved rooting structure	Reducing water requirement - soil moisture holding capacity	Better info on rotations	Sensors for farmer measurement of crop stands
Inefficiency of nutrient use in OSR (root structure)	Maximising energy production (maize)	Landscapes scale planning	New break crops for UK	Monitoring crop quality in stor



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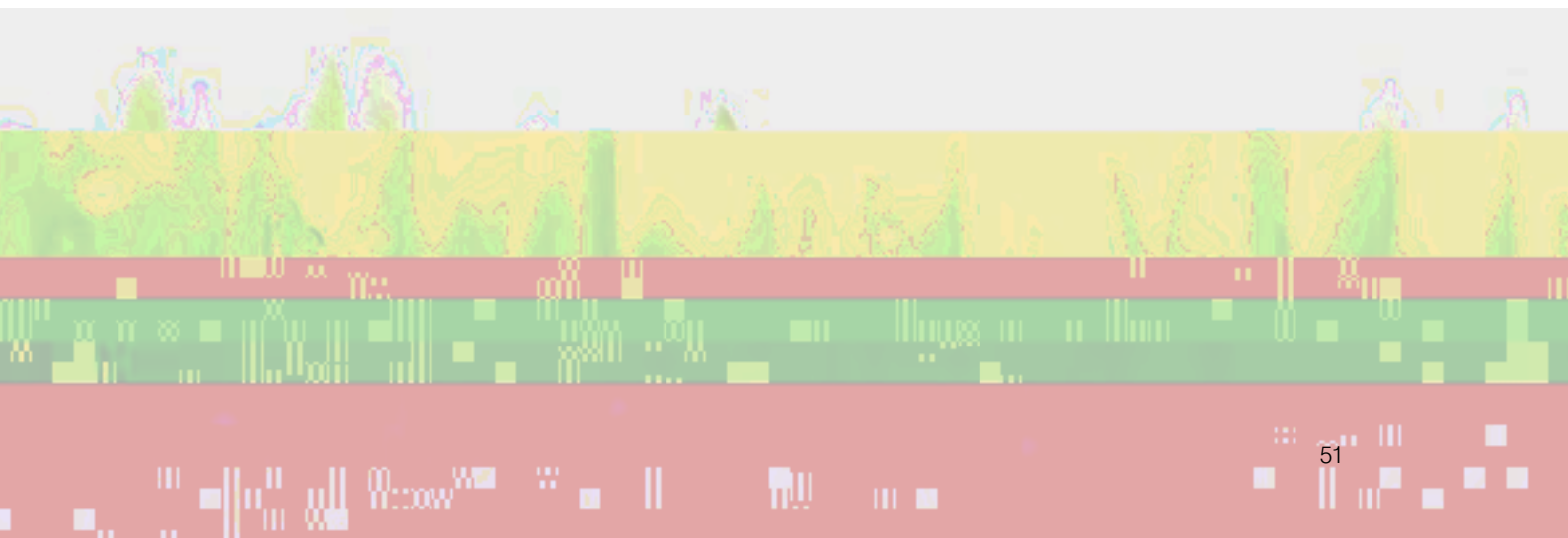
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## Q2. What generic areas of research will have the most positive impact on the sustainable intensification of agriculture in the next 20 years?

- Genetically modified crops - \*\*\*\*  
 - Sustainable agriculture practices - \*\*\*\*  
 - Precision agriculture - \*\*\*\*  
 - (Regenerative agriculture) - \*\*\*\*  
 - Gene editing (CRISPR) - \*\*\*\*  
 - Vertical farming - \*\*\*\*  
 - AI and data analytics in agriculture - \*\*\*\*  
 - Sustainable pest management - \*\*\*\*  
 - Water-efficient crops - \*\*\*\*  
 - R&D in soil health and carbon sequestration - \*\*\*\*  
 - Emission reduction technologies - \*\*\*\*  
 - GHG emissions (CO<sub>2</sub>) - \*\*\*\* (CH<sub>4</sub>)







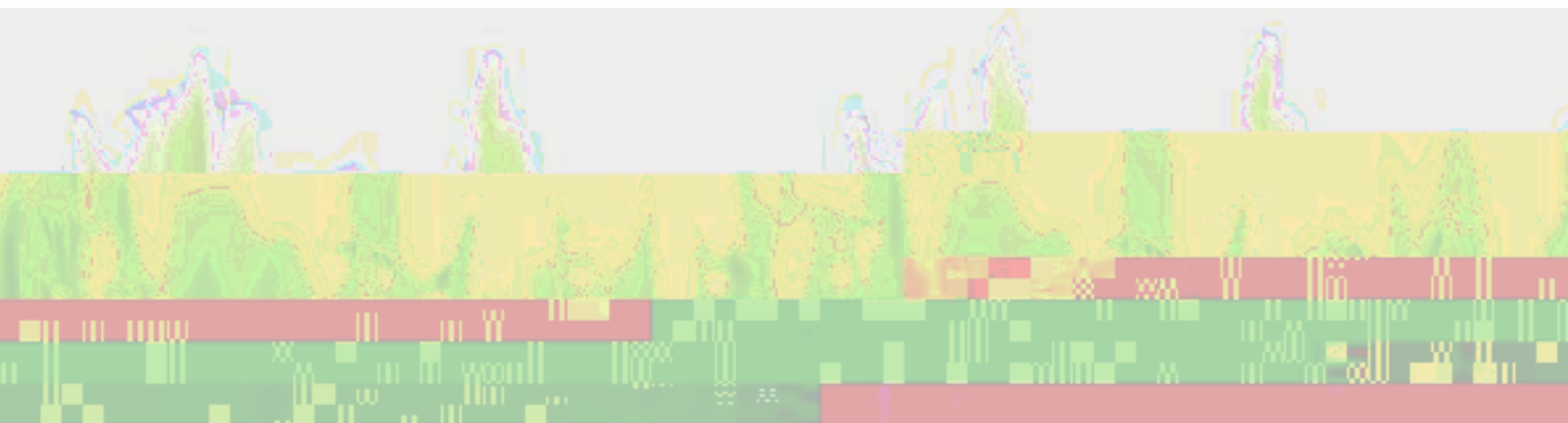
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**Valuing ecosystem services and developing land use systems to optimise delivery where appropriate**

- ...
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**Endemic and emerging disease management and eradication in livestock**



**Q5. What other factors (positive and negative) will have a significant effect on agricultural production between now and 2030, and what role does R&D play in ensuring those impacts are optimised/mitigated against?**

**Positive factors:**

**1. Consolidation/ collaboration of agricultural R&D with other strategic imperatives**

Ex. - AD

- Integ. of agric. R&D with other strategic imperatives
- Ex. - AD (R&D for agric. R&D)

**2. Climate change opportunity**

Ex. - AD

- Integ. of agric. R&D with other strategic imperatives
- Ex. - AD (R&D for agric. R&D)

**3. Rising demand for food**

Ex. - AD

-

- Reporting on greenhouse gas emissions.

## 5. Carbon accounting



# A 4. &

## 1. The Australian model for applied agricultural research: rural development corporations

Rural development corporations (RDCs) are a unique form of agricultural research organization in Australia. They are established by the government and are funded by a levy of 0.5% of the value of agricultural production. RDCs are responsible for funding and conducting applied research in their respective regions. There are currently 15 RDCs in Australia.

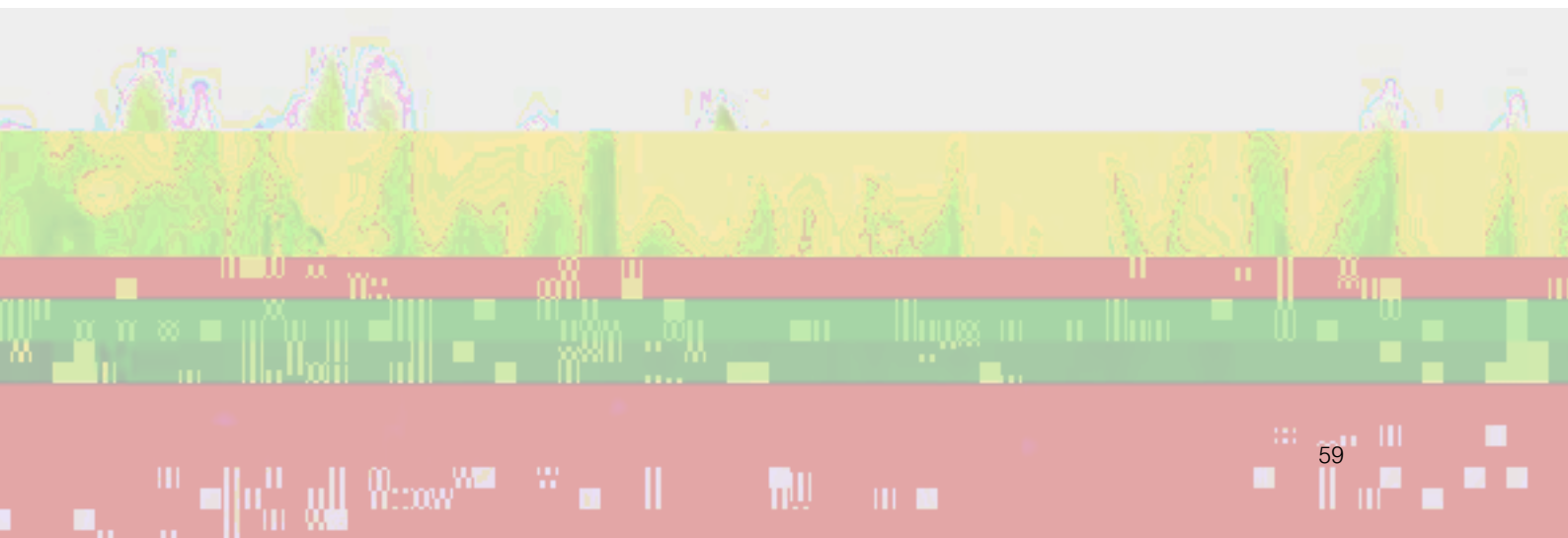
## 2. The Consortium for Plant Biotechnology Research, St Simons Island, Georgia, USA.

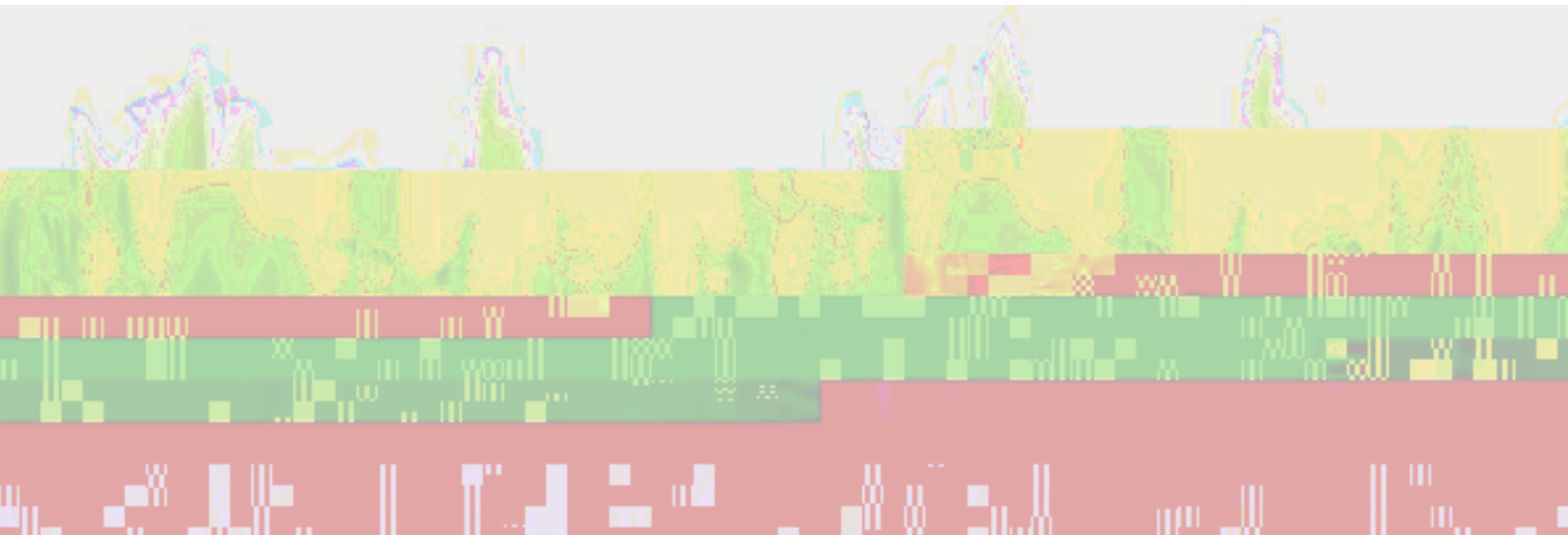
The Consortium for Plant Biotechnology Research (CPBR) is a multi-institutional research center located on St. Simons Island, Georgia, USA. CPBR is a consortium of the University of Georgia, the Georgia Institute of Technology, and the University of South Florida. CPBR is a leading center for plant biotechnology research, focusing on the development of transgenic plants for improved crop production and environmental sustainability. CPBR has a long history of research in plant biotechnology, and has been instrumental in the development of many important transgenic crops, including cotton, soybean, and corn. CPBR is currently focused on research in the areas of plant stress tolerance, plant nutrition, and plant defense. CPBR is a member of the National Science Foundation's Plant Biotechnology Research Centers Program, and is also a member of the International Plant Biotechnology Research Consortium. CPBR is a leading center for plant biotechnology research, and is committed to advancing the science of plant biotechnology for the benefit of society.

### 3. Canadian Agri-Science Clusters

→ The value of \$68.5 million in agri-science clusters in Canada is a reflection of the Government of Canada's commitment to agri-science. → In fact, the value of agri-science clusters in Canada is expected to reach \$10 billion by 2025. → The agri-science clusters in Canada are expected to create 10,000 jobs and generate \$1 billion in economic activity. → The agri-science clusters in Canada are expected to be a major driver of economic growth and innovation in the agri-food sector.

→ The agri-science clusters in Canada are expected to be a major driver of economic growth and innovation in the agri-food sector. → The agri-science clusters in Canada are expected to be a major driver of economic growth and innovation in the agri-food sector. → The agri-science clusters in Canada are expected to be a major driver of economic growth and innovation in the agri-food sector.







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### Technology Strategy Board – Calum Murray

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& Food Innovation Strategy

