



**A Nuffield Farming Scholarships Trust
Report**

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**Increasing the uptake of
integrated pest management in
UK arable farming**

Teresa Meadows

November 2022

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A Nuffield (UK) Farming Scholarships Trust Report

Date of report: November 2022



*"Leading positive change in agriculture.
Inspiring passion and potential in people."*

Title	Increasing the uptake of integrated pest management in UK arable farming
Scholar	Teresa Meadows
Sponsor	The John Oldacre Foundation
Objectives of Study Tour	<ul style="list-style-type: none"> Investigate the stimuli, or range of factors, which have driven the uptake of integrated pest management (IPM) practices for the farmers and organisations visited. Seek IPM practices from other countries, or sectors, which could be used in UK arable farming. Develop ways that these practices can be successfully implemented in the UK to enable IPM strategies to be further adopted by farmers, agronomists and the industry.
Countries Visited	<p>Online: Australia, New Zealand, Nepal, Bangladesh, USA, Germany and Switzerland</p> <p>In-person: The Netherlands, Kenya, USA, Scotland and England</p>
Messages	<p>To enable a step-change towards the uptake of integrated pest management in UK arable farming, we need to move from "regulatory IPM" to "voluntary IPM".</p> <p>To achieve this, as arable farmers, agronomists, researchers, extension advisers, governments, buyers and consumers, we need to put into practice actions across all five areas of the RESET Mindset behaviour change model:</p> <ul style="list-style-type: none"> <u>R</u>ULES: Achieve the changes before the rules come into force <u>E</u>DUICATION: Invest in training and knowledge <u>S</u>OCIAL PRESSURE: Create a community <u>E</u>CONOMIC STIMULI: Ensure the economics are in place <u>T</u>OOLS: Research the tools <p>IPM practices are many and varied. If we're to move forward, all components of IPM need to be considered and actioned on-farm in a holistic manner. To ensure success, we need to integrate those practices and think about adopting a system, not just individual components.</p>

EXECUTIVE SUMMARY

The need for integrated pest management (IPM) strategies to control pests, weeds and diseases in UK arable farming has become more pressing. Although IPM practices have been used for generations, the recent loss of key active ingredients, new government policies and an increased environmental consciousness have raised the need to adopt a more integrated approach, using all components of IPM, including prevention, monitoring, cultural, physical, biological and chemical controls and evaluation.

The questions I set out to answer on my Nuffield Farming Scholarship included: How best to motivate further widespread adoption of IPM methods? What techniques and best practice can we learn from diverse countries and different agricultural sectors to apply to UK systems? Which factors have created an incentive, or are seen as barriers, to increasing the uptake of IPM practices?

From the doors that opened to farms, businesses and organisations around the world, both virtually and in-person, the conversations showed that using all elements of the RESET Mindset Model for behaviour change would lead to IPM uptake. Successes in motivating change and uptake of practices around the world have come from implementing rules, education, social pressure, economic stimuli and the use of tools.

Through the studies and discussions, effective change can be seen from:

- Rules - policies, product registration, markets, certification and resistance
- Education – training, knowledge, capacity building, language, efficacy and risk management
- Social pressure – lead farmers, communities of practice, extension, trust and consumers
- Economic stimuli – premiums, markets, systems, a cheaper alternative and business benefits
- Tools – research, monitoring, time, practices, techniques and future innovations

By implementing the elements from these five areas and ‘pressing all the buttons’ of the RESET mindset model, IPM adoption in the UK arable farming sector would be advanced. We need to move IPM adoption by individuals, agronomists and the industry from being carried out as a result of compliance with rules – *regulatory IPM* – towards motivating adoption through knowledge, community support, financial incentives and the resources required – *voluntary IPM*.

Furthermore, as an industry, we need to encourage a step-change in how we view IPM by towards taking a holistic and integrated systems approach. Aiming for optimum plant health, soil health and a diverse ecosystem will ultimately achieve reductions in pests, weeds and diseases and create a more resilient arable farming sector. Thinking should change from ‘what can we kill?’ to ‘what can we introduce?’

As Gwendolyn Ellen from the Oregon IPM Center in the USA said: “To think ecologically is not only a radical act, but imperative.” Working together to implement IPM strategies on a large-scale in our arable farming sector will benefit crops, economics, the environment and human wellbeing.

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DISCLAIMER

The opinions expressed in this report are my own and not necessarily those of the Nuffield Farming Scholarships Trust, or of my sponsor, or of any other sponsoring body.

Please note that the content of this report is up to date and believed to be correct as at the date shown on the front cover.

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CHAPTER 1: PERSONAL INTRODUCTION

Growing up on a sheep and beef farm in Dorset, there was nothing better than checking round the sheep in the morning with my Dad. This led to a love of, and appreciation for, farming. Following a few years looking at wider geographic, social and environmental areas through university studies and global travels, I started my career in agriculture, working with Natural England.

In Yorkshire I was out and about with the Catchment Sensitive Farming team, assessing Sites of Special Scientific Interest (SSSIs) for their ecological condition and, whilst in the North West, I worked with farmers to make the most of environmental stewardship applications in the uplands and lowlands.

Farm advice and extension being a key motivator, I moved to the Chelmer and Blackwater catchment to work with farmers and advisers to improve the water quality in the catchment with Essex & Suffolk Water. Alongside the necessary technical knowledge, I recognised that knowledge of social science, including what motivates farmers to change, how to overcome the barriers to uptake and use language appropriate to an individual farmer, really led to successes in improving river water quality.

Joining the Agriculture and Horticulture Development Board (AHDB), it was through the farmer-to-farmer knowledge exchange activities, technical events and discussion group conversations with arable farmers in East Anglia and across the UK, that I further understood the importance of matching high yields and business performance with future resilience and environmental improvements. During this time I had the joy of listening to passionate Nuffield Scholars sharing their learnings from their travels for the benefit of many agricultural sectors.

From this the idea was born to be able to combine the areas that I believed in the most – working with arable farmers to further encourage the use of integrated pest management techniques and being able to link that to ways in which we could enable the adoption of IPM across the whole sector - from farmers of every scale to agronomists and advisers from East to West.

Was mindset the key if the research and knowledge already existed? I was keen to find out ...



Figure 1. Teresa Meadows in an apple orchard using multiple IPM practices, Madison, USA. Source: Author's own



CHAPTER 2: BACKGROUND TO MY STUDY SUBJECT

Integrated pest management (IPM) in arable farming is a concept that is not new, but has recently become much more important, both for farmers and the wider industry.

IPM is a holistic term and defined by the European Commission (2022) as:

“Integrated pest management means careful consideration of all available plant protection methods and the subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products (pesticides) and other forms of intervention to levels that are economically and ecologically justified and reduce or minimise risks to human health and the environment.

“Integrated pest management emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.”

On an individual arable farm, a farmer along with their agronomist will typically walk crops, establish thresholds, use models, choose resistant varieties, select an effective rotation and manage pests, weeds and diseases, often balancing many different challenges to a crop at the same time. However, does this go far enough? Is this successfully carrying out IPM?

The recent loss of neonicotinoid seed treatments has led to challenges with the control of cabbage stem flea beetle on oilseed rape, whilst increasing resistance to chemical controls for black-grass has meant that cultural control solutions (including crop rotation and delayed drilling), have had to be widely adopted.

How can we encourage farmers, advisers and the industry to increase adoption of IPM strategies before we lose more active ingredients, develop resistance or new policies are introduced? Is it best to engage the farmer, their agronomist or the whole supply chain? Are different approaches needed to engage with these different groups? How do you make using the IPM approach an attractive one – in terms of effectiveness, time and cost – so that we encourage the broad adoption of IPM techniques within the UK’s arable industry. These are the questions I was keen to investigate during my Nuffield Farming Scholarship journey.

My aim was to: **learn from farms, organisations and different sectors worldwide about their techniques, so that we can motivate the use and widespread uptake of IPM practices in the UK arable sector.**

With this in mind, my objectives and questions for this study include:

- Investigate the stimulus, or range of factors, which have driven the uptake of IPM practices for the farmers and organisations visited.
- Seek integrated pest management practices from other countries, or sectors, which could be used in UK arable farming.
- Develop ways to successfully enable IPM strategies to be further adopted across the UK industry.



CHAPTER 3: MY STUDY TOUR

In planning my Nuffield study, I was keen to talk to those leading the way in IPM and techniques, whatever their crop or farming system. This led to me having a fascinating set of conversations with farmers and organisations covering wheat, corn and cotton, blueberries, kiwifruit, and broccolini to laying hens, roses and tea! From Kenyan smallholders to UK risk managers, researchers in Bangladesh to biological control companies in the Netherlands, the Nuffield journey has been wide, varied, welcoming and always thought provoking.

Conducting a global travel scholarship in a pandemic could never have been imagined when applying for my Scholarship, but coronavirus opened the door to a new world of possibilities from the comfort of my home office. I have loved being able to talk to people all over the world online, exploring the innovations that we have on our doorstep in the UK and doing the ‘traditional’ Nuffield travels in person across three continents.

My study tour has taken me to:

ONLINE		
My home office! <i>Autumn 2020</i>	Australia, Scotland, Switzerland, Nepal, England, Germany, New Zealand, Bangladesh, USA	A unique opportunity to talk to farmers, advisers, business people and practitioners about their use and development of IPM, whilst bringing to life information found from researching the topic online.
IN-PERSON		
UK <i>December 2021</i>	Essex, Norfolk, Yorkshire, England and Angus, Scotland	To discover practices in place and innovations on our doorstep – how were farmers in the UK successfully putting IPM into practice already?
The Netherlands <i>April 2022</i>	Wageningen, Oisterwijk, Rotterdam, Rodenrijs	To visit the home of one of the world’s leading research organisations and where one leading biological control first started...in a back garden greenhouse!
Kenya <i>July 2022</i>	Mbita, Kisumu, Kericho, Naivasha, Timau, Thika, Athi River, Nairobi	To see in-person, the adoption of push-pull technology on a large scale with 90,000 smallholders and IPM practices used in many different sectors, for example horticulture and floriculture for the export market.
USA <i>September 2022</i>	Iowa, Michigan, Minnesota, South Dakota	To uncover the successful extension programmes for IPM in the arable sector and successes with uptake in a similar broadacre cropping environment.



CHAPTER 4: BEHAVIOUR CHANGE – RESET THE MINDSET

As I began my Nuffield Farming Scholarship journey, a frequent topic of conversation was that the technical knowledge for IPM already exists, but encouraging widespread adoption was difficult.

How much of this is due to encouraging a change in behaviour or mindset; and how much is due to wider factors?

Ed Brown, Head of Agroecology at Hutchinsons, said that “observing and getting to know the farms you’re working with” was an important part of being able to implement change. Having an honest conversation was important and often resulted in being able to do something differently.

Indeed, knowing your farmer or adviser and their mindset for change was a really important thread through many conversations. One innovative company lead even stated that the farmers and growers, for whom they provided consultancy, needed the right mindset for change, otherwise they were “not my type of grower”.

4.1 FARMER TYPOLOGIES

So, who are the types of growers and farmers with a mindset for change?

Jimmy Pittchar is a Social Scientist with the International Centre of Insect Physiology and Ecology (*icipe*) in Kenya. He is employed as part of the country’s push-pull technology programme, as well as 18 other countries worldwide. This is a system for controlling agricultural pests and weeds using repellent ‘push’ plants as an intercrop and a trap crop that acts as a ‘pull’ for beneficials. Employing this system involves adopting new practices, away from conventional cropping methods.

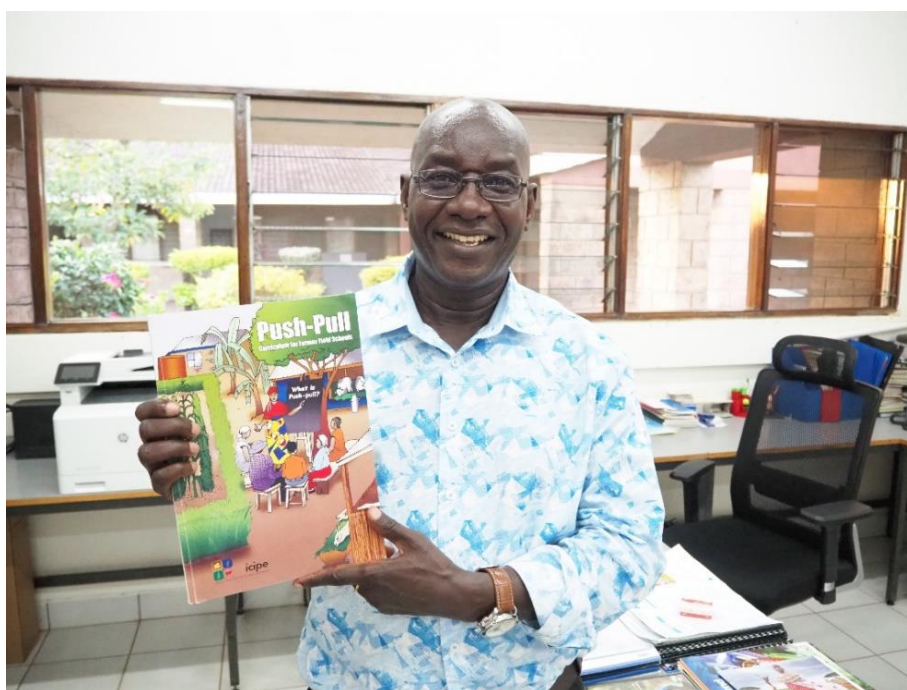


Figure 2. Jimmy Pittchar, *icipe* social scientist, showing the Push-Pull technology Farmer Field School handbook used to train extension advisers in the technology. Source: Author's own



Jimmy splits the farmers that they work with into two categories:

- **Subsistence farmers:** characterised by produce grown for household consumption; no long-term planning and “stuck in a cultural frame of thought”.
- **Managed agriculture:** financially driven; seek scientific data; can invest in high inputs; higher capacity and demand a higher accountability from extension officers.

“But things have changed,” said Jimmy, subsistence farmers have a need for greater intensification, especially with pressures such as climate change and globalised food systems. He expressed the need for a cultural change from waiting for things to happen, e.g. waiting for the weather to plant crops, to being data driven and using new practices.

Jason Stegink, a Crop Advisor and Scout at the Kellogg Biological Station in Michigan, USA had a similar split. He described first those who were forward thinking and considered not just the current crop but the wider ecosystem and future crops, which required critical thinking. Second those who were resilient and knew enough to manage the current crop and thirdly the “small fraction farming the way Grandpa taught me”, perhaps “farming to go out of business”.

Indeed, Defra has its own farmer segmentation model (Figure 3) that reflects these approaches and categorises farmers into five categories – from those who see themselves as custodians of the land, to those for whom business sense is a key driver.

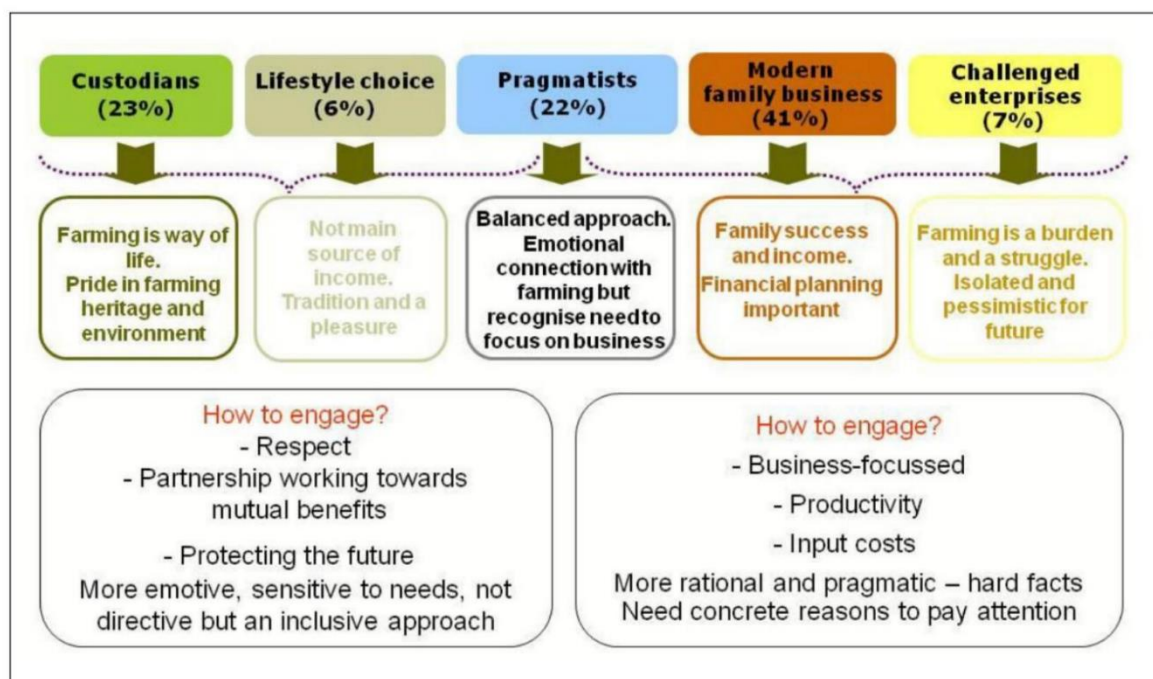


Figure 3. Defra Farm Segmentation Model (Pike, 2008)

If we understand the farmer type, can that enable engagement in an appropriate and more successful way for their respective mindset?



Within the Defra categories, is also the question of where people sit on the diffusion of innovation curve (Figure 4). It could be argued that each category could equally have innovators, early adopters, early majority, late majority and laggards.

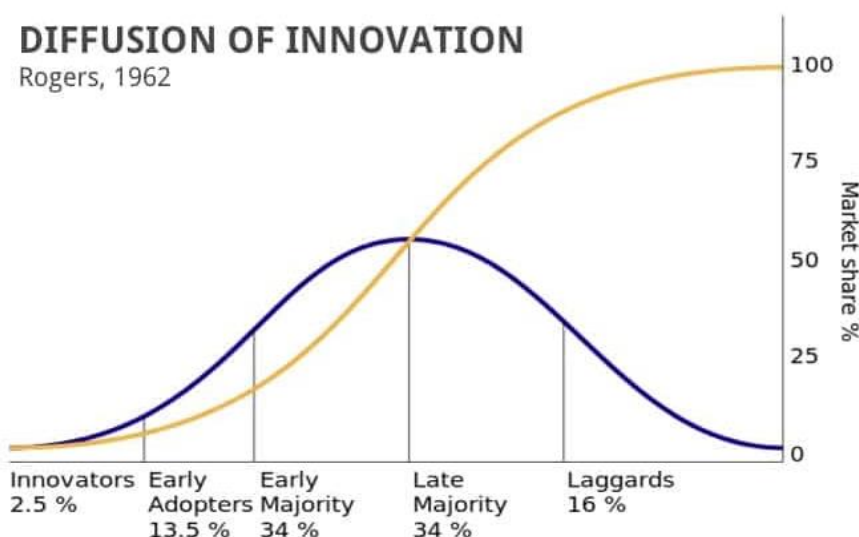


Figure 4. Diffusion of Innovation curve (Rogers, 1962)

How can people within each category be encouraged to move through the adoption curve and take up new IPM practices?

Joyce Gema, Managing Director of Tradecare Africa, explained that she taught a slightly different framework for designing extension that took the following into account:

- **Contextual factors**
- **Household and personal factors** including capacity and willingness to change

When designing extension in a subject, an adviser needs to be thinking about the target group and designing an approach that takes into account both areas, as both are needed to motivate change.

4.2 RESET THE MINDSET

Considering all these factors, no single area could consistently be attributed to the uptake of IPM measures. It was a combination of factors at play, creating the 'nudge' or 'shift' towards doing something different and adopting IPM.

These were outlined in different ways by different people. Abdullah Al Shakib, a research consultant who has studied behaviour change drivers and barriers with 55,000 farm households in Bangladesh, said: "In every business, you need to show them incentives – either cost reduction or an increase in productivity or an increased price – either two or all three."

The late Caroline Drummond, former CEO of LEAF in the UK, stated four ways of driving change: 1. Show and tell, for example Demonstration Farms; 2. Make sure it works; 3. Market opportunity; 4. Legislate.

There are many other examples from people I spoke to across the world in my Nuffield studies, online and in-person. However, I discovered, almost without fail, that these could be categorised



into Lam, Jansen and Wettel's model of behaviour change – the RESET Mindset model. Created originally for decreasing antibiotic usage in Dutch dairy cattle (Lam et al., 2017), the model has been adapted from multiple models in social psychology and can be applied to any situation where behaviour change is encouraged.

To achieve behaviour change, all five 'buttons' need to be pressed – rules, education, social pressure, economic stimuli and tools.

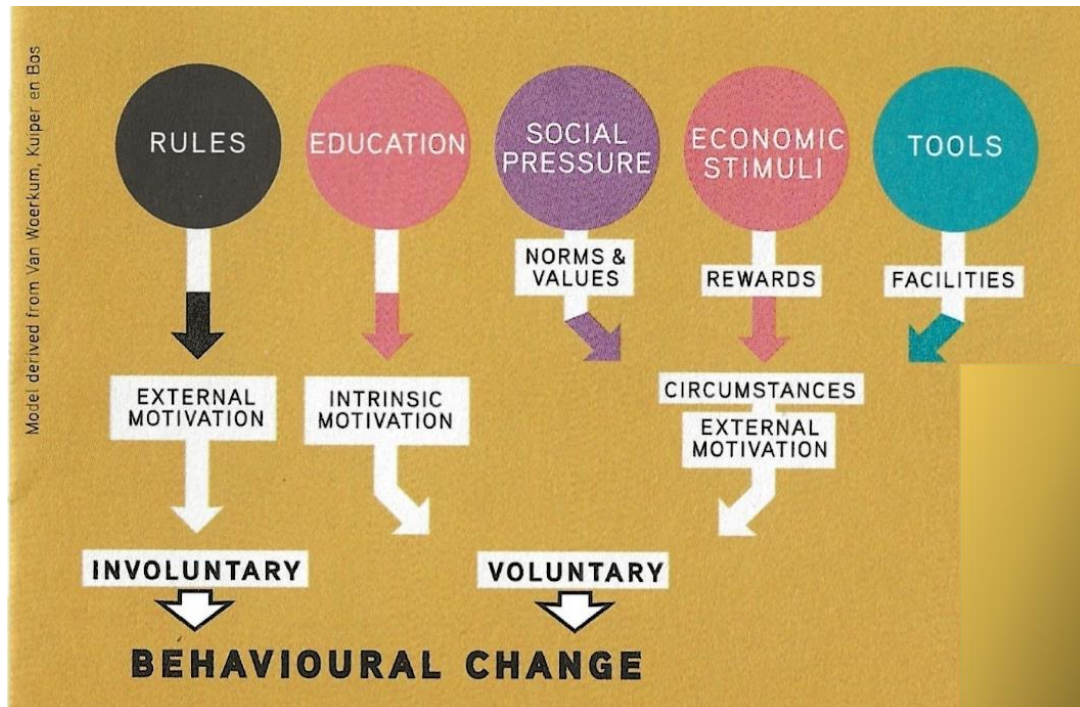


Figure 5. The RESET Mindset Model created by Lam, Jansen and Wettels

As Katie Dentzman, Social Scientist at Iowa State University (ISU) said, increasingly social scientists are being involved in research and extension projects to enable uptake, "...but they throw us in at the last moment". Adoption and uptake are expected immediately, but time is required to understand the sociological aspects, to allow for practices to be put in the right context and to achieve uptake.



Figure 6. Katie Dentzman, Social Scientist with ISU. Source: Author's own

In order to share the journey of this Nuffield Farming Scholarship study, I have started with the behaviour change concepts and will now employ the use of the RESET Mindset model to frame my learnings. In the following chapters, I will take you through my findings into how we can use these five 'buttons' to encourage widespread uptake of IPM in the UK arable farming sector.

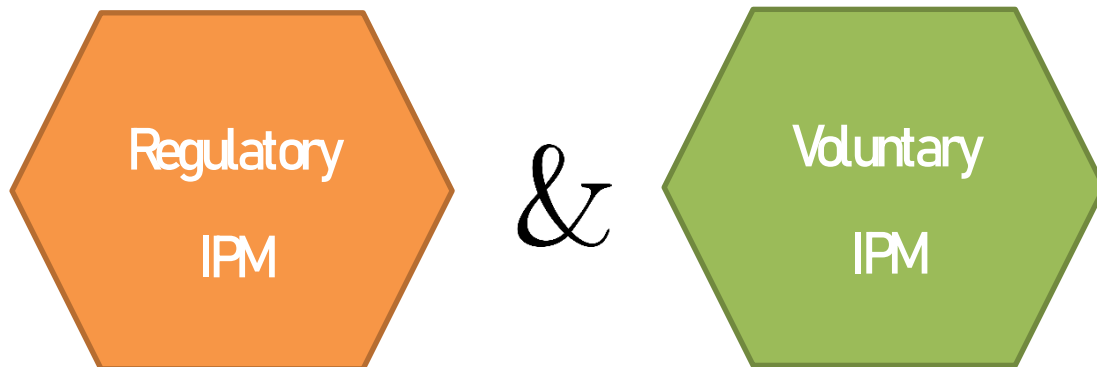
Key messages:

- Knowing farmer motivations and mindset can enable a successful approach to extension.
- From my Nuffield conversations, by employing all five areas of the RESET Mindset model - rules, education, social pressure, economic stimuli and tools - we can enable the widespread uptake of IPM measures.



CHAPTER 5: RULES

The words of Joyce Gema (Managing Director of Tradecare Africa) have stuck with me on my journey through what drives the adoption of IPM. Joyce said there are two types of IPM:



Regulatory IPM includes the IPM that is carried out because of rules; whether that be because an active ingredient has been banned, government policy dictates the use of a measure or perhaps the market demands the use, or not, of one or many IPM practices. Voluntary IPM, by contrast, is therefore where a farmer, grower or adviser uses a practice through their own volition. This balance is also played out in the RESET Mindset model (Figure 5).



Figure 7. Joyce Gema sharing the concept of regulatory vs voluntary IPM. Source: Author's own



5.1 POLICY

Policy from a national government or more widely, for example the European Union, is one way of rules driving change in IPM uptake.

The Farm to Fork Strategy (2020) from the European Union states targets, which include reducing nutrient losses, increasing organic farming and reducing the environmental and climate impact of animal production. Specifically, for IPM it states:

“The Commission will take additional action to reduce the overall use and risk of chemical pesticides by 50% ... by 2030.”

In order to achieve this, the Commission has stated several key actions, including revising the Sustainable Use of Pesticides Directive, strengthening IPM through encouraging alternative control techniques, e.g. crop rotation and mechanical weeding, promoting biological active substances and reducing the length of the pesticide authorisation process by Member States.

Marcel Dehler, part of the Cash Crop Team with agribenchmark in Germany, has noticed the imprecision of this Strategy – it states that it will “reduce the amount and risk” but does not address how it will measure pesticide reduction and provided no reference year. This is solely a strategy - will all the goals become national law? There will be discussion and perhaps the metrics will change, for example will the 50% goal be reduced to 30%? However, there is a strong policy direction for reduced pesticide use and therefore a real need for IPM practices. As Marcel stated, “what drives IPM from my point of view is policy, combined with other arable restrictions, for example resistance”.

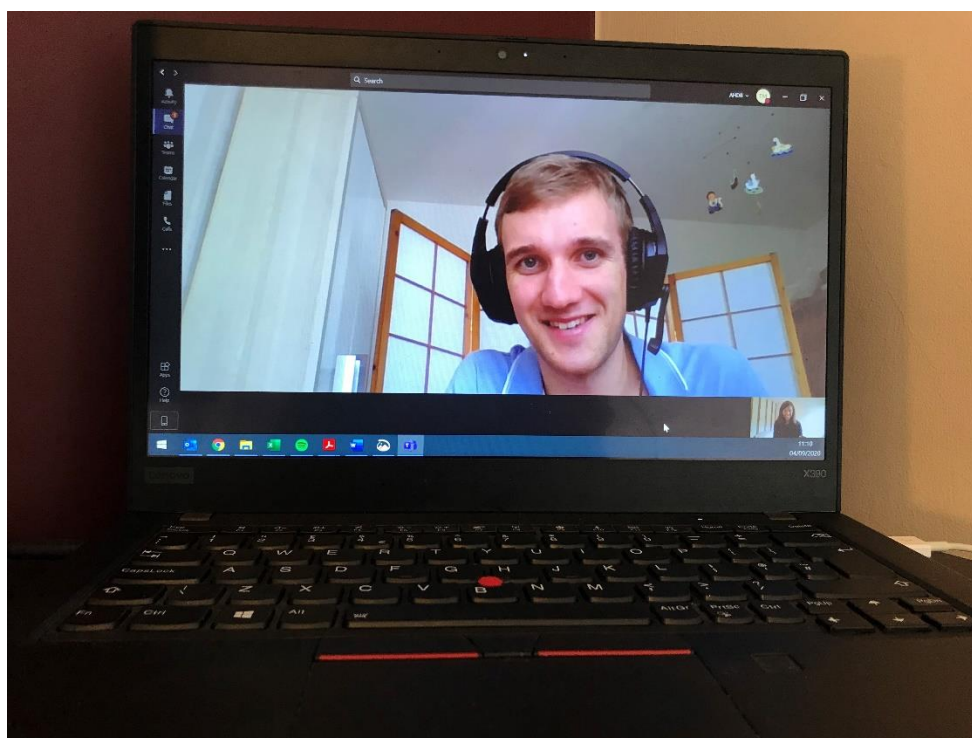


Figure 8. Teresa talks to Marcel Dehler about the EU's Farm to Fork Strategy and ambitions.

Source: Author's own



5.2 PRODUCT REGISTRATION

The opposite is true for the biological approval process in Kenya, which has been a real policy success. Enabling legislation by the Kenyan government has sped up the registration process for biological control products and so is allowing faster innovation and adoption of IPM techniques in a wide range of different agricultural sectors, explained Henry Wainwright and Louise Labushagne, co-founders of a leading Kenyan biological control company.

Although for Laban Koima at Kakuzi, who is growing blueberries, a new crop for Kenya, there are no pesticide active ingredients or products approved for use in the country for that specific field of use. For this reason, Laban has made the commitment to use IPM and biological control measures from the start. He is successfully growing blueberries with no chemical control, which means that he can employ his useful pollinators in the polytunnels with no compatibility concerns. He carries out frequent scouting for pests and diseases, has a focus on plant health and nutrition and uses biological control programmes, including predators, pheromone and sticky traps when needed.



*Figure 9. Laban Koima, Blueberry Manager, the blueberry crop and pollinator hive at Kakuzi, Kenya.
Source: Author's own*

5.3 MARKETS AND CERTIFICATION

Market demand and certification were a key 'rule' that has led to IPM adoption all over the world. Raul Ruiz at Gowan explained that market requests from the US, Europe and Japan in the fruit industry had driven IPM adoption in this sector. In Kenya, horticulture producers told me that Fairtrade International has moved active ingredients such as chlorothalonil, imidacloprid, lambda-cyhalothrin and glyphosate onto its Red list of products that cannot be used from June 2022, which, along with the MPS-ABC certification which demands sustainably produced roses, has encouraged the rapid adoption of IPM to meet its standards.

Where a standard exists, growers and farmers have needed to and have realised the adoption of IPM measures in order to achieve the necessary certification. As Neil Helyer, IPM Specialist at Fargro said, there is "very little option" to do anything else, if you want or need that market access – especially when there are only a few big customers.



5.4 RESISTANCE



Figure 10. Jan Koppert, founder of biological control company, Koppert. Source: Koppert

Bram Klapwijk from Koppert told the company's story:

Fifty-five years ago, Jan Koppert had a number of glasshouses in the Netherlands that he used to grow cucumbers. He noticed a problem with resistance as his insecticides were becoming less effective for spider mite control. Following discussions with an adviser from Wageningen University, and a visit to Switzerland, Jan came back with leaves hosting beneficial mites, the natural enemy *Phytoseiulus persimilis*.

These mites weren't widely used for biological control until Jan Koppert built a small greenhouse with a heater in his garden to keep a small number overwinter. After seeing success in his greenhouses, he bred them again for the next season. His neighbours and friends then started asking him "can I get some, too?". Jan thought that if he were to breed them, then they could buy from him. This is where the principle of Koppert was born, breeding beneficial insects with his sons, Peter and Paul and nephew Henry Oosthoek.

Nick McTurk, an egg producer in Essex, also saw resistance resulting in innovation and uptake of IPM. Noticing that insecticides had stopped being wholly effective against mites in laying hens due to resistance, and that many products had been withdrawn from use for customer safety standards, Nick sought a different solution.



Figure 11. Nick McTurk with his predatory mites used as a biological control for red mites in his laying hen houses. Source: Author's own

He now employs a system using predatory mites for mite control, along with parasitic wasps for fly control. The benefits? Predator mites achieve the same level of control as previous chemical treatments, show a cumulative effect of use, are safe for operators and, he said: “I’m not worried about insecticide on the chickens or eggs.” Although the biological alternative wasn’t a cheap solution and chemical control might be easier to use in some instances, he added: “If we were ever to use an insecticide again, we would be back to square one. If you don’t stick with it, you don’t get the success.”

As Bram from Koppert explained “...it’s not a discussion – chemicals or beneficial insects? Always beneficials...it’s in our genes to use beneficials. Every time they move into a new field, people say it is too expensive or too difficult. Five years later, the government has taken out the chemicals, so they are illegal to use...and so growers use biologicals.”

Regulatory IPM certainly encourages adoption and uptake of IPM practices. As Joyce said, most farmers and growers using IPM, are doing so because of rules and regulations.

Through these discussions and studies, my aspiration is to move more farmers across to voluntary IPM, before they receive the ‘nudge’ from a rule, and it becomes compulsory. Some growers that Katie Dentzman from ISU had worked with moved to IPM as a result of new regulations: “felt trapped with no other options”; “felt like they didn’t have a choice/agency”.

How might we be able to encourage this voluntary move and remove barriers to adoption? This will be explored further in later chapters.

Key messages:

- Rules and regulations act as a driver for IPM adoption and uptake. These can be in many forms from policy and markets, to product registration and resistance.
- Other tools may be required to support a voluntary approach that builds intrinsic motivations for sustained behaviour change.



CHAPTER 6: EDUCATION

“If we have our eyes on the principles, we can keep a look out for practices that work,” said David Montgomery, USA Professor of Earth and Space Sciences and author in an online discussion when we talked about increasing the adoption of practices. Knowledge of the principles through training is often the start to awareness and the drive to put these principles into practice. What role does education play in facilitating IPM uptake? Here we find out.

6.1 TRAINING, KNOWLEDGE AND CAPACITY BUILDING

“Training can really change the perspective,” said Leah Mururi from the biological control company, Dudutech. Recognising the importance of grower training in increasing the efficacy of their products, the Dudutech Academy was created. The Academy carries out training with all involved in the growing process, from scouts and growers to directors and agronomists. Building competency through training was seen as essential for uptake and efficacy.

The importance of training and growing knowledge was a theme from many of my visits and discussions – whether formal training or self-study. Jason Stegink, an adviser and crop scout linked to the Kellogg Biological Station, Michigan said that for IPM to be taken up, people need to: 1. Know it academically and 2. See it personally. John Kempf at the start of each of his Regenerative Agriculture podcasts, which I often listened to whilst travelling, said that “We believe that knowledge and information is the foundation of successful regenerative systems,” and Bram Klapwijk from Koppert, said that more than 10% of their colleagues are consultants, visiting the growers every week after providing the products, to assist growers with knowing how they work and how to use them. “If I give you a pencil, you know how to use it,” he said “...and the same is the case with spraying. If I give you one of our biological products, you don’t know.”



Figure 12. Bram Klapwijk in the fascinating Koppert Experience Centre. Source: Author's own



The same principle was seen with CABI's international Plantwise programme with training modules on areas like IPM and biocontrol to "sensitise farmers to be able to understand and conceptualise new notions" and ReallIPM in Kenya introducing BASIS and FACTS training for all its clients.

At Zespri in New Zealand, Jemna Hughes and Melanie Walker believe that it's not that their kiwifruit growers don't want to adopt IPM, rather it's simply a lack of understanding. Whilst creating factsheets about pest issues, management methods, monitoring recommendations and more, they realised that "education had fallen off the radar". As a result, they have implemented more "mandatory training to make sure that they know the basics". This ranged from the products that growers were using and, importantly, how a product works and when to use it, as many hadn't considered the effects of the time of day that they are spraying or the product being applied.

This need for understanding and going back to basics was noted by Joe Rolfe, an organic carrot grower at RB Organic in Norfolk. When he recognised that to move forward and design new practices, he needed to first "take a step back and understand the pest itself – lifecycle, habitat, how it overwinters, trapping timing and damage". This understanding has allowed him to successfully implement practices for aphid control from three-year margins and the introduction of beneficials to trapping. New drilling and lifting methodologies for carrot root fly have led to effective control.

Investment in training is important, said Sarah Mansfield from Agresearch in New Zealand, to prepare for the shift to new ideas. "To do IPM, is knowledge intensive," she said.

This shift was identified as requiring not just training but also a generational change of farmers to prevent them "falling back into the easy habits," said Sarah. Marcel Dehler also identified that young farmers needed new knowledge in their "learning period" and Martin Lines, Chair of the Nature Friendly Farming Network, and John Pawsey, a Suffolk farmer, identified a "need for UK agronomists to re-train" with a focus on nature-based IPM and to focus on what is happening on growers' own farms and new practices.

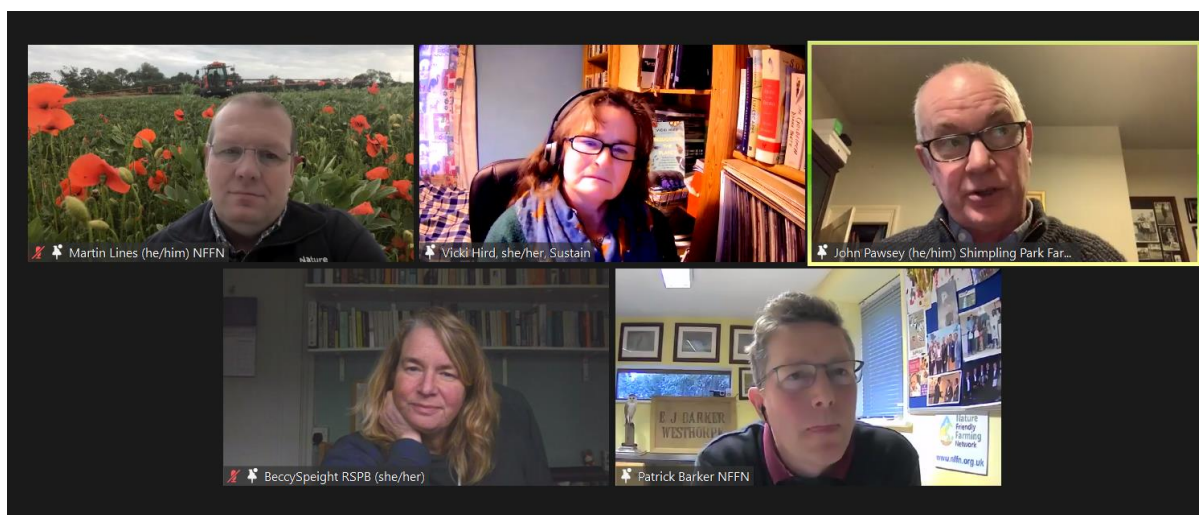


Figure 13. 'What is needed to get to a pesticide free future' session at the Oxford Real Farming Conference.
Source: Author's own

Ultimately, if people have invested in self-study and have sufficient knowledge, understanding and interest in the principles and basics, then IPM practices come from there.



6.2 LANGUAGE, TERMINOLOGY AND COMMUNICATION

Language is critical for training and how knowledge is passed on. Jimmy Pittchar, *icipe*'s Social Scientist, said you must use language at the right level for your audience when presenting knowledge. There is a difference between data (facts) and information (analysed or predicted value), and the trainer's art is presenting facts in context so this can be understood and actioned.

In addition, the language that we use is important for IPM practices. Speaking to horticulture producers, they always talk about their 'integrated pest management programmes'. In arable, we refer to 'fungicide programmes' or 'insecticide applications'. If we change the language to be similar to that in horticulture and always use 'IPM programme', perhaps it will encourage our sector to consider and use all the IPM practices when managing pests, weeds and diseases rather than going straight to chemical controls?

6.3 EFFICACY AND IMMEDIACY

Education in IPM was noted to be particularly important in how biological control differs to that of chemical control.

"Growers prefer an instant solution, IPM is slow," explained Evelyn Cheramgoi of the Tea Research Institute, Kenya. Evelyn talked about a grower asking what IPM measures could be used on their tea crop to manage a particular pest problem. Evelyn's advice was not to spray, but to use cultural practices, in this instance pruning. The grower would say "Yes, I will" but then do nothing. "They just want you to say, get a chemical and spray". IPM can sometimes be more difficult and take longer, but it will work. Education can effect that change, she said.



Figure 14. Evelyn Cheramgoi of the Tea Research Institute, Kenya. Source: Author's own



Similarly, Ram Yadav a weed scientist at Iowa State University stated the same with the use of integrated weed management (IWM) versus herbicides where growers “don’t see an immediate effect” and so “don’t want to use these techniques, until have no other option”.

“Farmers want an instant knock-down effect and to see insects dying,” said Dr Ivan Rwomushana of CABI, Kenya.

Education about how biological controls work – both natural and introduced – and how they differ from chemical control is really important. Growers and their agronomists need confidence in the efficacy of practices, especially as it can take a longer time to see an effect.

6.4 RISK – MANAGEMENT, APPETITE AND TOLERANCE

Technical knowledge and understanding about IPM measures can create a step-change in uptake. Through my Nuffield Farming Scholarship studies, I was also keen to explore the role of risk in IPM uptake. As Hazel Doonan, AIC, said if all IPM measures were risk free – would farmers do it? Yes, they would.

Risk and managing that risk in changing methods and practice is important for IPM uptake, both for a grower and their agronomist. How can you understand and mitigate those risks to enable IPM uptake?

To get an expert view on risk and how it can be managed, I spoke to Vanessa Clark, the Risk and Compliance lead at Action for Children, for her perspective. Vanessa explained that it is impossible not to take risks. We have to take risks in order to achieve what we want. Thus, risk management is an essential governance tool. But how do we address issues that might stop us achieving what we want to?

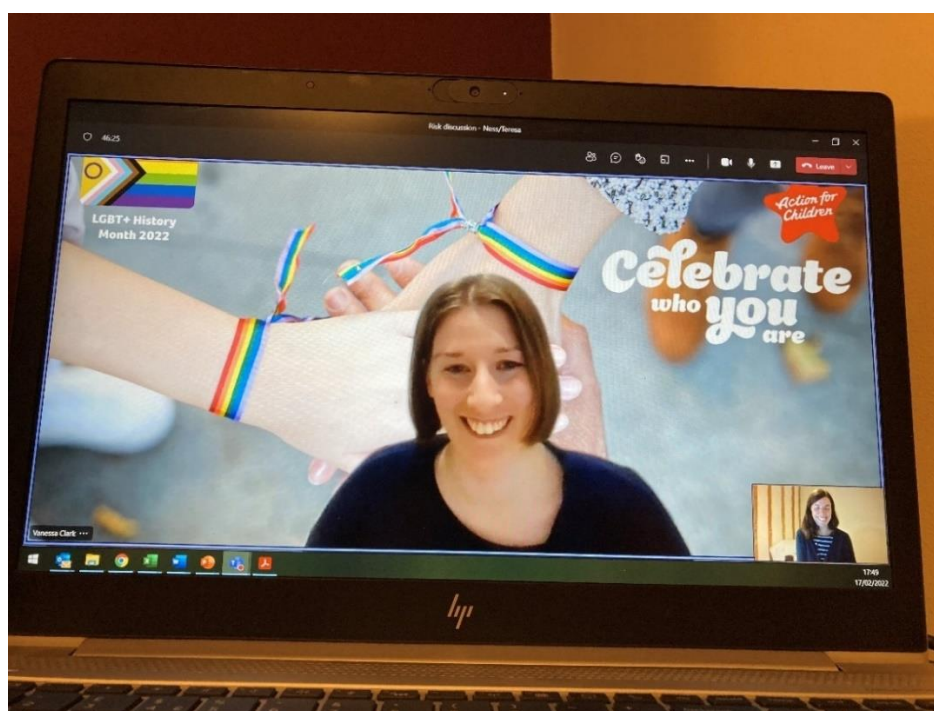


Figure 15. Discussing risk with Vanessa Clark, Action for Children. Source: Author's own

There are two key areas in managing risk: risk appetite and risk tolerance. To describe these, Vanessa used the following analogy from football. Imagine that you are Gareth Southgate taking

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England into a World Cup semi-final. You might say that my appetite is to win the game, with one yellow card or two, but all players making it through to the final. However, he could tolerate one player being sent off potentially if necessary.

As a business, what risk appetite do you have? What is the limit that you could go to without being really worried? Similarly, what risk are you willing to accept? How much can you tolerate before it becomes too much?

I advocate that we could use the same concepts when discussing moving to IPM practices with our farmers – what is the level of pest damage that you are willing to tolerate, for example and when considered alongside the benefits that could be gained from the build-up of beneficial insects in-field? What is your appetite to risk, for example with a potential change to yield? If we can have these conversations, for example between a farmer and agronomist, then the risk tolerance would be known and discussed. Perhaps new practices could be tried, even on a small area, and the risks managed to that agreed level.

In risk management, Vanessa advocates documenting what your appetite is and using a risk register to think through all the risks as illustrated in Figure 16 and then to create an action plan for managing these risks – both the causes and the impacts. Perhaps these might be withdrawal of an active ingredient, the environmental impact of a chemical control or a commercial disadvantage from not using a product.

The elephant in the room

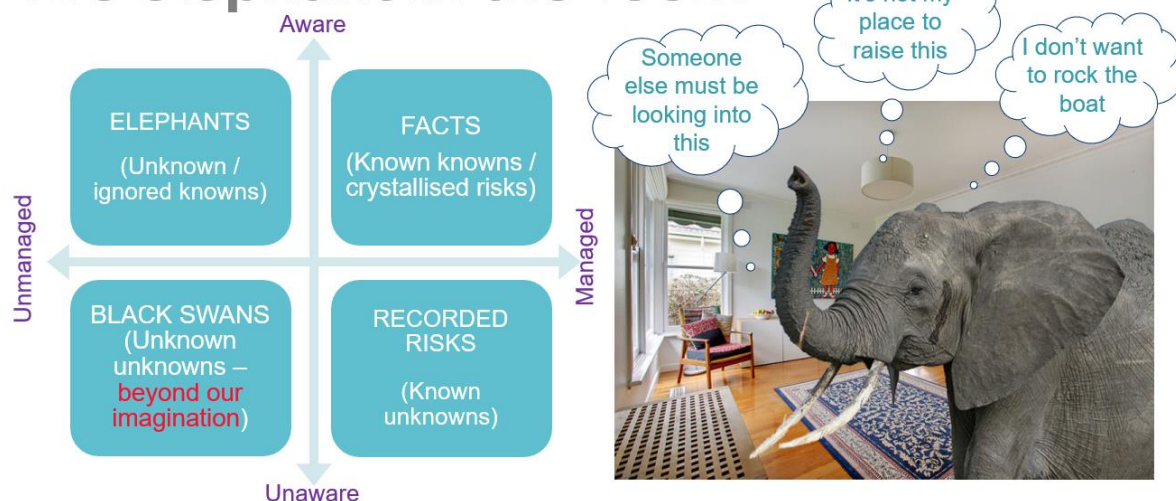


Figure 14. Capturing all risks, even the elephants and the black swans, on a risk register means that they can be managed. Source: Vanessa Clark

“When you have strong risk management,” said Vanessa “you have a good sense of what the risks might be, a good knowledge of risk appetite and this can then be used as a tool to judge and quantify risks – how much of a change am I prepared to make? What risk am I willing to accept? What could stop you from achieving your objectives?... Just having that discussion makes people think.”

Could education in risk management and subsequent discussions about risk appetite and tolerance be a key tool to move forward with IPM uptake in the arable sector?



6.5 EDUCATING CONSUMERS

Education doesn't stop with farmers and their agronomists - educating consumers in IPM is as important.

When Angus Soft Fruits introduced hoverfly in their blueberries, it worked brilliantly for aphid control but led to complaints from customers who found hoverfly larvae; "they were covered in worms" reported one customer. However, Darren Schreurs, a leek grower in Australia worked with their supermarket to change the packaging to an open top for two months while they used a fly to control the Rutherglen bug pest, so that the consumer didn't see the fly and the supermarket kept a chemical free product on the shelf.

Labelling is one way to educate consumers, improve the connection between the farmer/producer and the consumer, enable clear and consistent demand and influence wider industry behaviour to drive change, explained Hannah Jordan from Defra, but there are many demands on labelling.

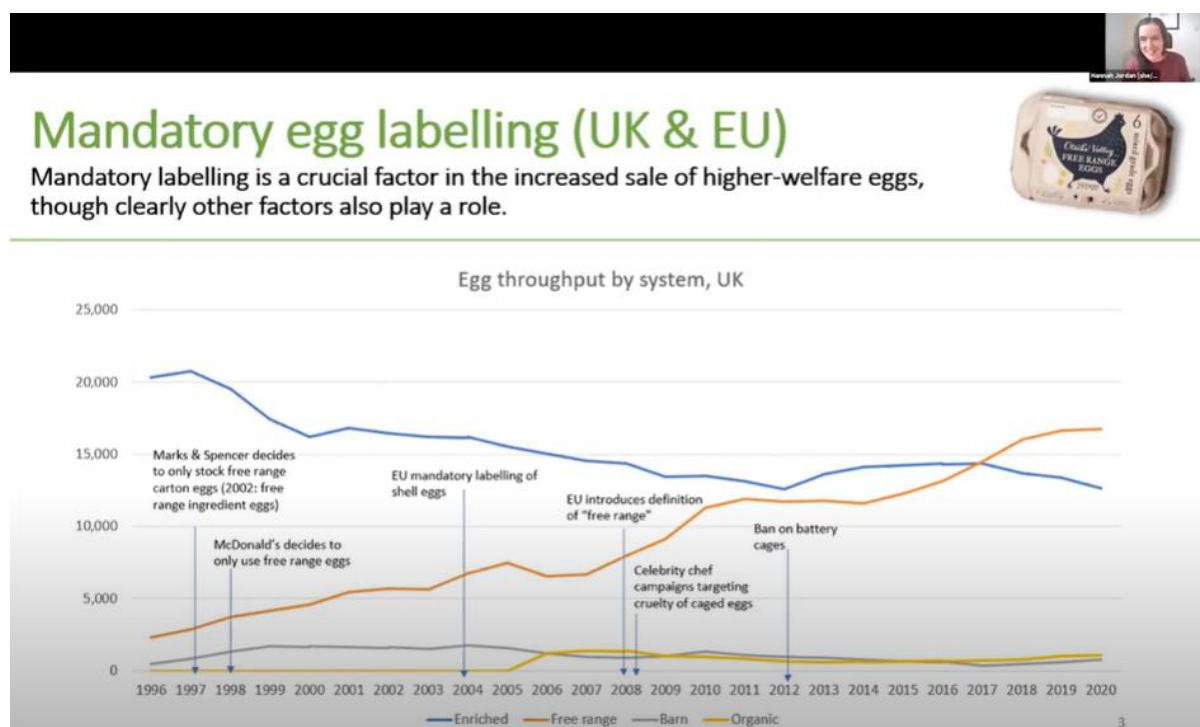


Figure 157. Hannah Jordan, Defra, presenting on consumer labelling at the Oxford Real Farming Conference.
Source: Author's own

The introduction of mandatory labelling in eggs increased the sale of higher-welfare eggs with 62% of free-range eggs sold now, compared to 32% in 2004, said Hannah.

Could we use labelling to educate our consumers and drive change for IPM in the arable sector too? 97% of the public want UK labels to be clearer on production, shared Martin Lines, NFFN, but in order for us to do IPM labelling, we would need clearly defined metrics of what IPM means.

Peter Werts works with growers using the EcoApple and TruEarth assurance schemes in the USA. He said that these schemes are different, as they focus on the floor, "rather than focussing on the ceiling" for IPM practices. "The sky is the limit for innovations in IPM," so their scheme standards set a baseline of acceptable levels of minimum IPM practices that must be in place to be certified and doesn't have a limit of practices that can be introduced. This then encourages innovation,

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continuous improvement, new technologies and ways of working by their growers. In this way, both consumer education and assurance of IPM can be achieved and it motivates uptake.



Figure 18. Tim Lang, Emeritus Professor of Food Policy at City University, London. Source: Author's own

However, Tim Lang suggests that currently “labelling is pointless unless you have a baby or a heart attack!” He suggests that “labelling is weak” and the lowest common denominator. Moreover, “it’s multi-criteria time or bust! We need to know about ingredients and sourcing, the environment, health, economics and labour... all of them matter.” Can IPM be singled out on a label? Consumers care about a range of measures and need coherence across these measures. Education on just IPM as a single issue doesn’t indicate the whole measure of sustainability, but finding methods to educate consumers could be a key driver for IPM uptake in the arable sector.

Key messages:

- Education is a vital component of increasing IPM uptake. As knowledge grows, consciousness grows, and this enables the uptake of new practices.
- Education takes many forms: technical knowledge of the principles and practices, efficacy of IPM measures in comparison to conventional controls, knowledge of risk appetite and tolerance and consumer education.



CHAPTER 7: SOCIAL PRESSURE

When listing the drivers for change, or what has provided the confidence to take up IPM practices, listening to other growers and learning from IPM experts was top of the list for Allen Innes, LM Porter Farm Manager and many other farmers that I met.

Our peers, communities, wider trusted voices and our consumers are a key motivator for change.

7.1 LEAD FARMERS

Amongst all the incentives that the Sustainable Agriculture, Food Security and Linkages (SaFaL) project introduced in SW Bangladesh, lead farmers were ‘found to be the most influential catalyst for group mobilisation, technology adaptation and resulting behavioural changes’.

Discussions with Abdullah al Shakib, the lead research consultant for this in-depth study of farmers’ behaviour change drivers and barriers for 50,000 farm households involved in SaFaL, found that lead farmers can have a big role in rural development. “Smallholder farmers tend to copy or follow their behaviour.”

However, the initial selection of lead farmers was not good in this particular project – they were initially selected by votes. Often influential, vocal, or active people seeking election were chosen, not necessarily people with prior knowledge. To be effective, certain characteristics were needed (Figure 19), including prior knowledge, time to leave the business and acceptance by local people. In places, where lead farmers had these essential attributes, their engagement worked well.



Figure 19. Profile of a successful lead farmer. Source: Al Shakib



In the UK, we use lead farmers in different ways already, for example through the Monitor Farm programme (a farmer-led knowledge exchange programme for sharing and developing best practice and productivity on-farm), but could we have IPM specific lead farmers? Some of us need to see a practice working well with another grower. That is very effective in creating a ripple effect of adoption. After all, “farmers listen to other farmers,” said Martin Lines, Chair of the Nature Friendly Farming Network.

7.2 COMMUNITIES OF PRACTICE

It’s not only farmer-to-farmer social pressure though, adoption also extends to communities of practice as an effective way to share knowledge about what works, said David Montgomery.

I found examples of these communities across the world from Nevin Rosaasen, a Canadian farmer who talked about the Alberta bug chat that happens every Wednesday at 10am to share information on pest management in the region; Philippa Dodds of Angus Soft Fruits, who is working with technical leads at a range of companies as they move to biological controls and said “they’re learning how to use it” and it “works for us to build up confidence”, and Rick Clark, a USA farmer, who stated the importance of needing to be a part of a community.



Figure 20. Philippa Dodds, Head of Agronomy at Angus Growers, works with manufacturer technical leads to increase the efficacy and success of biological control in their soft fruit production system.

Source: Author's own

Nicole Masters, a soil scientist from New Zealand concurs. Where social rules often stopped change, for example because of aesthetics: “they want to see it looking pretty and don’t want to see weeds” or want to keep “fields looking like they have for years,” she said. However, being part of a community taking part in the same regenerative practices provided space to be able to make change and for new practices to be accepted in that social situation.

We need to encourage these communities of practice, so that those who are pushing the boundaries of IPM, can share, learn, and adopt together in the UK. This could be developing existing UK peer-to-

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peer networks to include a further IPM focus or to set-up new communities interested in these practices.

7.3 EXTENSION ACTIVITIES

On-the-ground extension is a vital component of social pressure. Professor Khan at *icipe* advocates this approach. He has seen positive results of push-pull technology by taking research data, putting it into practice in the field and hosting field days for smallholders.

Sarah Mansfield is another advocate in New Zealand with pasture pests field days to “show what pests actually look like”, said Sarah. A field day provides an opportunity to show the “patchy and diverse” nature of the problem to those attending and explain why an IPM approach has to be adopted. This has been effective in changing the mindset from an ‘I’ll just ignore it until I see it’ to a mentality that damage can be prevented.

7.4 TRUSTED VOICES

In conversations with farmers, advisers, and researchers about the benefits of social pressure, the importance of trust was often mentioned.

As Eric Anderson from the Kellogg Biological Research Station in Michigan stated, you need to have “enough trusted voices”. When he asked who his farmers trust and who they listen to, the response was: “These guys”, referring to their fellow farmers stood around them. Another farmer said their uptake of IPM “takes a while and takes a relationship and a trusted adviser”. Winnie Nunda, an adviser with CABI in Kenya working with communities to eradicate the invasive prickly pear cactus with a beneficial insect, put her engagement success down to listening to the communities’ voices to understand where they are coming from on a very emotional subject and gain the trust to talk about new technology.

As Jilly Hall, a leading social scientist in the UK said, there is a strong relationship between risk, trust and power. If we have high trust, the perception of risk is low, whereas with low trust, the perception of risk can be higher. Trust, explained Jilly, can take many forms though, from manufactured trust to blind trust (faith-based rather than evidenced-based) and is founded on people’s personalities, life experiences and norms.

When working with farmers and advisers to encourage IPM uptake, it is important to work with a range of people to ensure that those engendering the change are ‘trusted voices’ and that this trust isn’t blind but evidenced.

7.5 THE CONSUMER LEAD

Lastly, consumer-led social pressure is renowned as a motivator for change.

Supermarket contracts and public acceptance of products can drive assurance schemes and an increase in IPM techniques, but social pressure is important in the other way too. “Consumers want clean fruit,” said Peter Werts from the IPM Initiative of North America, but Door Creek Orchard, Wisconsin is encouraging consumers to enjoy ‘ugly’ fruit that is grown in an integrated and more sustainable manner.



Figure 21. Door Creek Orchard's consumer engagement of eating their apples, whatever they might look like, as they are still delicious but might not be 100% perfect due to their commitment to an IPM approach.
Source: Author's own

Key messages:

- Social pressure can work both ways and if we put trust in our peers, whether that be fellow farmers, advisers, consumers, or stakeholders; social pressure can be a significant motivator in the adoption of new technologies and IPM practices.
- Creating communities of practice and peer-to-peer learning/networking is important for IPM adoption in the UK arable farming sector.



CHAPTER 8: ECONOMIC STIMULI

We are “risk averse financially before we are risk averse environmentally” said Richard Bramley, a Yorkshire farmer, when discussing IPM. For anyone running a business, financial turnover and returns are vitally important. However much a farm business might be keen to change its practices, it needs to be financially proven. Which economic stimuli can we use to stimulate UK IPM uptake?

8.1 FUNDING, INCENTIVES AND THE CHEAPER ALTERNATIVE

They “have beautiful policies, regulations and laws, but no funding to make it happen” said Irene Koomen who works on capacity building and sustainable development predominantly in Africa from Wageningen University & Research. Irene was referring to low- and middle-income countries and the important role that government funding plays in achieving policy objectives.

Government funding, in the right place, can certainly be an economic driver, but private funding and incentives are also a strong stimulus.

In the Philippines, Irene of Wageningen University & Research told the story of IPM training delivered by a leading manufacturer. She said: “They were providing training and then wondered why it wasn’t having an effect? But they were selling two boxes of pesticide with a free cap and with more boxes, you got a bike or TV!”

Similarly, in the US, explained Daren Mueller of Iowa State University, pre-tax sales have a December deadline. So, typical practice for growers is to buy all their fungicide in December so that they can claim for it with a preferential rate – where it would normally be \$100, it is \$60 in December. “How do you implement IPM, when the shed is already full of a season’s product?” he asked.

The economic incentive for continuing with pesticide use in these two situations strongly outweighs the educational aspect however keen the farmers might be to use non-chemical measures.

Marcel Dehler, of agribenchmark, shared similar stories from Europe, for example on larger farms in North East Germany, where IPM was not playing a very big role. He said: “Pesticides were too cheap ... with low operating costs and low direct costs, it is one of the reasons why glyphosate played such a big role.” The same could be said for the UK and other countries. Where this option no longer exists, “now farmers are forced to come back to IPM and to look for different opinions,” said Marcel.

Carrying out a cultural, mechanical, or biological control alternative to a chemical is often more expensive, if taken purely on a financial basis. This is a challenge for both farmers and the industry, where Bram Klapwijk from Koppert said that the economics had a “big change for open field crops – the turnover changes from turnover/m² in a glasshouse to \$/ha. They cannot afford the insects and we can’t breed enough of them!” How can we get an economic incentive that favours an IPM approach or influences the range of decision-making factors, so that it isn’t purely financially based?

8.2 PREMIUMS

Adding an economic incentive in the form of a premium has been a significant motivator for change in different crops. Australia is the world’s fourth largest exporter of cotton, with 1,200 growers. Uptake of IPM/sustainable practices has only been 12-15% for 20 years, explained Andrew Watson, a cotton grower in New South Wales, Australia. However, over the past few years, through the



Better Cotton Initiative, they have seen a premium at 1% of the value. In addition, Monsanto has provided an extra \$1/bale for the correct qualifications. This has been useful for both corporates, who are able to sell their brand as better cotton and also useful for growers. For Andrew, it has meant an extra \$30,000 dollars - at a rate of \$3/bale for a 10,000-bale grower. This was “quite useful if you get it for two to three years”, ...“a business has got to make money” said Andrew. They have been able to prove that you can farm in a more biological way during this time, for example by using beneficial insects instead of insecticides and doing it profitably. Marketplace acceptance and added value “certainly drove uptake in the industry” said Andrew adding, “now you’re doing it anyway, so might as well continue.”



Figure 22. Andrew Watson, who advocates for the economic incentive for motivating the uptake of IPM practices in his cotton crops. Source: Cotton LEADS

There were many other examples of an economic premium adding the incentive to try new practices among the horticulture growers. One example was Stephen Meale of AG Meale and Sons, who own a farm shop in Norfolk and use tomato boxes labelled with the wording ‘NO INSECTICIDES USED – POLLINATED BY BEES IN A SAFE ENVIRONMENT’. When asked the reasons for doing this, the reply came back “we might as well capitalise” on using biological controls when selling to consumers.



Figure 23. AG Meale & Sons farm shop consumer packaging. Source: Author's own

In horticulture, as with Andrew and the cotton crop, funding for new IPM practices might attract an initial premium but then this often becomes the norm. There were a number of brands I found that had started successfully, such as 'Friendly Grown' or the 'Good Natured Fruit' brands, but the point of difference between growers in the sector became less as uptake became more widespread, and so premiums diminished. Nonetheless, perhaps it provided a sufficient initial boost and incentive to use and understand the approach to enable long-term change.

Could we introduce a premium for use of IPM practices for our arable crops that might further drive the adoption of practices in the sector, which would become the norm?

8.3 BUSINESS BENEFITS

Do we always need a premium attached in the future? 'No' said Australian leek grower, Darren Schreurs, as there are savings to farm businesses from using the IPM approach.

Push-pull technology research, statistics and analysis have revealed the business case for using the practices said Professor Khan including, for example, the rate of return and the return on land – both were seen to be higher with push-pull than a basic inter-crop and a monocrop. Plus, there are intrinsic benefits (no cost to the farmer from buying pesticides that are now not needed and the increase in beneficials from reduced use of insecticides), along with the systemic cost and environmental risks of pesticide use.

Key messages:

- A financial incentive needs to be evident to enable IPM uptake, whether from government funding, market premiums or from inherent business benefits and savings.



CHAPTER 9: TOOLS

Now we have the knowledge, peer support and economic incentives in place, which tools can we use to put IPM into practice?

9.1 RESEARCH

Research is being conducted into current IPM practices and future technologies in countries across the globe. I learnt about and saw fascinating research into areas as diverse as the use of a parasitoid wasp to control the devastating papaya mealy bug in Kenya, prairie strips in the USA and entomopathogenic fungi (EPF) investigations in Brazil for pest control in broadacre crops.

“Training is good, but these farmers are businessmen – [the product] needs to work,” said Leah Mururi from Dudutech. For Dudutech, the “efficacy of a product is really, really, really key” and a lot is invested at many different stages to make sure that this happens. However, for Dr Roma Gwynn at Rationale, she shared that product efficacy can be relied on, as this has to be demonstrated on registration. She believes that farmers are “more concerned about reliability”. Research and trials that can demonstrate both efficacy and reliability are so important, to aid adoption and increase confidence in the IPM approach.

In Kenya, the scale of research in biological control was huge. They were waiting for the next biological control, whereas in the UK we currently wait for the next pesticide active ingredient. Dr Willem Jan de Kogel of Wageningen University & Research stated that “for open crops we are lagging behind”. Do we have sufficient research into IPM practices? In the UK arable sector could that research funding split be further directed into non-chemical control methods than it is currently, to further increase adoption?

9.2 MONITORING AND RECORDING

Using monitoring and recording as a tool frequently enabled a commitment to IPM practices from the knowledge gained.

In horticulture, the reliance on scouting was so important to be able to understand the issue and react quickly. “We can’t be in a curative situation,” said Laban Koima from Kakuzi as there are no quick knock-down solutions for blueberries with only biological controls available.

Kenyan rose growers, Thomas Fransen and Topper Murray, shared how their scouts look at every single plant and record any issues and controls multiple times each week. These are marked using their scouting system and pinpointed to the exact plant so that the control effect and long-term monitoring can take place (Figure 24).

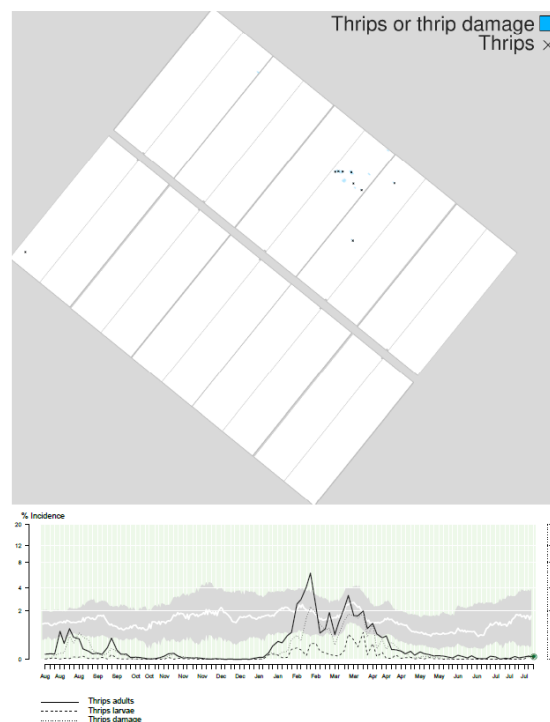


Figure 24. Sticks marking thrips damage in a rose greenhouse and scouting recording showing details of thrips damage for monitoring purposes. Source: Author's own and Scarab

In a field situation, Andrew Watson sees the value of crop recording. He not only records plant data (height, number of branches, number of fruit) and pest data on a weekly basis, but also maps the insect profile against his beneficial numbers.

Grower: Andrew Watson Farm: Date: 3/02/2020

Field	Pests							Beneficials					Crop Development and Health									
	Heliothi s/m	Mirid /m	Stink Bug/ m	ADB /m	Mites %	White fly %	Other	Beetles /m	spiders /m	Bugs/ m	Lace wing/ m	Others	Nodes	Nutrition	Retention FP-1%	Fruiting Branches	NAWF	Vigor / growth	Next irrigation	Comment		
LatA		1a2n		2a	20%	P	Pb,is high	14	7	1dm		Thrip	23-24'					0-3'	Hot	Soon	High shed,cav,boll stings	
N2		4n1a		5n	30%	P	Js	20	5	2dm		Thrip	24-26'		75%		0-3'	Cout	Wet	High sting bolls,shed,cav		
W4		5n		3a	25%	P	Js	15	8			Thrip	24-25'		78%		2-4'	Gd	Soon	Shed,cav,load up,stung bolls		
W11		3n		4n	10%	P	Pb,js	12	6			Thrip	24-25'		83%		2-4'	Gd	Soon	Very,shed,gd boll size		
M2		2.5n		5n	15%	Mod	High js	15	8			Thrip	24-25'		80%	16-18'	2-5'	Ok	Irri	Shed,cav		
MDH		1a2n		4a		P	Js	18	8			Thrip	23-24'		78%	14-15'	2-4'	Cmp	Damp	She,cav,stung bolls		
M4		3n		5na		P	Js	12	6	1dm			24-25'		78%		2-5'	Cmp	Wet	Gd boll load,stung bolls,horn dam		
Red		2n			15%	P	Js	14	7	2dm		Thrip	24-25'		80%	13-15'	3-6'	Gd	Damp	Shed,cav,stung bolls		
N3		4.3n		3n	20%	P	High js	8	5		1n	Thrip	24-25'		78%	15-17'	0-3'	Cout	Wet	Shed,high cav,boll stings		
HSn		4n		3a	10%	P	Pb,js	10	5			Thrip	23-24'		75%	14-16'	2-4'	Tight	Wtch	Heavy shed,stung bolls		
W7						P	Js	8	4			Thrip	18-19'				0			Shed,sunburnt bolls,crckd boll		

Comments:Andrew cotton approaching cutout/ @ cutout. High shed & cavitation in checks verticillium notes affecting some plants w11,LatA. Monitor.. Retention variable, affected by weather and insect pressure. Mirid activity ongoing, damage to bolls high. SLW low-moderate levels in checks but levels appear to be holding. Mites continue to increase watch, may require attention going forward. Reassess after weather coming.

Figure 25. An example report showing pest, beneficial and crop development records from Andrew Watson's cotton crop. Source: Andrew Watson



This has meant that Andrew has only needed to use insecticides once in 18 years as, on that occasion, beneficials were insufficient in numbers to control the pests.

Currently, predominantly in the UK arable farming sector, we focus on monitoring and recording pest, weed or disease – if we focussed on recording beneficials or made greater use of thresholds and data monitoring, might this take us a step forward in using IPM measures?

9.3 TIME

This intensity of recording and monitoring is often possible in horticulture, due to the scale of the site and frequency of staff passing through the crop. Is this same level of monitoring in an arable situation feasible?

Philippa Dodds of Angus Soft Fruits said that she “held hands too much at the start” of their move towards using more biological control methods rather than chemical methods. She could only be there every two weeks, so now encourages growers to do their own checking and monitoring as they are often in the crop, checking irrigation and carrying out field operations. Growers have more opportunity to carry out the monitoring and it has worked well.

In the UK arable setting, an agronomist walking crops once a week or once a fortnight might not have sufficient time to monitor beneficials as well as pests or be able to do it at the right frequency. Does the farmer have the time to do this monitoring? Where IPM and biological controls have proved most effective, the combination of frequent monitoring/scouting by knowledgeable staff has resulted in success. Who does this role in our arable sector? Is there an opportunity for a new post? Or do we need a technological solution to do this at scale? This area that needs to be considered for IPM uptake in the UK arable industry.

9.4 PRACTICES AND TECHNIQUES

A key objective of my Nuffield Farming Scholarship studies was to seek IPM practices and techniques that could be used and adopted in the UK arable sector. From conversations and visits, it was clear that there are a huge range of practices and techniques that can be used.

Techniques can be found abroad and at home, in the arable sector and from across the agricultural industry. The techniques I discovered weren't necessarily new, but my understanding of their potential for the UK arable sector grew as I travelled.

I learnt so much about how parasitoids work and was fascinated by the cultivation process of the parasitic wasp (*Acerophagus papayae*) to control papaya mealy bug in Kenya, illustrated in Figure 26, which was due to be released on the Kenyan coast and would make a real difference to smallholders. If we found the right parasitic wasp for cabbage stem flea beetle, might our problems be solved?



Figure 26. Parasitic wasp cultivation process for the control of the Papaya Mealy Bug. Source: Author's own

Similarly, it was fascinating to learn about the incredible nature of desmodium used as the intercrop 'push' in push-pull technology systems - a repellent for insects, a nitrogen fixing legume providing fertility and soil conditioning and the exudates from the roots providing an allelopathic effect to the yield-robbing striga weed. Could we find a similar species with the same effect on black-grass? That would be IPM in practice!

The practices I discovered are multiple, varied and diverse and I have included a summary of some practices discussed during the study conversations in Figure 27.

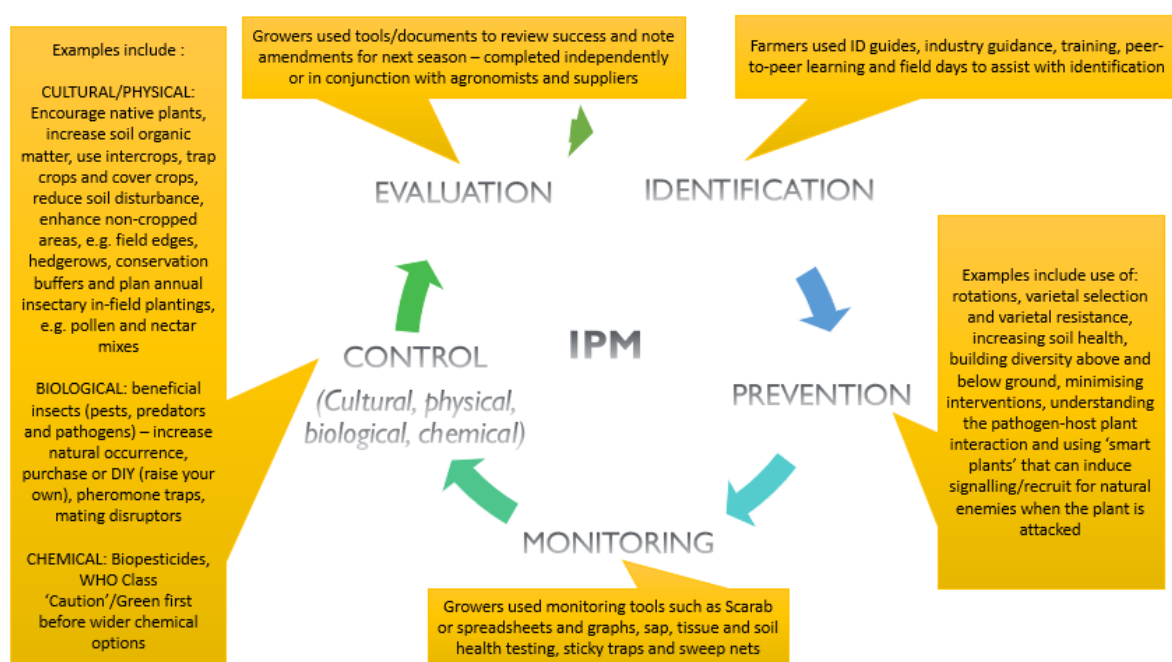


Figure 27. IPM Practices that can be employed on-farm. Source: Author's own



9.5 SEEING IS BELIEVING

Having the research, knowledge of practices and results of monitoring is really important, but there isn't anything quite like seeing results for yourself.



Figure 28. Darren Schreurs using predatory mites as a biological control. Source: Author's own and Peter Schreurs & Sons

Using broad-spectrum insecticides to control pests was the norm for Darren Schreurs, a leek grower in Australia, until one day when working with entomologist Paul Horn who said, “please Darren, stop spraying” and explained an alternative using predatory mites.

Darren set up a trial at home in a fish tank with three leek plants and a grow-light. He took two-spotted mites, his pest, from the field and added six predatory mites. The mite numbers started to reduce and within two weeks, the predatory mites had cleaned up all of the two-spotted mites. Darren had seen how this worked in a controlled environment and it “opened me up to a whole new world”. He now grows leeks on a raised bed, brings in beneficial insects, grows cover crops, uses native trees and grass strips to house beneficials and has adopted IPM across all his crops. There are still some difficulties, for example lettuce aphid that crawl into the heart of the lettuce, but he knows that in most crops if pests come, the beneficials will follow. He has been pleased to see input costs fall and profitability increase.

Henry Wainwright and Louise Labuschagne, from a Kenyan biological control company, took the same approach with new customers that hadn't used IPM before. Traditionally they would be given one greenhouse out of 50ha to try...and it would usually be the worst one! “It would be up to us to prove it works” they said as they had to gain grower confidence in the technology. “Our technology worked; we would make sure it worked.” Once the grower was convinced, they would then roll it out across the whole acreage.

The tools for IPM are many and varied. It is important to use a range of tools, following the IPM approach (Figure) 27, to see effective results.

Increasing the uptake of integrated pest management in UK arable farming by Teresa Meadows
A Nuffield Farming Scholarships Trust report generously sponsored by The John Oldacre Foundation



Key messages:

- Research of new IPM tools and technologies, along with their efficacy and reliability, is essential.
- Monitoring and recording can be a tool to assist in understanding effectiveness and control.
- There are multiple IPM practices that can be employed on-farm, putting them into practice following IPM principles is key to a successful approach.
- Being able to try tools in your own environment to gain confidence of their value in your farm system leads to adoption.



CHAPTER 10: DISCUSSION: INTEGRATED SOLUTIONS

“When you focus on life, biodiversity and soil health, then pests are not a problem,” said Dr Jonathan Lundgren, Ecdysis Foundation Director, as I experienced my Nuffield Farming Scholarship light bulb moment.

“The pests aren’t the problem...we’re creating the problem...pests are a symptom of what we’re doing to the land,” said Dr Kelton Welch, Ecdysis Research Entomologist and Collections Manager. “When you heal the soil, pests are not an issue,” continued Dr Lundgren, adding that for every one pest species, there are 1,700 beneficials.

Suddenly, everything dropped into place as I sat in the fabulous Ecdysis office on Blue Dasher Farm, South Dakota. We need to adopt a system, not a component, encourage diversity and achieve positive soil health. To manage our pests, weeds and diseases, we need to put tremendous effort into building the natural ecosystem and its holistic context. Control will come naturally as a result.



Figure 29. Dr Jonathan Lundgren, beneficial insects’ illustration and Dr Kelton Welch, Ecdysis. Source: Author’s own

10.1 THE ILLUSION OF IPM

“IPM isn’t integrated,” said Ram Yadav, a weed scientist at Iowa State University, during our conversation and referring to how research is carried out in separate departments and the single issue IPM methods that are often implemented on-farm, which was clearly laid out in ‘The Illusion of Integrated Pest Management’ article (Bottrell and Ehler, 2000).

Rather than just using one method, IPM needs to be seen as a chain to have a cumulative effect; Factor A might give 20% control, Factor B = 20%, but added together, they have the power to deliver a minimum of 40%. Inherent ecological activity comes from adding different factors together.

Thinking back over my Nuffield journey and re-reading conversation notes, there were many advocating an integrated approach from beginning to end: “A systems approach is really key,” said the late Caroline Drummond, LEAF, or Nicole Masters, a New Zealand soil scientist, who said that those who aren’t achieving a buy-in to regenerative agriculture, are those not thinking about the farm as a system.

Perhaps I needed to go on this IPM journey – to look into the component parts before this conclusion was clearly identified when talking to the Ecdysis team. Is the real solution to increasing the uptake of IPM not actually linked to IPM at all, but to a changed approach to systems thinking?

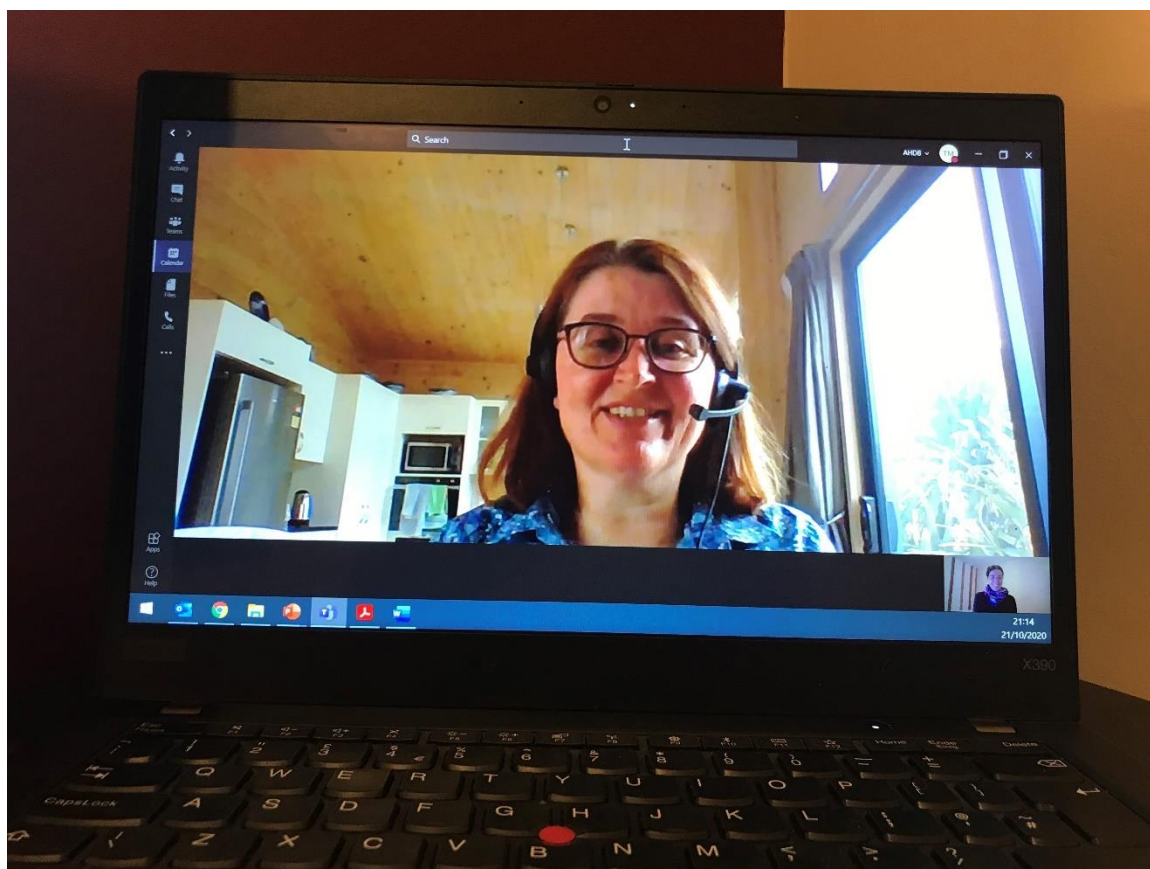


By investing in this change in thinking – rather than small tweaks and short-term thinking (which act as a “band aid” said Katie Dentzman) - the adoption of deep structural change will allow the full realisation of long-term benefits.

“We need to shift from reactive responses that lead to poor economic outcomes, to pre-emptive responses that are viable in the long term,” said Dr Sarah Mansfield, AgResearch. Sarah termed our current practices as “cryptic IPM” where we are practicing IPM, but it isn’t fully integrated.

“Recognising that there is a need for change, and an advantage to adopting an IPM approach, is the first step,” she said.

“If you’re going to do IPM on your farm, you’re going to have to get to know your farm – your crop is an ecosystem,” Sarah elaborated.



*Figure 30. An online discussion with Dr Sarah Mansfield of AgResearch, New Zealand, regarding 'cryptic IPM'.
Source: Author's own*

10.2 AN AGROECOLOGICAL FOCUS

The need to think of the farm as an ecosystem and, in biological terms, the ability of natural resistance to insect pests, weeds and disease, was advocated by many I listened to on my travels, from Roma Gwynn at Rationale, Joan Timmerman of NovaCrop Control, and John Kempf of Advancing Eco Agriculture. If you focus on soil health, nutrient management, and natural biodiversity then you will have a healthy plant with no pest or disease problems.

If you focus on boundaries, beneficials and the agricultural landscape structure, then natural integrated biological control will be successful. “To think ecologically is not only a radical act, but



imperative,” said Gwendolyn Ellen from the Oregon IPM Center in her introduction to the Agricultural Biodiversity on Western Farms Conference.

Beneficial insects don’t come one by one, they come in assemblages, she said. When you begin supplying what they need, you increase on-farm biodiversity at many levels. As Alison, a Californian orchard grower, said they now think: “What can we introduce? Rather than how to control or kill something.”

“If we take a bird’s eye look at the landscape, it is a monoculture,” (Figure 31), said Rachael Long, an Extension Farm Advisor with the University of California illustrated, as is the case in many arable cropping areas around the world.



Figure 31. An illustration of a bird’s eye view of the landscape. Source: Rachael Long

In order to achieve the systems change and enable a functioning agro-ecosystem to allow for successful IPM to take place, we need to “diversify, diversify, diversify.”

Introducing floral resources, field habitats, reducing or eliminating tillage, ensuring diversity – in cropping and across the landscape – guaranteeing soil cover and integrating animals are the key elements to an agroecological system. “When situations have these elements, they don’t have pests,” or wider issues, shared Dr Lundgren.

When I asked Professor Khan whether we have a lack of entomologists to solve the problems of IPM, to carry out research and provide advice, he answered no, “entomological knowledge is not the



most important - agroecology is important, nature friendly farming, taking into account the science of insect control, science of weed control..." and more.

An agroecological, integrated systems focus, coupled with adviser and farmer knowledge in these areas and putting into place combined practices on-farm, will inherently enable integrated pest management.

Key messages:

- Rather than focussing on component research or component solutions for pest, weed and disease management, we need to be focussing on systems level change and the integrated solution.
- Taking a systems approach that focuses on agroecological and regenerative practices to build soil health, plant health and biodiversity will enable IPM to take place naturally.



CHAPTER 11: CONCLUSIONS

Effective integrated pest management using all the principles of IPM, including prevention, monitoring, control, and evaluation, is key to the future of the UK arable farming sector. A step-change in the voluntary uptake of IPM practices is required to achieve future ambitions of food production alongside environmental improvements.

Through my Nuffield Farming Scholarship conversations around the world, online and in-person, it has become clear that there isn't one single factor that will enable the increased adoption of IPM practices. Increasing knowledge (**E**ducation), encouraging communities of practice (**S**ocial pressure), creating incentives, or quantifying the benefits (**E**conomic stimuli) and demonstrating practices that work (**T**ools) all need to be actioned by farmers, agronomists and the industry together. If all of these 'buttons' of the RESET Mindset Model are employed, the uptake of IPM practices will occur proactively before rules determine the change.

IPM practices are many and varied, from the use of *phytoseiulus* predatory mites and nutrient sap testing to encouraging naturally occurring beneficials via flowering strips. They can be taught, seen or learnt from peers or other sectors and some will require further research for our arable environment. However, if we're really to move forward, perhaps we need to think beyond individual IPM practices and consider adopting a system, not just individual components.

My Nuffield study travels have shown that if we increase our focus on plant health and biodiversity and build a healthy, diverse agro-ecosystem then our pest, weed and disease control could be ecologically led in our outdoor arable cropping environment. Rather than thinking: 'How do we control this pest, weed or disease?' can we move to thinking: 'What can we introduce'? Long-term systems change towards an agro-ecological approach should perhaps be our ultimate aspiration to achieve integrated pest management.

In order to be successful, each arable farmer and agronomist are likely to go on a journey, with the different aspects of the RESET Mindset Model acting as a prompt for change and the resultant voluntary adoption, step-by-step, of IPM principles and practices.



CHAPTER 12: RECOMMENDATIONS

By RESET-ing our mindset and putting into practice actions across all five areas of the RESET Mindset Model, we have the opportunity to create a step-change towards the voluntary uptake of integrated pest management in the UK arable sector. This will ensure that IPM moves from classrooms to crops, research projects to fields and from policies into practice.

The industry as a whole needs to put this into practice, to take that step forward – through close collaboration of farmers, agronomists, researchers, extension advisers, government, buyers and consumers.

We need to:



EDUCATION: Invest in training and knowledge

Increase availability of training, encourage wider learning and knowledge about IPM principles and practices, put IPM at the front and centre of training materials and ensure that all principles are understood and followed.



SOCIAL PRESSURE: Create a community

Ensure the use of IPM measures are considered as best practice and supported from across the arable community. Encourage champions at all levels, along with discussion and sharing of IPM successes and learning areas.



ECONOMIC STIMULI: Ensure the economics are in place

Calculate and share the economics behind the changes in traditional areas (costs, return, margin) and the intrinsic business benefits from using an IPM approach. Stimulate long-term change through incentives and funding, where possible.



TOOLS: Research the tools

Fund and encourage research into all of the IPM principles and as an integrated, holistic system on-farm. Highlight IPM practices that can be used for prevention, monitoring and all aspects of control.



RULES: Achieve the change before the rules come into force

The introduction of rules drives innovation and adoption of practices. However, we need to ensure that these are enacted only as a last resort, to allow time for change and innovation to take place using the above approaches.



CHAPTER 13: AFTER MY STUDY TOUR

It has been said that “with Nuffield, doors slam open!” The opportunity to do a Nuffield Farming Scholarship has created new opportunities both during and since the Scholarship travels and studies.

With integrated pest management fast becoming a key Government policy focus, there has been a heightened interest in strategies to enable increased uptake. It has been exciting to have been able to feed in my Scholarship conclusions and recommendations and provide an international perspective into related Defra and private sector projects, such as the new Defra IPM Uptake Theory of Change evidence project and IPM toolbox initiatives.

Steps have begun to put actions from this study into practice, for example through discussions with AHDB on running risk management training with farmers and agronomists to enable further conversations on knowing and managing risk when implementing IPM practices. Putting IPM at the front and centre of BASIS training course syllabi and advocating for increased research on biological controls and the agro-ecological approach in the arable sector, will also be actioned.

Farmer discussion group presentations have introduced the findings and studies to new groups of people. It has been a joy to share my journey and new practices that could be employed on our arable farms in the UK and my hope is that everyone goes home with the same insights that I gained from my travels into the possibilities of future biological control options and can describe EPFs, parasitoids and the principles of push-pull technology now, too!

A Nuffield Farming Scholarship however, is about so much more than your topic. Being able to bring in the differing perspectives of climate change from Kenya and the USA, the varied connectivity to agriculture from communities visited and the importance of food production, standards, and methods to achieve environmental ambitions into conversations with producers, policy makers and organisations has been invaluable.

Completing the travels and study is just the start of my Nuffield Farming Scholarship. I am looking forward to building on the learnings, conclusions, and recommendations to make a difference in our industry in the future.



ACKNOWLEDGEMENTS AND THANKS



Happiness is talking agriculture with farmers, researchers, practitioners, and extension advisers around the world. Completing a Nuffield Farming Scholarship has been a huge honour and privilege.

I would like to thank the Nuffield Farming Scholarships Trust for providing the opportunity and structure to study a topic around the world, make connections and discover new ideas and practices to bring back and share, for my personal and professional benefit and for those farmers and wider industry, in the true Nuffield tradition. To the John Oldacre Foundation

and Ian Tremain - thank you for the funding to make the journey possible, derived from the generosity of a businessman, rooted in family and the countryside all those years ago.

To those that talked, shared, and hosted, from a polytunnel in Scotland to a Friday night Teams call in Bangladesh, from a push-pull maize field in Kenya to research demonstration sites in the USA, the journey has been incredible. With huge and heartfelt thanks to all those that have willingly given their time, opened their doors and shared their passion, experiences and expertise. A Nuffield Farming Scholarship is often said to be all about the people...to all those that have walked, talked, hosted, discussed, laughed, and shared the most memorable of experiences, I thank you.

Completing a Nuffield Farming Scholarship is not possible without a community – thanks go to those that inspired and encouraged me to take the first steps (David Walston, Richard Hinchliffe, Tom Bradshaw, Tom Chapman, Russell McKenzie and Susannah Bolton), and to all those that have reviewed and edited my final presentation and report. To my dedicated AHDB and BASIS colleagues for your enthusiasm, interest, support, and commitment to the opportunity that continuous professional development allows through the completion of a Scholarship journey, thank you.



To my other half, Barrie, and our families and friends – I couldn't have done this without you. For your unending support in a multitude of different ways, for asking about the meetings online and the in-person adventures, for sharing the stories, for provoking the questions and being interested in the findings – the experience has been made so much richer as a result.

To all those that have followed from the start and those I have met along the way, it has been special to share the Nuffield Farming Scholarship so far with you – *thank you*.



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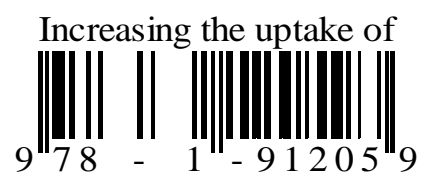
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