A Nuffield Farming Scholarships Trust Report

Award sponsored by

The Richard Lawes Foundation

UK Agronomy: What can we learn from overseas to better curate the use of pesticides?

Mark Dewes

August 2019

NUFFIELD UK

This report is intended for all those who are involved with the Agronomy sector in the UK. This includes farmers, agronomists, pesticide manufacturers and distributors together with researchers and those who govern the industry.

NUFFIELD FARMING SCHOLARSHIPS TRUST (UK)

Awarding life changing Scholarships that unlock individual potential and broaden horizons through study and travel overseas, with a view to developing farming and agricultural industries.

"Leading positive change in agriculture"

"Nuffield Farming" study awards give a unique opportunity to stand back from your day-to-day occupation and to research a subject of interest to you. Academic qualifications are not essential, but you will need to persuade the Selection Committee that you have the qualities to make the best use of an opportunity that is given to only a few – approximately 20 each year.

Scholarships are open to those who work in farming, food, horticulture, rural and associated industries or are in a position to influence these industries. You must be a resident in the UK. Applicants must be aged between 22 and 45 years (the upper age limit is 45 on 31st July in the year of application). There is no requirement for academic qualifications, but applicants will already be well established in their career and demonstrate a passion for the industry they work in and be three years post tertiary education. Scholarships are not awarded to anyone in full-time education or to further research projects.

Full details of the Nuffield Farming Scholarships can be seen on the Trust's website: www.nuffieldscholar.org. Application forms can be downloaded and only online submission is accepted.

Closing date for completed applications is the 31st July each year.

ISBN: 978-1-912059-18-8

Published by The Nuffield Farming Scholarships Trust
Southill Farm, Staple Fitzpaine, Taunton, TA3 5SH
Tel: 01460 234012
Email: director@nuffieldscholar.org
www.nuffieldscholar.org

A UK Nuffield Farming Scholarship consists of:

(1) A briefing in London.

(2) Joining the week-long Contemporary Scholars' Conference attended by all new Nuffield Farming Scholars worldwide.

(3) A personal study tour of approximately 8 weeks looking in detail at the Scholar's chosen topic.

(4) A Global Focus Tour (optional) where a group of 10 Scholars from a mix of the countries where the scheme operates travel together for 7 weeks acquiring a global perspective of agriculture.

*****

The Nuffield Farming Scholarships scheme originated in the UK in 1947 but has since expanded to operate in Australia, New Zealand, Canada, Zimbabwe, France, Ireland, and The Netherlands. Brazil, Chile, South Africa and the USA are in the initial stages of joining the organisation.

A Nuffield (UK) Farming Scholarships Trust Report

Date of report: August 2019

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

Title	UK Agronomy: What can we learn from overseas to better curate the use of pesticides?
Scholar	Mark Dewes
Sponsor	The Richard Lawes Foundation
Objectives of Study Tour	• To examine the role of the Agronomy industry, legislation and other factors in the UK, to assess their effect on pesticide use. • Compare and contrast this situation with that in other countries. • Make recommendations for the future direction of the UK Agronomy sector to help drive sustainable productivity improvements in UK arable farming.
Countries Visited	Germany, Denmark, Canada, Italy, Brazil, Uruguay, France
Messages	Introduce more accountability to the agronomy sector both financially and for the long-term stewardship of the pesticides we use by: a. Making agronomists' decisions more financially accountable b. Introducing Treatment Frequency Index as the metric for pesticide use c. A voluntary pesticide reduction programme administered through a new body: Responsible Use of Pesticides in Agriculture (RUPA) d. Reinforcing farmer to farmer KE through the AHDB Monitor Farm programme and others.

EXECUTIVE SUMMARY

The use of plant protection products or pesticides has become an established part of the management of arable crops. The complexity of the pesticide market stimulated the birth of a trade, practitioners of which have become known as agronomists. Agronomists exercise a great deal of influence over pesticide use in the UK. The out-sourcing of pesticide management to agronomists has contributed to a disengagement of farmers from their own agronomic decision making. This disengagement appears greater than that which I observed in other countries for a number of reasons including the diversified nature of UK farm businesses, the opacity of our pesticide market and the compulsion by assurance schemes that farmers engage qualified advisors.

Systems in which UK agronomists operate, as sub-contracted pesticide managers, lack established lines of accountability. This applies both to agronomists who sell products and those who work independently. I believe this system of working encourages the use of pesticides at levels above the economic optimum for growers and takes too little account of the long-term stewardship of pesticides. The data collected on pesticide use are insufficient to determine how appropriately these products are being used at a landscape level, but studies conducted in France conclude that significant reductions in use could be made on most farms without reducing productivity.

None of the countries which I visited employ systems which address all of these issues, but I observed examples of mechanisms of accountability which could offer improvements to the UK. Incentivising agronomists by measurements of productivity in South America and the evolution of pesticide use metrics in Denmark were two such examples. Other useful examples have been drawn from the efforts to better steward antibiotics in medicine and agriculture.

The genetic development of crops offers the potential to reduce our reliance on pesticides and extend the sustainability of crop production systems. UK and European legislators should take this into account.

The following interventions to UK Agronomy should result in better long-term stewardship of pesticides, their more cost-effective use and a reduction in their diffuse, unintended effects:

- Launch a new concept in agronomy and crop input supply where agronomists become financially accountable to our decision-making, using crop gross margins as success criteria.
- Introduce Treatment Frequency Index (TFI) as the measure of pesticide use and make it one of the reporting requirements for the Integrated Pest Management Plan.
- Borrow the livestock industry's approach to antibiotic management by creating a task force for the Responsible Use of Pesticides in Agriculture. Agree targets based on voluntary, self-reported pesticide reduction, measured by three-year rolling averages of TFI.
- A drive towards a system support, rather than product support model of agronomy. This should be facilitated by a re-doubling of the AHDB's focus on peer to peer knowledge exchange through bench marking groups and monitor farms. External resources and expertise should be sought to develop this project into a self-sustaining movement which can meet the challenges of descending "Peak Pesticide".

CONTENTS

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.

CONTACT DETAILS

Mark Dewes

Markedwarddewes@gmail.com

+44 (0)7967 811373

Nuffield Farming Scholars are available to speak to NFU Branches, Agricultural Discussion Groups and similar organisations

Published by The Nuffield Farming Scholarships Trust
Southill Farmhouse, Staple Fitzpaine, Taunton TA3 5SH
Tel : 01460 234012
email : director@nuffieldscholar.org
www.nuffieldscholar.org

1. Introduction

My name is Mark Dewes. I grew up on a farm and I've always belonged to the land but knew from an early age I needed to find a living away from farming alone. I had heard of the job title "agronomist" and liked the idea of going to other people's farms as a paid visitor. I had a vision of being called on to deliver solomonic wisdom on record-breaking crops. I'm still working on that bit, but I have called myself an agronomist since 1996 when I started work for ADAS. I continued with ADAS, then TAG until 2010 when I left to set up my own company, again as an independent agronomist. Having taken that company as far as I thought I could, I wound it up and took a job as a sales agronomist for Agrii in 2015. Throughout that time I have also run my own farming business, currently growing around 100 hectares of arable crops on owned, tenanted and contract farmed land near my home in Withybrook, North Warwickshire. I live there with my wife and two children on a farm which once belonged to my Grandparents.

Figure 1: Mark Dewes author of this report

Having worked in the two main systems of agronomy delivery (independent and sales) in the UK for some time, I have remained ambitious for improvements in the way advice is delivered to the arable sector. Being an agronomist is an important and well-paid role which some excellent people fill. However, I believe the systems within which we work often fall short in delivering the best value to our customers and the industry at large. So, as my 45th birthday was approaching, I took my chance

of an international study tour to seek out better ways of operating by applying for a Nuffield Farming Scholarship

I was fortunate to be awarded the scholarship in November 2017 with the kind patronage of The Richard Lawes Foundation.

2. Background to my Study

An agronomist is defined by the Oxford Dictionary as “An expert in the science of soil management and crop production”. When I tell people unfamiliar with farming what I do, they are often surprised that the role exists: “Don’t farmers already know how to grow their crops?” is a typical response.

The fact that most arable farmers consider it necessary to employ an agronomist is a result of a combination of legislative and cultural issues which have largely been shaped by the development of the pesticide industry. I will refer to these issues throughout this report.

As our relationship with pesticides evolves, particularly in Europe, and in the UK on the fringes of that jurisdiction, then the role of the agronomist must surely evolve too.

I have always been curious about the development of the agronomy sector in other countries. The idiosyncrasies of the UK model seem so unlikely when considered to the lengths that I have on my solitary route marches around thousands of acres of arable crops.

I have asked myself the following question: Why are we using more pesticides when they are becoming less effective? While I haven’t found a complete answer to this question, I have examined the UK model, compared it to others in different parts of the world and suggested improvements that could help in our future relationship with pesticides.

I found a great willingness to share experience on my travels both abroad and in the UK. I remain extremely grateful and humbled by the generosity and the desire of those whom I contacted to engage with, and host me during my scholarship travels. With their help I have tried to offer an independent view from the inside, to critique the industry and make specific recommendations for improvement

3. Study Tour Details

During 2018 and 2019 I spent nine weeks travelling to countries including Denmark, Germany, Canada, The Netherlands, Italy, France, Brazil and Uruguay along with many visits within the UK. I met with agronomists, farmers, pesticide manufacturers, sales staff, researchers, policy makers and other stakeholders in the world of agronomy. I thank them all for their candour and assistance.

Figure 2: A reception committee of farmers and agronomists in Parana, Maringa, Southern Brazil

4. Genesis of the Modern Agronomist

A local UK farmer told me of his first memory of working with his agronomist from the 1950's: "He rang at lunch time and told me to nip into Boots to pick up a can of 2-4D for the Long Meadow. He said that he'd leave it behind the Lipstick counter". From these beginnings, the modern agronomist was born. This brief story illustrates the early role which has become associated with the term agronomist as used in the UK.

While agronomists who make their money from selling products will recognise their origins in our Boots rep from the 1950's, those who charge solely for their advice may take exception to sharing this evolutionary root. The two main branches of the UK agronomist family tree are those of the Sales and the Independent agronomist. They have become competitors in the market to decipher the complexity of pesticide use for their farmer clients, and it is the perpetuation of this complexity which has, in part, evolved their role. Although Independent agronomists do not profit from the sale of the products they recommend, their position is equally reliant on the pesticide market as those who sell products directly.

Through the second half of the twentieth century the development of new active ingredients for use as pesticides in agriculture brought about huge increases in productivity. It also created an industry to support the development, testing, marketing, sales and technical support of these new products. The use of pesticides has been seen as sufficiently separate to the overall operation of farming to be largely sub-contracted out to a specialist. The complexities of the pesticide market and industry governance have been contributory factors in shaping the agronomy of a crop as the preserve of an out-sourced expert.

There is a perception that it is a legal requirement to employ an agronomist in the UK. This is incorrect. BASIS is the organisation which administers the certification of advisors and sales people in the pesticide industry. It is a legal requirement for pesticide sales staff to hold a BASIS certificate, but the requirement to source advice from a qualified advisor is derived from the Red Tractor assurance schemes. This effective enforcement has done a great deal to elevate the agronomist's role on UK farms and has contributed to the institutionalised dependency of many farmers on their agronomists. This dependency has led to the disengagement of many farmers from the decision making involved in growing their own crops. The situation is further amplified by the diversified nature of many UK arable farms in comparison to their overseas arable counterparts. For example, when meeting with a group of around 20 large arable farmers from the Schleswig-Holstein area I found none of them engaged in significant business diversification but when dealing with similar groups within the UK, the majority of arable farms have diversified business income which divides their management resource. Necessity for concentration on other parts of their business often encourages UK farmers towards the out-sourcing of decision-making in the arable production section of their businesses. In turn these factors have left many agronomists with a greater and increasing level of responsibility. This level of responsibility is not always sought and can contribute to the high level of stress felt by agronomists when responsibility is assumed without control. I have felt this personally and seen other colleagues suffer in the, often solitary, world of the agronomist. Sought after or otherwise this responsibility has cemented our role as essential on many farms.

Many UK agronomists have always been, and are increasingly, involved in decision making outside of pesticide use. It is interesting to consider what the market for agronomists would be in the absence of pesticides. Looking at the organic arable sector in the UK, the attitude is understandably different. Absent from this sector seems to be the concept of a professional advisor on a regular farm visiting routine, secured either through an annual retainer fee (acreage charge) or the commitment to purchase crop inputs through that advisor's employer. It seems a reasonable hypothesis to suggest that the wide and complicated array of pesticide application choices is the principal reason for the engagement of a regular agronomist (sales or independent) by most UK arable farmers. Indeed, a recent poll by the distributor company Hutchinsons (*Fieldwise December 2018)* indicated that 88% of arable farmers use a regular agronomist to inform their decision-making. Despite the wide-scale influence of agronomists, no formal systems of accountability are employed to monitor agronomists' decision-making. Farmers do have the option to dispense with the services of their agronomist offering the ultimate form of accountability; however, in my opinion this is a rather blunt tool which is not commonly used.

The backdrop of pesticide use is changing. The reduced flow of new pesticides to the market, the loss of large numbers of previously authorised active ingredients through legislation, and the rapid increase in resistance of many pests, weeds and diseases to existing chemistry are all well documented. If we accept that an agronomist's *raison d'etre* is to manage pesticide use, then these changes must surely have an impact on our role.

Figure 3: Agronomist Soenke with client Philip, in Schleiswig- Holstein

Specific factors in different areas of the world have influenced the evolution of their agronomists' role. The role of the UK agronomist and our associated supply chains are unusual when compared to

our international peers. For example, Soenke (pictured above with his client Philip in Schleiswig - Holstein in Germany) is an agronomist who leaves precise field recommendations to his customers. He spends most of his time helping a group of farmers benchmark their businesses to improve their productivity.

Indeed, the role of agronomist as someone who inspects the crop frequently and prescribes regular, detailed recommendations for pesticide use is not one universally recognised in that part of the world. The absence of assurance schemes to enforce a pesticide advisor's qualification, together with less diversified arable businesses have evolved a system where farmers have not become as dependent on out-sourced agronomy as those in the UK.

Figure 4: Agronomist Francisco and his CREA group colleagues in Uruguay

Move to South America and we find agronomists like Francisco from Uruguay (pictured above centre with two members of his CREA group). FUCREA (La Federación Uruguaya de Centros Regionales de Experimentación Agropecuaria) is a non-profit civil association integrated and directed by agricultural entrepreneurs who meet in groups to share experiences and knowledge. Here the focus is on finding farm business management solutions from other farming members rather than from the agribusiness supply chain. The influences of a Latin culture where business and socialising are commonly mixed are named as reasons for the success of this movement.

Jette and her colleague pictured below work for Landbosyd in Denmark and are both independent agronomists. They spend much of their time making strategic pesticide/fertiliser plans and recording the application details for their customers to satisfy reporting criteria for government. They leave much of the detail of the application of these inputs to their clients who refer back to them remotely or in group meetings. The long-standing and onerous Danish legislation regarding farming and its

inputs have sustained an unusually large number of independent farm advisors. Most of these agronomists are employed by companies previously owned by local farming unions. There is estimated to be one advisor for every three farmers in Denmark. While this may be something of a rural myth, the scale of the advisory sector was plainly much greater than in the UK.

Figure 5:. Jette and her colleague, independent agronomists at Landbosyd, Aabenraa, Denmark

Chapter Conclusions:

The principal role that keeps agronomists in regular employment in the UK is to decipher the complexity of pesticide use.

A combination of factors has led to an institutional dependency of UK farmers on their agronomists. This has disengaged farmers from their decision making and placed a disproportionate level of responsibility on their agronomists. Systems of accountability have not been employed to monitor UK agronomists' decision-making.

This agronomist role is not the same in all countries and a range of influencing factors dictate what that role is and what importance is attached to it.

As pesticide use changes then so will the role of the agronomist.

5. The metrics of Pesticide Use

5.1 UK Data

UK Government does not have a specific pesticide reduction target or stated ambition. It does, however, frequently imply that it would like to see reductions in their use. Michael Gove's carefully chosen words in 2017 mentioning the "Drenching of soils in chemicals" triggered a great deal of debate in arable farming circles. Comments such as these have stimulated a re-examination of attitudes and practices around pesticide use.

FERA (Food and Environment Research Agency) is the UK organisation which began over 100 years ago as the Institute for Plant Pathology services and is tasked by government to collect data on pesticide applications. FERA samples 6% of arable farms and extrapolates this data to reflect overall UK use in terms of number of applications and weight of pesticide used. Their reports show that farmers in the UK have reduced the number of kg of active ingredient used by over 50% between 1990 and 2015 but there has been a recent reversal in this trend associated with increased use in response to falling efficacy due to resistance build-up. In the period 2010 – 2018 the weight of pesticide applied to arable crops increased by over 15%. (*FERA 2018(1)).*

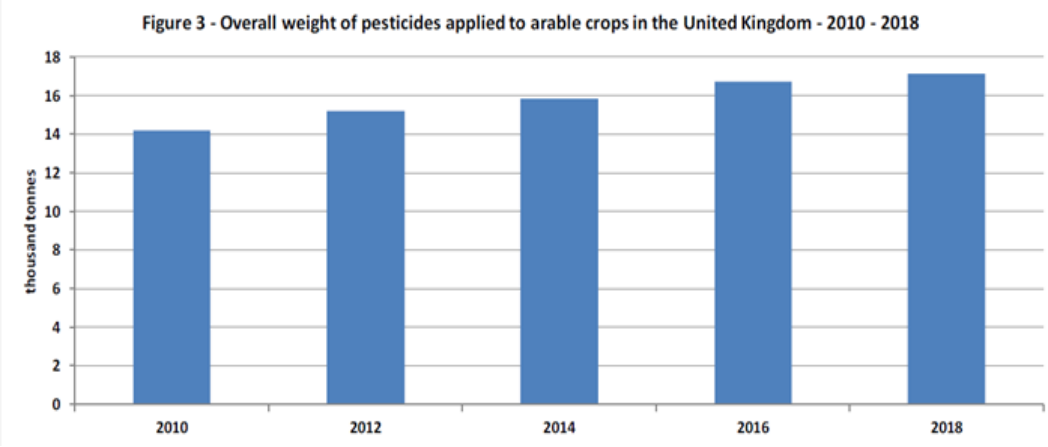


Figure 6 Overall weight of pesticides applied to arable crops in the United Kingdom – 2010- 2018

(Source FERA 2018 Pesticide Use Survey (2))

The number of hectares treated has also risen as shown below specifically for cereal crops over a longer time frame.

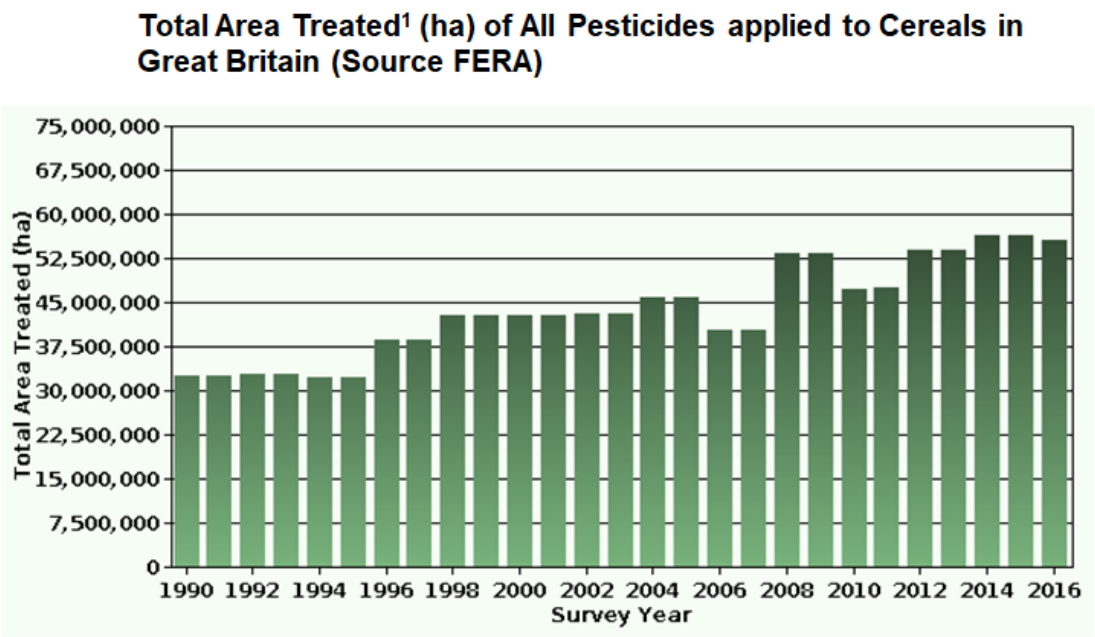


Figure 7: Pesticide use trends by number of hectares treated

(Source FERA Pesticide Use Survey 2018(3))

Weight of product and number of applications are somewhat crude metrics and do not take into account equivalent dose rates per hectare or the relative activity of one active ingredient against another.

5.2 Treatment Frequency Index

Another more useful metric is a system called Treatment Frequency Index (TFI). This calculates the combined full rate equivalent of pesticide use for any given area or crop. For example;

0.75 Rate Herbicide

0.5 rate Fungicide

0.5 rate Fungicide

1 rate Insecticide

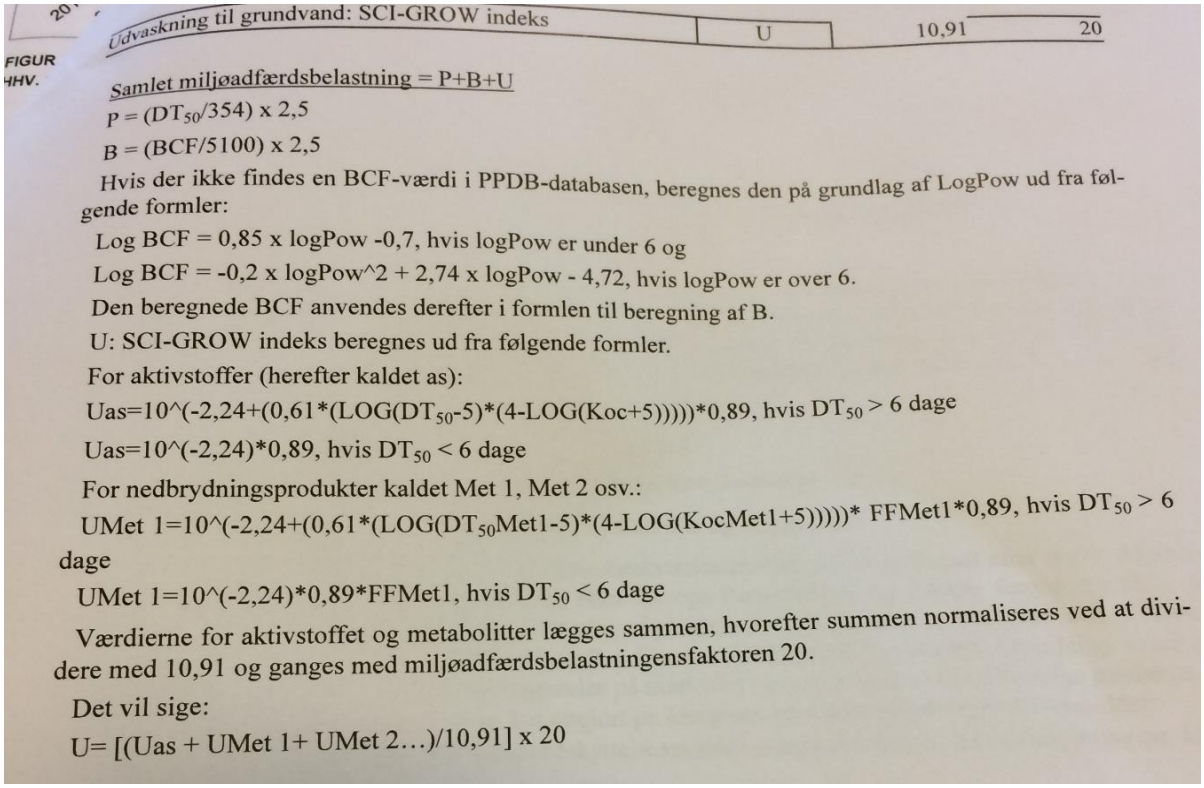
TFI = 0.75 + 0.5 + 0.5 + 1 = **2.75**

Olivier (pictured below) farms near Chartres in France. He is part of the DEPHY network of farmers who are seeking to reduce their reliance on pesticides. The DEPHY network (named from an acronym derived from the description of the group's objectives: Réseau de Démonstration Expérimentation et production de réfèrences sur les systems économiesen PHYtosanitaires) is a government funded knowledge exchange platform intended to promote the reduction in pesticide use which government has optimistically targeted at 50% by 2025. Although Olivier is committed to reducing pesticide where commercially advantageous, neither he nor the other French practitioners I discussed this with have any conviction that this target is realistic.

Figure 8: Olivier farmer and Dephy Network member Chartres, Loire Valley, France

5.3 Pesticide Load Index, Denmark

Denmark was particularly precocious in its development of a pesticide reduction strategy. Having implemented a similar reduction target to France's current model based on TFI in the 1990's it became clear that significant changes, not least in culture, would be required to make headway in reaching those targets. Partly in reaction to this difficulty and partly to address the failings of TFI as a metric, Danish authorities introduced the Pesticide Load Index (PLI) for measuring the impact of pesticide use. PLI has been accepted but few practitioners would claim to understand the complexity of its calculation. As well as the cumulative dose, the PLI seeks to measure the environmental impact of a product in a weighted equation. This is used both in recording pesticide use and to calculate the tax to be levied on each product. The picture below shows an example of the equation used to determine the PLI of a product. The concept of the PLI is undoubtedly superior to TFI as it takes into account a range of factors including toxicity, longevity and effect on operators. The complexity and contested nature of these assumptions have largely been overcome in Denmark. However, to transplant this system in another country with a different set of active ingredients and environmental/productivity priorities without first going through some of the evolution that Denmark has lived through would, I believe, prove very problematic.



Udvaskning til grundvand: SCI-GROW indeks | U | 10,91 | 20

Samlet miljøadfærdsbelastning = P+B+U

$P = (DT_{50}/354) \times 2,5$

$B = (BCF/5100) \times 2,5$

Hvis der ikke findes en BCF-værdi i PPDB-databasen, beregnes den på grundlag af LogPow ud fra følgende formler:

Log BCF = 0,85 x logPow -0,7, hvis logPow er under 6 og

Log BCF = -0,2 x logPow^2 + 2,74 x logPow - 4,72, hvis logPow er over 6.

Den beregnede BCF anvendes derefter i formlen til beregning af B.

U: SCI-GROW indeks beregnes ud fra følgende formler.

For aktivstoffer (herefter kaldet as):

$Uas=10^{(-2,24+(0,61*(LOG(DT_{50}-5)*(4-LOG(Koc+5)))))*0,89}$, hvis $DT_{50} > 6$ dage

$Uas=10^{(-2,24)*0,89}$, hvis $DT_{50} < 6$ dage

For nedbrydningsprodukter kaldet Met 1, Met 2 osv.:

$UMet\ 1=10^{(-2,24+(0,61*(LOG(DT_{50}Met1-5)*(4-LOG(KocMet1+5)))))*}$ FFMet1*0,89, hvis $DT_{50} > 6$ dage

$UMet\ 1=10^{(-2,24)*0,89}$*FFMet1, hvis $DT_{50} < 6$ dage

Værdierne for aktivstoffet og metabolitter lægges sammen, hvorefter summen normaliseres ved at dividere med 10,91 og ganges med miljøadfærdsbelastningensfaktoren 20.

Det vil sige:

U= [(Uas + UMet 1+ UMet 2…)/10,91] x 20

Figure 9: A photograph of an example of the complex equation used to calculate the Pesticide Load Index of pesticides in Denmark

When I broached the subject of pesticide use metrics in Canada and South America with researchers, farmers, agronomists, pesticide manufacturers and other stakeholders it was notable that the subject had not been discussed to any great extent. It appears that European countries have given more consideration to the subject.

5.4 'Peak Pesticide?'

There is a body of opinion that suggests that pesticide use and effectiveness have peaked in the UK and other European countries. This opinion is supported by conversations with senior managers of pesticide manufacturing companies including Chris Cooksley (European Strategy manager for Bayer CropSciences) and Andrew McConville Global Head of External Affairs and Communications Syngenta. Syngenta make commitments (via its evolving website) that food "production needs to be achieved sustainably: with fewer pesticides" (Syngenta 2019) However, this commitment is less well supported by the pesticide use statistics illustrated above. I believe that pesticide effectiveness has peaked but a lag in the peak of pesticide use may be partly due to inadequacies of the metrics used to gather data and also the inertia of the system which supports pesticide use. If we have reached "Peak Pesticide" in the UK over the last few years we are now descending that summit by reducing use and substituting pesticides with other management interventions. The increase in spring cropping (with its reduced pesticide input) in the UK as a response to herbicide resistant black-grass is just one example.

Chapter Conclusions:

The weaknesses in the measuring system for pesticide use in the UK leaves the industry poorly placed to assess the appropriateness of pesticide use on a landscape scale.

In Europe, legislative pressure has coincided with greater reliance on fewer remaining pesticides which suffer more from resistance build up as active ingredients are lost. Non-pesticide management interventions have not yet bridged that gap and an increase in pesticide use has been recorded.

Subsequently and as yet undemonstrated by the data which is currently collected, I believe we are at "Peak Pesticide" in the UK, as more non-pesticide management interventions begin to replace pesticide use.

6. How much is too much?

Many areas of society and business require a ”social licence” to operate, particularly those with wide ranging and diffuse effects on the environment and societal well-being. Examples such as the gambling industry, social media, personal financial services, the energy market and many others are facing increasing government and self-imposed regulations to maintain their social licence to operate. Pesticide use as part of food production is facing increasing pressure to maintain its own social licence.

The role of the agronomist in the UK includes determining the “correct” use of pesticides. “Correct” can cover a wide range of circumstances but is generally considered to be the amount and mix of pesticides which gives the optimum economic outcome while fitting into the growers’ success criteria and current legislation. A great number of trials are conducted in the UK and around the world to demonstrate the performance of different products in different circumstances; for example, the Nordic database pulls together a range of independent trials results from Norway, Denmark, Sweden and Finland. These trials results are fed into decision support software to help Danish agronomists generate crop management plans.

Figure 10: Agronomist Jens with a group of farmers in Jutland, Denmark

In spite of this wealth of data it is rare to attempt to assess how close to the optimum pesticide use has actually been. The study "Reducing pesticide use while preserving crop productivity and profitability on arable farms" (*Lechenet at al. 2017*) has attempted to assess just that on a landscape level in France by studying the effects of various levels of pesticide use on the profitability and productivity of 946 non-organic French farms. It generated some challenging conclusions. Although contestable, it suggests that pesticide use was substantially above the optimum. Indeed, the report states that pesticide use could be reduced by 42% on 59% of the farms in the survey without reducing productivity.

A domestic example is to be found within cereal fungicide use in the UK. Despite substantial fluctuations within weather patterns from year to year the use of fungicides is remarkably stable. This should come as no surprise when we consider the lack of incentive for agronomists to tailor programmes too closely to the economic optimum. Without a trial in every field it is impossible to tell the difference between a fungicide programme which was excessive and one which was adequate. The only obvious difference is in the programme which was substantially inferior; hence the motivation for a programme to be designed "comfortably" above the economic optimum by those who have decision making responsibility but are unaccountable to the financial outcome. There is of course the concept of risk in this process and one of the first questions to answer for farmers and agronomists in making fungicide decisions should be "What are the current risks and what is our attitude towards them?"

The concept of insurance is often used with regard to fungicide use. Individuals can opt for more or less robust levels of insurance according to their attitude to risk. 'Insurance' seems to me a very poor analogy for fungicide use. Insurance usually involves a relatively small premium pooled by a large number of people to account for the large cost of an unlikely peril. Fungicide use at the levels commonly employed involves a cost which is a substantial proportion of a commonly experienced and somewhat predictable peril.

One simple, practical way of addressing this conundrum was evident in Germany where it is standard practice to have an untreated control in every field for fungicide applications. Where a field of wheat receives three fungicides in a season, then there will be small plots which receive zero, one or two of those applications only so that the full treatment can be assessed in comparison with the reduced treatments and the untreated.

Although the paragraphs above have concentrated on fungicide use due to the wide availability of trials data with comparative yields, there are similar pressures on decisions involving herbicide, molluscicide and insecticide use.

Figure 11: Philip and Soenke assessing different levels of fungicide application in German wheat

Chapter Conclusions

It is likely that the use of pesticides in the UK is greater than optimal. This conclusion has been demonstrated to be the case in France and is supported by my own observations.

Decision making by agronomists who feel no impact from the financial outcome of their decisions tends to overshoot the economic optimum to provide a safety net. Conversely, we react too slowly and are too inhibited when significantly greater use of pesticides would provide better economic outcomes.

Untreated trial plots should be used routinely to assess the visual efficacy of treatments (particularly fungicides).

7. Sustainable Pesticide use in the UK

7.1 Self-regulation

The Sustainable Use Directive (SUD) is a European Directive which calls upon all countries in the EU to develop a National Action Plan with regard to pesticide use. This plan is periodically reviewed and prompted the establishment of the UK industry's self-regulation body - The Voluntary Initiative (VI). The VI has been responsible in the UK for overseeing the introduction of the testing of sprayers through the NSTS (National Sprayer Testing Scheme) and NRoSO (National Register of Sprayer Operators) training and CPD (Continual Professional Development). These initiatives have relied upon the widespread membership of Red Tractor assurance schemes to enforce their on-farm application. It is the assurance scheme auditor who is required to see the training certificate of the operator and the "MOT" (NSTS proof of safety) certificate for the machine. These measures have been widely welcomed as being an effective method of increasing the standards of machinery and its use. However, there has been increasing dissatisfaction, particularly from the environmental sector of the organisation's stakeholders. This culminated in the withdrawal of support of the VI in April 2019 by the RSPB and also the Wildlife and Countryside Link (which represents bodies like The Wildlife Trusts and Butterfly Conservation). In a letter to Mr Gove, the Secretary of State for the Environment at that time, the charities said: "Our organisations have long participated in these voluntary groups in the hope that they would lead to better protection for the environment. However, in that time they have failed to take meaningful or significant action to reduce pesticide-related harms." (*Daily Telegraph 19/4/19*).

The National Action Plan has, so far, stopped short of requiring specific reductions in pesticide use; I believe that position will and should change.

7.2 Anti-microbial Resistance

There is a very relevant comparison to be drawn from the agricultural industry's response to the issue of Anti-Microbial Resistance (AMR). The issue of AMR has a much more directly correlated link to human health than pesticide use, but there are clear parallels in the use of synthetic products with external costs and consequences used for the improvement of productivity in the food chain. Antibiotic use in agriculture poses a direct threat to human health by increasing levels of Anti - microbial resistance to pathogens in the livestock population which could move into human populations. Pesticides can pose direct threats to humans through exposure at application or through residues in food, although the licensing procedure seeks to avoid that. The greater threat to the wider environment comes from the unintended effects of pesticides on non-target organisms and ecosystems.

7.3 RUMA; Responsible Use of Medicines in Agriculture

RUMA (Responsible Use of Medicines in Agriculture) has widespread industry support. It was founded in 1997 and was tasked with overseeing the responsible use of medicines in livestock production. In May 2016, instigated by HM Government, Jim O'Neil chaired the committee which produced recommendations, published by the Wellcome Collection, and entitled "Tackling Drug-

Resistant Infections Globally" (O'Neil 2016). This report dealt with the situation of Anti-Microbial Resistance and its effect on human health. It generated recommendations for the stewardship of Antimicrobials (particularly antibiotics) and made specific reference to the way in which they are used in agriculture. I do not seek to diminish the gravity with which this report should be viewed by transposing the principles onto pesticide use; I am well aware of the gulf in impact on human health there is between the effects of irresponsible use of antimicrobials versus pesticides. However, if we apply the principles of the O'Neil report onto pesticide use there are some striking areas of similarity. Intervention 3, as recommended in the report, is to "Reduce unnecessary use of antimicrobials in agriculture and their dissemination into the environment". This recommendation prompted a government response; stating "We will reduce antibiotic use in livestock … we will work closely with individual sectors to ensure that appropriate sector specific reduction targets are agreed by 2017 so that the future reductions are greatest where there is most scope" (*HM Government 2016*). In turn this prompted RUMA to instigate their Target Task Force whose mission is to move closer to optimal use of antibiotics. RUMA members' acceptance that historic use was, in some areas, super-optimal has resulted in reduction targets that have both improved their production systems and is satisfying the objective of reducing antimicrobial use. In all livestock sectors a commitment has been made to the maintenance or reduction of antibiotic use. For example; the Pig industry has recorded a reduction in antibiotic use from the baseline of 263.5 mg/kg (2015) to 110 mg/PCU in 2018 and is committed to reducing further to its target in 2020 to 99mg/kg which will represent a total reduction of 62% (*RUMA Target Task Force: Two Years on October 2019*)(1).

The difficulties of data collection exist in the same way in the livestock industry as in the arable sector. This has been addressed by RUMA with an acceptance that collecting a large proportion of data is better than nothing and that delaying any action until all data can be collected is based on an unrealistic expectation which would hamper any progress. For example; RUMA believe they captured 61% of antimicrobial use data for the pig sector baseline figures (*RUMA 2017 Target Task Force (2)*).

The question of data collection and harmonised metrics is dealt with by both the O'Neil report and RUMA. The O'Neil report recommends the use of mg of antimicrobial use per kg, but allows some flexibility, which has been adopted, for instance, by the egg production sector which uses a metric of "number of medicated days per 100" (*RUMA 2017 Target Task Force (3)).* This demonstrates how different sectors can be pro-active in reporting their resolution of an issue through appropriate metrics.

7.4 RUPA; Responsible Use of Pesticides in Agriculture - a-recommendation

Referring back to Chapter 5 on the metrics of pesticide use, the UK arable industry should adopt the measurement of Treatment Frequency Index. This should also be used for the implementation of voluntary pesticide reduction targets monitored by an organisation on similar principles to RUMA. The data is already available for the vast majority of the industry through the crop recording software which is employed on most farms. Adopting voluntary reduction targets would introduce a balancing consideration in the decision-making process which I believe currently has a pre-disposition to the super-optimal use of pesticides.

I recommend that a sister organisation should be founded to replicate this work in the pesticide industry. This could evolve from the Voluntary Initiative. RUPA (Responsible Use of Pesticides in Agriculture) should elicit pesticide reduction targets from different sectors which (as for RUMA) would be voluntary, non-binding and self-reported. It would require widespread backing and the acceptance that pesticide use in the UK has been and probably still is super-optimal. My conversations with Chris Lloyd (Secretary General of RUMA) have confirmed their willingness in principle to extend their knowledge and experience in assisting the set-up of such an organisation.

Chapter Conclusions

Responsible Use of Pesticides in Agriculture should be set up to encourage each sector of the arable industry to take part in a non-binding, self- reported pesticide reduction target. This will help to re-balance the decision-making process for pesticide use.

The UK should adopt a system for reporting a three-year rolling average of Treatment Frequency Index as part of the Integrated Pest Management Plan. This would form a starting point for measuring pesticide use to demonstrate a reducing environmental footprint and provide a means of comparing data to drive efficiency of use. It would impose a very small administrative burden and be effectively enforced through Red Tractor Assurance schemes.

8. Prescription Behaviour

Some journalists and agricultural representatives choose to describe pesticide use with vocabulary borrowed from the medical profession; pesticides become medicines, agronomists become crop doctors and so on. This is a comparison worthy of consideration.

Extending the medical analogy to agronomy leads me to consider and compare the behaviour involved in prescription.

“Inappropriate prescription has been associated with mounting rates of antibiotic resistance worldwide, demanding more detailed studies into physician’s decision-making process”. This comment comes from “Understanding physician antibiotic prescribing behaviour: a systemic review of qualitative studies” *(Rodriguez et al. 2013)*

If we substitute the words antibiotic for pesticide and physicians for agronomists then we can understand the way in which inappropriate decision making has contributed to the loss of efficacy of many of our pesticides. Medicine, understandably, attracts more resources than agronomy and so it should not be surprising that studies of the prescription behaviour of doctors are much more numerous than those of agronomists. Ingram (Ingram 2008) made one of the few qualitative studies of agronomist/farmer knowledge exchange encounters and characterised them in a range from authoritarian, through reactive, to facilitative. While Ingram’s study is interesting and shows a variation of attitude, I believe it is superseded in relevance by those studies into the medical profession of which *Rodrigues et al* are representative

Rodrigues et al review 35 studies, including the responses from over 3500 prescribing doctors in a number of European and non-European countries and examined the factors affecting antibiotic prescription. The factor which had the greatest effect on doctors’ prescription (and mis-prescription) of antibiotics was identified as their attitudes which are defined below:

• **Complacency:** attitude that motivates the prescribing of antibiotics to fulfil professionals’ perceptions of their patients’ expectations;

• **Fear**: attitude relating to fear of possible future complications in the patient and/or fear of losing patients (*as customers*);

• **Responsibility of others:** attitude underlying the belief that responsibility for generating antibiotic resistances lies with other professionals

• **Confidence:** term that seeks to describe the self-reliance felt by physicians when prescribing antibiotics. This attitude may be defined as the level of confidence felt by physicians when deciding whether or not to prescribe any given therapy including antibiotics, on the basis of the maxim ‘never change a winning practice’.

This situation is very recognisable in the context of agronomy. Many agronomists will accept that they feel the need to be seen to be doing all that is possible to address a problem even if the remedial intervention is ineffective, unprofitable and ultimately adds to the problem of resistance

build-up. The term complacency is defined with reference to "professionals' (*agronomists'*) perceptions of their patients (*customers'*) expectations". I believe this has a direct correlation in agronomy. I arrive at this observation through my own experience over the years of the way my agronomist colleagues and I work with our customers; experience demonstrates that the seasonal demands of the job make it very difficult to discuss each decision in detail with our clients. Our customers' diversity in attitude towards risk, thresholds and the term over which a decision should be considered all have an impact on our decisions on their behalf, but that diversity makes the job more difficult and complex. Agronomists frequently work to our own thresholds and tolerances rather than those of our customers, not least because those customers often find it difficult to express their preferences having been disengaged from the process for many years or even generations. This position has been arrived at through decades of conditioning of both customers and agronomists and I believe this situation has a negative effect on the decision-making which affects business productivity

Fear of losing customers is a tangible risk for agronomists. An oft-repeated lesson from sage older agronomists is that customers never remember the time you saved them money by not treating, but they always remember when you didn't kill the wild oats/keep the crop standing/stop the BYDV etc. There is some truth in this parable. The fact that the safest way to discharge our responsibilities is to take a "belt and braces" approach is a symptom of a relationship which has no system of accountability for the costs (both financial and long-term external) of this approach.

The final point I draw from this review of studies is that physicians' express desire for a quick fix and the problem of diagnostic uncertainty were reported as being the basis of antibiotic misuse in 23% and 43% of studies respectively.

Chapter Conclusions:

Studies into doctors' attitudes to prescribing show how certain attitudes including complacency and fear contribute to the inappropriate prescription of antibiotics. It is reasonable to consider that the same factors in agronomists encourage inappropriate use of pesticides. Such inappropriate use is likely to have contributed to the build-up of resistance to a range of pesticides.

9. Independent vs sales agronomists

This debate has been covered many times, usually by people with very strongly held opinions supporting one or other of these two options. I will try to present a balanced view on the advantages and disadvantages of both systems with reference to examples from other parts of the world.

Independent agronomists have a point of difference from their sales counterparts; they receive no direct financial benefit from any sale of crop inputs. This should allow them to make decisions on behalf of their customers without the obvious conflict of interest where the sales agronomist is incentivised to sell a product to his customer which is profitable for his employer but which may not best address his customer's crop problem. The perception of this problem is so great in France that the provision of advice together with supply of products is in the process of being outlawed. This arrangement is yet to be implemented so is difficult to evaluate; it appears to be based more on ideology than on any expected outcomes. There is no data that I am aware of which supports the suggestion that sales agronomists use more pesticides than their independent counterparts. My own experience suggests that the difference in pesticide use between independent and sales agronomists is that sales agronomists tend to use "segmented" products (on which pesticide merchants make the highest profit margin), whereas independent agronomists tend to use "whole market" products (on which the pesticide manufacturers make the most profit margin). To my knowledge the net cost/benefit to the grower of either system is not one which has been conclusively compared.

9.1 Manufacturers, Distribution and Marketing

The distribution sector in the UK is characterised by a small number of large companies which have grown through merger and acquisition over the last four decades. In the 1980's there were more than 400 supply companies in the UK. That number now stands at 5 for the main actors, plus a handful of much smaller regional businesses. This domination of the supply market together with a substantial share of the advice market has afforded those 5 companies a very powerful position in the supply chain.

This "super- consolidation" appears to be unique among the countries I have examined. In Canada, for example there are around 265 distributor companies. This diversity has limited their influence individually in the market when dealing with the small number of chemical manufacturing companies, leaving a much greater role for those manufacturers to influence the choice of crop inputs, particularly genetics and pesticides. Bayer, for example, has an exceptionally deep market penetration, facilitated partly by their domination (before the Monsanto merger and subsequent divestments) in Canola GM technology. This platform affords Bayer an increased opportunity to incentivise growers to use a "stack" of Bayer products using a progressive system of discounts and rebates, beginning with the seed and accruing with subsequent purchases of herbicides and fungicides. The supply chain is effectively by-passed in this process of influence in a way which is rarely achieved in the UK. This re-positioning of influence and value retention in comparison to the UK system facilitates greater resources employed in agronomy support by Bayer in Canada. A large team of representatives seeks to support and influence farmers and agronomists and helps to achieve greater market share for Bayer products.

By way of further comparison, there are an estimated 5000 distributor companies in Brazil. Brazilian distribution companies also occupy a relatively weak position of influence on their customers in comparison to their UK counterparts.

Figure 12: Tiffany (BAYER Crop sciences) with Andre (independent agronomist), checking for seed weevil in a crop of GM Canola in Alberta, Canada

The powerful position into which the UK supply channel has evolved, allows the distribution sector to influence the terms under which they work with manufacturers to a degree which was not evident in any of the other countries I visited. In order for a manufacturer to achieve its desired market share in the UK, especially for a product which has significant competition, it needs to make its offer attractive to its sales channel. It is necessary to make their products exclusive to individual distributors or at least different enough to give each distributor commercial protection from comparison with their competitors. For this reason, slightly different inclusion rates of active ingredients and/or a variation of co-formulations or partnered products are employed to avoid direct product comparison. The opacity this creates allows the market to be segmented and profit margins to be maintained for longer, while also strengthening the case for farmers employing an agronomist (Sales or Independent) to decipher this complexity. I recently counted over 1400 different products available to use on UK winter wheat using over 70 active ingredients, averaging 18 products per active ingredient. This is a level of complexity which most farmers find difficult to navigate.

Manufacturers still have a powerful position in the UK market. They are keen to control the sales of their products in a variety of ways: They prefer to see that these segmented offerings are directed towards their supply chain's "serviced" customers (those who take a large proportion of their advice from the supplier). In this way the manufacturer can be more confident that the supply channel is genuinely influencing the choice of a particular product, thus increasing that manufacturer's market share. Manufacturers are also very keen to see that their products are being sold at the prices that they stipulate, as undercutting within and between marketing regions can be difficult for them to manage and arrest any price erosion. Manufacturers also leverage their portfolios by contracting individual supply channels to take a basket of their products in particular volumes. These targets, when met, are rewarded by rebates. Rebates make a substantial contribution to the profits which are generated by distributors. Volume commitments have the potential to influence the sales and use of products in the same way as the segmented product model.

The UK supply channel receiving a greater share of the value in the supply chain through this mechanism allows expenditure on a variety of things; for example, the extensive R and D programmes embarked upon by distributors; the many non-product based trials and demonstration sites which have added a great deal to the cultural control of problems like black-grass without adding to sales volumes; and, of course, greater remuneration for supply channel staff and profit for the owners of these businesses.

I believe it is fair to assume that the segmented product model with its reliance on co-formulated/partnered active ingredients together with the rebates employed to incentivise target product volumes, affects the market and use of pesticides.

In order to reduce these effects, there are some measures which could be employed: Co-formulation and partner products could cease to be eligible for registration and a limit on single formulations of active ingredients could be imposed to remove the segmentation opportunity. Equally, rebates on product volumes could be disallowed or sales and advice could be split as is happening in France (they have also outlawed rebates and volume discounts). The necessity for primary legislation to enforce these measures and the infringement on legitimate business activities should not be ignored as impediments to these interventions. It should also be acknowledged that segmentation is a rapidly dwindling influence in the pesticide market as it is being starved of products with which to work.

The UK pesticide market is already evolving through less choice, more transparency and market intelligence to reduce profitability in the distribution sector. This may result in a reduction in distributor agronomy support. This situation is about to be tested in France. Joel is the Director of Agronomy at SCAEL (La Société coopérative agricole d'Eure-et-Loir) co-operative in the Loire Valley. His co-operative will have to choose by 2021 whether it wants to sell pesticides or offer advice; it will be illegal by then to do both. As the business model does not work without the profit generated by pesticide sales and this is unlikely to be replaced by the smaller and yet to be established revenue stream from advice, it seems unlikely they will choose to set up a separately owned advisory company. This will reduce the agronomic support to the region's farmers and the effect on productivity and pesticide use is something of an unknown.

9.2 Independent Agronomists

UK Independent agronomists predominantly work for single employee businesses and are effectively self-employed. For these micro-businesses, the individual concerned *is* the main business asset and these businesses have proved very resistant to the consolidation which has been manifest in the pesticide manufacture and supply trade. While this has advantages in maintaining diversity, limiting cost and affording participants good remuneration, it has limited the development of some of the benefits larger businesses can bring, such as career progression, job security, administrative and human resource functions, co-ordinated technical support, cover for illness and holiday. These are just some of the things that agronomists who choose not to work in the independent sector remark on as areas which discourage them from choosing this option. It is true that a small number of companies employ a number of independent agronomists where some of these advantages are more available; however, this applies very much to the minority. The future of these single employee businesses is also affected by the commonly held, unrealistic assessment of their capital value. Many independent agronomists believe their businesses to be worth multiples of their turnover which make their purchase by a new entrant extremely difficult; this is one of a number of reasons why succession in the independent agronomy sector is a big challenge.

If the demand for existing agronomy services is maintained in the UK, the independent sector may have the potential to absorb a gradual move away from sales agronomy, but the independent sector is ill-equipped to take on a dramatic swing away from sales agronomists.

Independent agronomists escape the charge of direct financial gain from inappropriate pesticide use. However, the influence and interference from another set of non-productivity related factors is often ignored. These include the propensity of many agronomists to;

- Cover larger tracts of land to increase profitability but reduce attention to detail
- Employ more prophylactic but potentially less productive strategies to reduce agronomists' risk of missing a potential problem.

In both forms of the agronomist trade, when a decision to spray or not is finely balanced between future risks and reward, there are few disincentives to the use of the pesticide.

Chapter Conclusions

Incentives are different for agronomists working in the independent vs sales streams but the incentives to both streams are likely to result in higher pesticide use than the economic optimum.

The segmented product model has diverted more of the profit of the pesticide market towards distributors in the UK than in other countries. Some of this money has been used to develop the productivity of the industry whilst some has gone towards greater remuneration for staff and business owners.

The segmented model, with its effect on profitability has the capacity to affect pesticide choices. The way in which active ingredient and product registration is carried out could reduce this market distortion but other forces are already diminishing the significance of segmentation.

Reform of the relationship between manufacturers and distributors is necessary to support the "social licence" for pesticide use. This may delay the loss of distributor profitability, and thus agronomist capacity, which the independent sector would be unable to absorb in the short term.

10. The Technology Pipeline

10.1 New technologies

A supply chain needs a product and *vice versa*. The diminution of the range of pesticides already discussed is leaving a hole in the fabric of the supply chain. The precautionary approach applied to pesticide registration has led to a large, rapid and accelerating loss of existing active ingredients. The increasing cost of registration and raised environmental threshold for authorisation has reduced the pipeline for potential new active ingredients to something of a dribble.

That hole *could* be filled with new technologies such as bio-pesticides, biological controls, nutrition technology, genetic improvements, application and sensing advancements which include robotics, digital solutions and artificial intelligence to name a few. These areas are much discussed in fora better informed than this report. However, their collective progress in recent years has made a relatively small impact on productivity gains thus far.

10.2 New Breeding Techniques

Looking at the technology pipeline in other parts of the world, the biggest difference between European crop production and many other countries is the access to Genetic Modification (GM) technology. The GM variety traits I observed in use on the North and South American Continent have dramatically improved the sustainability of crop production systems and act as a stark contrast to the non-GM world of Europe. GM traits have enabled the growth in productivity of the Brazilian Soya crop in what would otherwise be an unsustainably close rotation (most of their arable land is double cropped and grows soya every year interspersed by a winter crop of cereals).

The availability of GM traits has strengthened the armoury of Brazilian growers and (to date) has extended the profitable pursuit of intensive crop production in the light of increasing resistance problems. It is clear, however, that production systems such as glyphosate tolerant soya in Brazil and Uruguay are breaking down, as glyphosate resistant weeds are increasing in prevalence and the use of the active ingredient is under legislative threat. There are now Soya varieties which are resistant to a combination of Glyphosate, glufosinate ammonium and 2-4-D. It will only be a matter of time before weed populations build up the same resistance. This highlights the need to rely on a basket of technologies and methods of crop production. To date no one development has overcome the ability of plants to develop coping mechanisms (resistance), but awareness is growing of the need to improve longevity by use of a mix of technologies and inputs, such as a variation of cultivation practice and cropping.

Figure13: GM Soya in Brazil

While GM use in Europe appears to be a lost cause, Gene Editing may have a chance of being accepted as an area of potential development in the UK even if its future continues to be limited in the rest of Europe. Michael Gove, former Secretary of State said a number of times that, subject to further justification, this technology is regarded as a significant part of future productivity development in the UK. The use of GE technology to manipulate variety traits could improve the sustainability of crop production by reducing the reliance on pesticides, as GM technology has done to some extent in non-European countries.

If gene editing were to be introduced in the UK it could be brought to market by the existing pesticide supply channel as most significant players have broadened their offer significantly into genetics, recognising the changing market place. There is the potential for a diversity of Intellectual Property associated with gene- edited crop traits; the technological advancements in this area may allow smaller, more agile businesses to develop valuable products. Thought should be given to the development of the laws surrounding patents of this type of genetic advancement to allow unfettered development of commercially valuable products.

Chapter Conclusions

The supply chain is running out of products to supply.

The next products which could help support the current agronomy resource are gene-edited seed varieties which, subject to authorisation, could extend the sustainability of crop production systems as GM has done in the non-European world.

In the absence of the introduction of New Breeding techniques such as Genetic Editing a reduction in the supply chain capacity may be expected.

11. Remuneration and payment by results

Agronomist behaviour and subsequent crop management decision making is influenced by a range of factors as discussed in previous chapters. One such area is clearly remuneration. Businesses in every sector adapt their behaviour to maximise profits within their constraints, both imposed (by law and regulation) and self-imposed. The way in which an agronomist maximises her profitability depends on the structure in which she works.

The two main structures in place in the UK are payment by an acreage fee for independent agronomists or payment through margin on product sales for sales agronomists. Working on an hourly charge is another mechanism used in a minority of arrangements.

Denillo is the in-house agronomist for Sape Agro, a 7000 hectare operation in Matto Grosso Du Sul, Western Brazil. He is paid by results. Not only is the profitability of the crops they grow used to calculate his pay, but also physical outcomes such as the evenness of establishment of the soya crop he was inspecting in the picture below. This is ascertained by drone monitoring and the number of missing plants is one of the parameters used to calculate his pay. He has the opportunity to increase his base salary by 250%. He is very keen to ensure the seed spacing is correct at planting time.

Figure 14: Denillo; an agronomist in Brazil paid by his results

Payment by results is common practice in South America, often on the basis of agronomists receiving a percentage of the total yield, ignoring costs. In other cases, crop profitability is the factor which dictates the agronomists' remuneration. Basing results only on yield is a crude but simple metric. The more complicated calculation of margin is less frequently used. The complex suite of measures used in Denillo's case seems to offer the most comprehensive balance of incentives although requires more administration.

The heavy reliance on out-sourced agronomic decision making in large parts of the UK arable industry lends itself to the possibility of incentivising agronomists to drive farm productivity with remuneration. Where agronomists have a large degree of autonomy over their clients' management, then by rewarding more successful decision making, that process could be driven to improve. The structure of any such incentivised agreement would, of course, be more complex than the straight forward arrangements which currently exist between agronomists and their UK customers.

I have been working as part of a team which has been developing a pilot scheme to address this area of development. This business model incentivises the productivity of agronomic decision making. As the profitability of this type of farmer/agronomist agreement is rewarded through a profit/loss sharing mechanism then the agronomist is driven to question each part of the crop management in terms of its effect on profit. This should skew the emphasis away from product sales, ease of contract management, risk avoidance and other non-profit considerations. The current version of the model includes a range of measures to attempt to reward true productivity gain and seeks to minimise the influence of crop sale price and "natural weather-driven" yield variation from season to season. The structure also sets a "cap and collar" to the potential profit/loss share to limit the transfer of funds from and to each party in the agreement.

Chapter Conclusions

Payment by results is currently very unusual in UK agronomy. It is common in South America

I have been developing one such scheme. If pilots prove successful this could drive more effective decision making by agronomists. Farmers should demand this service of their suppliers to encourage development in this area.

12. When the drugs don't work

As has been referred to in a number of chapters a confluence of factors is moving crop production away from the paradigm of pesticide product related solutions. If we assume that the developments in the technology pipeline discussed in chapter 10 continue to fail in driving the growth in productivity needed as described by the AHDB Horizon report from 2018 (AHDB 2018) "Driving productivity growth together" it would seem reasonable to shift the focus away from products and towards systems-based solutions which build resilience and reduce the reliance on product-based solutions.

Developing resilient systems is something the organic sector can teach us something about. Suffolk farmer John Pawsey, having converted from conventional to organic farming about twenty years ago on some 1600 hectares, has seen a shift away from the regular agronomic advice he had previously out-sourced. He had a short period of using occasional strategic advice from a specific organic arable agronomist but in recent years has had limited external agronomic support. This is a situation he would like to change through more collaborative work with peers and experts but the lack of revenue from a product vehicle which could fund such groups has hampered development of this kind of systems-based support. Innovative Farmers (a part of the Soil Association), is one organisation which attempts to address this need for both organic and non-organic farmers with its Field labs, farmer led research and knowledge exchange programme. However, its scale and reach mean it has, so far, been quite a minor influence on the industry.

The development of non-product-based systems support has been limited as the product-based systems have predominated in the UK. The revenue streams developed by those products have provided a support infrastructure built around them. Knowledge exchange (particularly where it is peer to peer) is not monetised in the same way and so has not afforded the development of support structures to facilitate its growth. AHDB have instigated initiatives to address this. Monitor Farms and benchmarking groups have been gathering momentum as platforms for engaged farmers to compare their businesses, including agronomy inputs, and to improve productivity. These groups are being subsidised by the AHDB in a useful attempt at establishing this peer to peer model. This has some similarities to the CREA model which is very successful in South America

CREA is based on the concept of farmers finding solutions to their business problems from within their peer group. It operates on the assumption that issues which cause problems to one business are likely to have been experienced by others and, through a collective effort, can be overcome. Transparency and full disclosure are fundamental to the operation of these groups. A non-member acts as a paid facilitator to the group with the support of the CREA organisation. The track record of CREA in Argentina shows over 250 groups of 20 or so farmers in each group all paying to be members and consistently performing in the top quartile of productivity for their regions. This expertise and knowledge should be accessed and leveraged to assist the developing AHDB Monitor Farm and Farm Bench network to help improve productivity through systems, rather than product led improvement processes. During my meetings with CREA officials, they expressed willingness to be involved in this development.

Figure15: Gonzalo, a CREA group facilitator, and me at CREA offices in Montevideo, Uruguay

Chapter Conclusions

The benefits of pesticides will continue to fade, particularly in Europe where pressure on their efficacy is greater without the diversified control strategies offered by GM technology.

The expertise in CREA and other groups should be accessed and applied to the development of AHDB's farm monitor and benchmarking groups to assist the progression from a paradigm of product-based solutions to one of building resilient production systems, facilitated by peer to peer learning.

13. Overall Conclusions and recommendations

As the epoch of pesticide use evolves then the systems which have augmented their use will change. While market pressures will drive this, the inertia of a well-established support industry could delay progress. A combination of revised industry self-regulation and a new product offering from the agronomy industry should help to optimise future pesticide use.

My recommendations are as follows:

- Launch a new concept in agronomy and crop input supply where agronomists become financially accountable for their decisions by making crop gross margins the success criteria
- Introduce Treatment Frequency Index (TFI) as the measure of pesticide use and make it one of the reporting requirements for the Integrated Pest Management Plan.
- Create a task force for the Responsible Use of Pesticides in Agriculture with a pesticide reduction target based on voluntary, self-reported pesticide reduction targets measured by three- year rolling averages of TFI.
- Reinforce the AHDB's focus on peer to peer knowledge exchange through bench marking groups and monitor farms. External resources and expertise should be brought in to develop this project into a self-sustaining movement to meet the challenges of descending the summit from "Peak Pesticide".

14. After my study tour

Having lobbied widely within the industry for the improvements I believe would be worthwhile and have outlined in this report, I plan to develop the one which I can have most effect upon. I have been working on a vehicle to make agronomists financially accountable to their decision making. I will spend time piloting this concept to improve the quality of agronomic decision making. I will continue to lobby for the industry wide changes I have advocated. In addition to this I have been appointed as an agronomist member for the AHDB Recommended List Committee for Wheat Varieties and intend to use that opportunity to drive for better genetic options to be made available to UK growers.

14. Acknowledgements

I wish to thank The Richard Lawes foundation for the support which enabled this study and the Nuffield Farming Scholarship Trust for offering the opportunity to further my personal and professional development. I also thank the great many people I visited and consulted in this study both in the UK and abroad. I also wish to thank my family for their support.

16. References

AHDB 2018 (Report text page 31)

Driving Productivity Growth Together

https://ahdb.org.uk/knowledge-library/driving-productivity-growth-together-2-january-2018. p 3-9

Daily Telegraph 19/4/19 (Report text page 17)

RSPB Resigns governments pesticides forums as chemical use soars

https://www.telegraph.co.uk/science/2019/04/18/rspb-resigns-governments-pesticides-forum-chemical-use-soars/?WT.mc_id=tmg_share_em

FERA 2018(1). (Report text page 9).

Pesticide Use statistics

https://secure.fera.defra.gov.uk/pusstats/surveys/index.cfm "Graphs Function"

FERA 2018 Pesticide Use Survey (2). (Report text page 9)

https://secure.fera.defra.gov.uk/pusstats/surveys/index.cfm

Pesticide use statistics 2018 surveys. Arable Crops in the United Kingdom 2018 Report 284 Published Nov 2019 p5

FERA 2018 Pesticide Use Survey (3) (Report text page 10)

https://secure.fera.defra.gov.uk/pusstats/surveys/index.cfm "Graphs Function"

Fieldwise December 2018 (Report text page 6)

Hutchinson

https://www.hlhltd.co.uk/fieldwise-newsletters.html

Ingram (2008) (Report text page20)

Agronomist-farmer knowledge encounters: an analysis of knowledge exchange in the context of best management practices in England. Agriculture and Human Values, 25 (3). p405-p418.

http://eprints.glos.ac.uk/420/1/Agronomist-farmer%20knowledge%20encounters.pdf

Pages 9 – 19 in eprint version from Gloucester University.

HM Government (2016).(Report text page 18)

Government response to the Review on Antimicrobial Resistance

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/553471/Gov_response_AMR_Review.pdf Summary list of Recommendations 3.5 DEFRA p18-19

Lechenet et al 2017 (Report text page 15)

Nature Plants 3(3) 17008 Reducing pesticide use while preserving productivity and profitability on arable farms.

https://www.nature.com/articles/nplants20178 Abstract

https://bangmosnowdotcom.files.wordpress.com/2017/01/reducing-pesticide-use-productivity-profitability.pdf p 1-23 Includes Supplementary Methods

O'Neil 2016 (Report text page 18)

Tackling Drug Resistance globally. The review on Anti-Microbial Resistance

https://amr-review.org/Publications.html

At time of compiling references this report was not available via the internet. The link below downloads a UK parliamentary briefing document on the content of the report with further reading and references included

http://researchbriefings.files.parliament.uk/documents/CDP-2017-0074/CDP-2017-0074.pdf

Rodrigues et al. 2013 (Report text page 20)

Understanding Physician antibiotic prescription behaviour Int J Antimicrob Agents. 2013 Mar;41(3):203-12 P 208-210

http://bdigital.ipg.pt/dspace/bitstream/10314/2488/1/ATR.Understanding%20physici

RUMA Target Task Force: Two Years on October 2019 (1) (Report text page 18)

https://www.ruma.org.uk/wp-content/uploads/2019/10/SO-309-RUMA-TTF-2-years-on-Full-Report-LR.pdf p32

RUMA 2017 Target Task Force 2017 (2) (Report text page 18)

https://www.ruma.org.uk/wp-content/uploads/2017/10/RUMA-Targets-Task-Force-Report-2017-FINAL.pdf p34

RUMA 2017 Target Task Force (3). (Report text page 18)

https://www.ruma.org.uk/wp-content/uploads/2019/10/SO-309-RUMA-TTF-2-years-on-Full-Report-LR.pdf p18-19

Syngenta 2019 Report text page 12

https://www.syngenta.com/what-we-do/the-good-growth-plan/make-crops-more-efficient. Sustainability page

Published by Nuffield Farming Scholarships Trust
Southill Farm, Staple Fitzpaine, Taunton, TA3 5SH
T: 01460 234012 | E: director@nuffieldscholar.org