OILSEED RAPE YIELD LIMITING FACTORS – FAILURE TO TRANSLATE CULTIVAR IMPROVEMENT INTO COMMERCIAL PERFORMANCE

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INTRODUCTION

Oilseed rape production in the UK has expanded from just over 2,000ha in 1970 to current areas of about 600,000ha. The most rapid phase of crop expansion was associated with the transition from single-low (high glucosinolate, low erucic acid) to double-low varieties in the 1980s. At this time new varieties showed a drop in yield potential as breeders worked hard to develop breeding programs for varieties which would meet the new EU standard of 35µmoles/g of seed. Since that time there has been an ever increasing flow of new varieties into the UK testing system resulting in an estimated increase in yield potential of just below 2% per annum. At the same time, commercial yields have shown only small improvements and the reasons for this are the subject of much debate amongst UK arable farmers and advisers. This paper charts the crop expansion and variety improvements and considers the factors limiting commercial crop improvement.

METHODS

Annual data for crop areas have been abstracted from Defra[1] annual publications and records of commercial yields from the Defra[2] website. Yield estimates presented for varieties are based on a compilation of trial results from a testing system based on that described by Kightley (1993) using annual data from UK National List (NL) and Recommended List (RL) trials. Because the large number of varieties under test at any one time, separate trial series are run for varieties in year-1 and year-2 of NL trials and for subsequent years in RL trials. For the purposes of this paper, linkage of this fragmented data set has been by means of a 2-stage Fitted Constant Analysis (Patterson and Silvey, 1980) to produce annual and over-years means. While good trial-to-trial and year-to-year linkage makes the data matrix technically robust it should be noted that protocols were only standardised to adopt a fungicide treated regime after 1990. Before that time a 'best local practice' approach was used, with regard to fungicide use and disease may have had a considerable impact on trial variability in some seasons. The move to a fungicide treated protocol will also have contributed, to an extent, to the yield improvement observed subsequently.

RESULTS

Crop areas and the national yield trend

Figure 1 illustrates the increase in the UK crop area since 1970 and the national yield trend since 1984, the beginning of the double low era. It should be noted that the picture is confused by the inclusion of the lower yielding spring oilseed rape crop within the data sets. Spring rape was important until the late 70s when the first single-low winter varieties were introduced. Since then the higher yielding winter crop has predominated, although spring rape enjoyed another brief period of popularity in the early 90's, when the CAP area-payment subsidy scheme made the lower cost of growing the spring crop seem relatively attractive. Current estimates for spring rape cropping are in the order of 20,000ha p.a.

Variety improvement

Table 1 illustrates the improvement in variety yield since 1984. The figures represent the adjusted mean yields from their entire time in National and Recommended List trials,

Figure 1. UK commercial crop areas and yields for oilseed rape

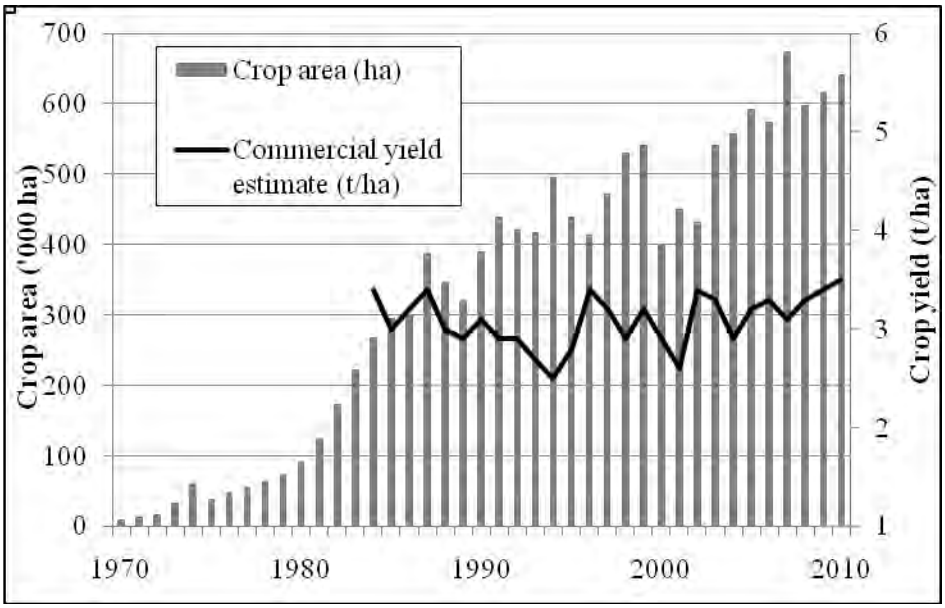

Table 1. Mean yields (t/ha) of improved and other landmark commercial varieties in the UK, compared with the highest single low yield level of 3.86 t/ha, set by the variety Bienvenue.

Year first tested	Low glucosinolate/low erucic acid variety types							
	Open pollinated		Composite hybrid		Restored hybrid		Semi-dwarf hybrid	
	Variety	Yield	Variety	Yield	Variety	Yield	Variety	Yield
1984	Ariana (1)	3.54						
1986	Cobra (2)	3.75						
1988	Falcon (2)	3.84						
1989	Envol (3)	3.85						
1990	Bristol (3)	3.99						
1991	Apex (4)	4.03						
1994	Capitol (3)	4.08	Synergy (12)	4.42				
1995					Pronto (2)	4.42		
1996	Magrigal (5)	4.31						
1997	Escort (6)	4.32	Gemini (13)	4.52				
1998	Canberra (3)	4.30						
	Fortis (5)	4.45						
1999					Royal (5)	4.63		
2000	Winner (7)	4.53						
2001	Expert (8)	4.68			Exact (10)	4.67		
2002	Es Astrid (9)	4.72						
	Castille (10)	4.68						
2003					Excalibur (10)	4.79	PR45D01 (15)	4.55
2005					Flash (14)	4.84		
2006	Vision (11)	4.87			PR46W21 (15)	4.94	DK-Secure (10)	4.66
2007	DK-Cabernet (10)	4.99					PR45D05 (15)	
2008	Sesame (12)	5.21					DK-Sequoia (10)	4.78
2009							Thorin (16)	4.85

( ) = Breeders – as originally listed: 1, Semundo; 2, Lembke; 3, Cargill; 4, Dippe; 5, Syngenta; 6, Limagrain; 7, Raps; 8, Momont; 9, Euralis; 10, Monsanto; 11, Lantmannen SW; 12, Serasem; 13, KWS UK Ltd; 14, DSV; 16, Pioneer Hi-Bred Northern Europe

charted against the year in which they were first listed. The varieties presented are those which offered yield advances and, in a small number of cases, other varieties that became commercially important because of other, non-yield characteristics. Varieties are divided into four categories: conventional, open pollinated (OP) varieties; varietal associations (VA) - mixtures of a sterile hybrid line and a pollinator OP line; restored hybrids; semi-dwarf restored hybrids. As a point of reference, the yield of the highest yielding single-low variety, Bienvenue, is given.

DISCUSSION

Table 1 shows that the first double lows represented an 8.3% drop in trial plot yields, from 3.86t/ha, down to 3.54t/ha. Subsequent yield improvement progressed steadily to the current estimated value of 5.21t/ha for the OP variety, Sesame, averaging 1.96% p.a. The initial advantage indicated for the first hybrids was not been confirmed and is now attributed to a defect in the trials system with, in the early years of hybrid testing, all varieties fully randomised within trials. This is now believed to have greatly benefited partially male sterile composite hybrids, because of the excess of pollen provided and, after numerous disappointments from commercial crops, these hybrid types were largely discredited in the UK and then abandoned. Analysis of restored hybrid performance in trials revealed that their yields benefited from inter-plot competition when grown next to OP varieties and the two types are now blocked separately within trials. Since introducing this protocol amendment hybrids have shown no consistent advantage over OPs. It can be argued that the factors suppressing improvement of commercial yields are largely economically driven are considered here.

Rotations

The popularity and economic value of the crop has resulted in short rotations and a wheat:wheat:rape cycle is now common in the major arable regions. This has caused an intensification of pest and disease problems. For the major diseases of oilseed rape – stem canker, (*Leptosphaeria maculans*) light leaf spot, (*Pyrenopeziza brassicae*) and Sclerotinia (*Sclerotinia sclerotiorum*) – inoculum levels have inevitably built up to high levels in the soil. While good control by fungicides is available, when weather conditions permit timely spraying, the use of fungicides is sometimes reduced, as an economy, in seasons when predicted crop prices are low. There are also reports of reduced efficacy for the control of light leaf spot by triazole fungicides, in the north of the country. New threats, linked with short rotations are emerging. In 2007 the first UK reports of Verticillium wilt (*Verticillium longisporum*) were received and research by the University of Warwick has identified two fungal root pathogens (*Olpidium brassicae* and *Pyrenochyta sp.*) which appear to build up to high levels in soils with a history of frequent rape cropping.

Soil nutrition

Use of fertilisers has not moved significantly to address the greater genetic yield potential of modern varieties. Date collected for the British society of Fertiliser Manufacturers (BSFM – Dawson, personal communication) indicates that nitrogen use has declined from application rates in the region of 250kg/ha in the 1980s to 180 – 200kg/ha since the early 1990s. The application of both phosphate (P) and potash (K) has declined steadily from a high of about 60kg/ha in the early 1980s to a lowest recorded application rate in 2009, of less than 20kg/ha. Sulphur is important for oilseed rape crops and UK industrial emissions of sulphur dioxide have fallen dramatically since 1970, from over 6,000kt to current low levels of 500kt. Sulphur deficiency in soils was recognised in the early 1990s and since then the proportion of the national rape crop receiving sulphur applications has risen from 8% to 70%. Availability of sulphur-containing fertilisers is limited however and 2009 saw a drop to only 60% of the crop receiving sulphur.

Cultivations

In attempts to reduce costs (and reduce moisture loss) we have seen a progressive move away from ploughing/deep cultivation to prepare seed beds. The newer techniques – min-till, direct drilling, auto-casting – can often result in compacted soils and this can present a significant limiting factor to oilseed rape rooting and subsequent capture of water and nutrients. A new approach, involving the sowing of rape in wide rows behind a sub-soiler, is becoming popular. There is little, or no loss of soil moisture and the geminating rape can root down easily into the slot left by the sub-soiler leg.

Variety choice

While there is strong evidence that variety improvement has been steady over the period under discussion, growers have not always chosen to move forward with their variety selection. In the early years of double-low winter rape farmers were quick to adopt new, top performing varieties on an almost annual basis but in many cases yield improvement was not associated with particularly favourable agronomic characteristics. Often varieties were too tall, or weak stemmed, (for the high seed rates used in the UK) or were too susceptible to disease, to have enduring popularity. Very few varieties have made a major, lasting impact and these have not always been the top-yielders. Several of the most successful can be characterised as relatively short and usually with a good combination of lodging resistance and disease resistance, such as Apex, Canberra, Castille and Es Astrid. An early exception was Winner, a tall variety which survived several seasons of favourable weather before its lodging and disease susceptibility were eventually exposed. Hybrids tend to be tall and this, together with higher seed costs, makes them relatively unattractive to farmers. An investigation by Kightley (2010) suggests that hybrid yields show a negative relationship with plant height. The most successful hybrid to date has been Excalibur, a relatively short hybrid but now well below the best for yield. Historically there has also been a tendency for farmers to by Common Catalogue varieties of unknown provenance within the independent advisory network, especially where seed has been relatively cheap.

CONCLUSIONS

Several sets of factors have combined to suppress commercial yields of oilseed rape in the UK. These include heightened pest and disease pressure associated with short rotations, reduced fertiliser usage which fails, perhaps, to address the needs of improved new varieties and new cultivation techniques which may limit root development. In addition, failure to adopt top yielding varieties on a sufficiently large scale, also impacts on the rate of national crop improvement.

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