AUSTRALIAN NUFFIELD FARMING SCHOLARS ASSOCIATION

REPORT OF VISIT TO THE UNITED KINGDOM

By

David Shannon
(South Australia 1987 Awards)

A study of the Grain Legume Industry in the United Kingdom & France

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which ultimately benefits all Australian Farmers.

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CONTENTS

LIST OF TABLES

1. **INTRODUCTION:** When awarded The Nuffield Travelling Scholarship my main objective was to travel to Europe to study The Grain Legume Industry in the hope that I could learn something of that Industry which would be of benefit to farmers in Australia. My original list of objectives was quite long and detailed. However my report does not cover all these areas in detail, but rather concentrates on those areas I saw as being of greatest interest and relevance.

Every decision made by European farmers is affected in some way by The Common Agricultural Policy (CAP) of the European Economic Community and thus I have included aspects of the CAP that affect Grain Legumes in my reports.

Now having written the report there are some areas I feel I have not covered adequately and others that perhaps I concentrated on too much, but perhaps that is the very nature of the Nuffield Scholarship.

My original aims and objectives were:—

To study Grain Legume production in order to increase the profitability of these crops in their own right, and as part of a crop rotation plan.

This will necessitate the study of the following areas:

1. The most useful place in a crop rotation
   - after a cereal crop or after a pasture phase
   - problems associated with various crop rotations
2. Pre-seeding management
   - cultivation techniques (if any)
   - chemical applications
   - the use of rhizobial innoculants to improve nodulation
   - seed dressings, fungicidal or insecticidal
3. Seeding of the crop
   - row spacing, affect on yield, disease control, weed control
   - seeding depth for various crops, root development,
   - establishment rates, crop yields
   - seeding rates (as per row spacing)
   - seeding equipment, new larger seeded beans may need different
     seeding equipment, broadcasting.
4. Fertilizer use
   - rates & type used
   - placement & timing of application
   - the use of N at seeding
   - affect of fertilizers on innoculant seed dressings
5. Weed Control
   - use of chemicals pre & post seeding, rates, application
   - previous crop & chemical residues
   - trash & chemical efficiency
   - row spacing & seeding rates, affect on weed populations
6. Disease control
   - use of seed dressings
   - chemical control with fungicides
   - crop rotations, previous crops as hosts/non-hosts
   - rates of chemicals & timing of sprays as well as climatic conditions expected at & after spraying
   - types of fungal diseases etc.
7. Pest control
   - at emergence, flowering & pod set
   - seed dressings & sprays used
   - time of application, rates, type of chemical
   - length of effective control
   - determining critical rates of infestation
   - types of insects experienced
8. Harvesting
   - type of header used
   - techniques to reduce harvesting losses (wind rowing)
   - treatment of stubbles
9. Storage
   - handling methods
   - type of construction
   - moisture content requirements for long term storage
   - fumigation for insect/pest control
10. Marketing
    - access to world markets, identify key areas & their requirements, quantity & quality required, timing of delivery
    - producing for local markets, feed & human consumption
    - promotion of products
11. Increasing crop yields
    - new crops & varieties
    - experimental data from as may sources as possible
    - identify the limiting factors
    - identify where our climatic conditions can be of benefit
12. Grazing management of crop residues
    - suitability of stubbles for various types of stock
    - toxicity problems & how they are managed
    - avoidance of soil erosion
13. Research work being done
    - relevance to Australian conditions
    - directions for research work here

2. STRUCTURE OF THE UNITED KINGDOM GRAIN LEGUME INDUSTRY:

(a) PEA AND BEAN AID SCHEME — This scheme was introduced by the EEC Commission in 1987 and is designed to achieve 3 aims;

1) Ensure that protein peas and beans are available to the UK compounders and to provide a competitive alternative to soya bean meal.

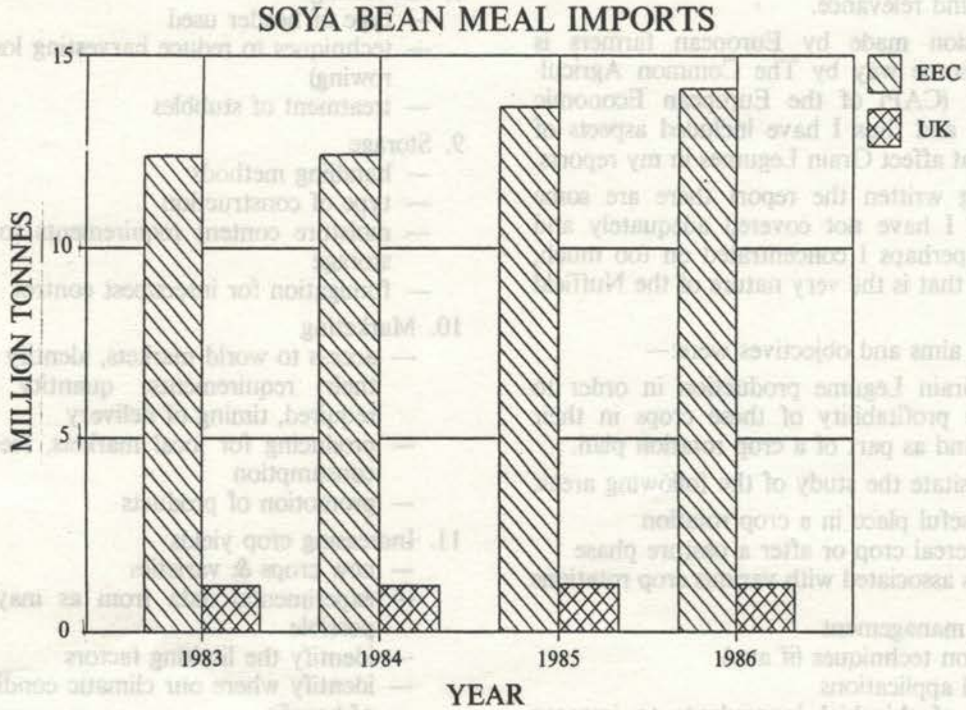
2) Ensure that the price paid to Farmers provides a favourable return making peas and beans attractive to grow.

3) Reduce the Community's dependence on imported protein sources.

Under the scheme Farmers receive a statutory guaranteed minimum price for their produce. Compounders are paid an EEC subsidy which is calculated each month by the Commission, so that peas or beans can always be incorporated at a competitive price to soya bean meal.

SOYA BEAN MEAL IMPORTS
(million tonnes)

YEAR	EEC	UK
1982/83	12.39	1.19
1983/84	12.43	1.19
1984/85	13.67	1.24
1985/86	14.13	1.24



The introduction of the pea and bean aid scheme was introduced at a time when there was a growing demand for protein in the EEC for use in the animal feed compounding sector. This increase in demand is in itself due to a swing away from cropping to livestock brought about by surplus cereal grain production and a fear by farmers that quotas will be introduced to limit cereal production. Coupled with this is the decrease in the guaranteed minimum price for wheat over the past two years which as tended to make livestock more attractive especially as the EEC is not self sufficient in either beef or sheepmeat.

In 1985/86 the total EEC production of peas and beans was 2.81 million tonnes compared with an import of 14.13 million tonnes of soya bean meal. Even assuming a direct substitution of peas and beans for soya, the total EEC production only accounts for some 20% of protein requirements. Assuming an ongoing increase in area sown to grain legumes of the current 25% and no increase in demand for protein it will take the EEC 7 years to become self sufficient in vegetable protein.

As well as having a guaranteed minimum price paid to growers, a threshold price for soya bean meal, called the activating price, is also fixed on the basis of 44% protein, 8% moisture CIFFO Rotterdam. This price is fixed at a very high artificial level and for July 1986 was £319.52/tonne when the actual price for soya bean meal on the world market was £118.42/tonne.

Where the actual price of soya is less than the activating price, 45% of the difference is available to the compounder using EEC produced peas and beans. In this case where the difference between the world price and the activating price was £201.10, £90.50 is then available to the compounder. This in effect reduces the price he pays for EEC produced preas or beans from £179.51 to £89.01 making them much more attractive than imported soya at a world price of £118.42.

With the world price for peas at around £90.00/tonne, the grower is receiving a subsidy of approximately £90.00/tonne and the compounder £90.50/tonne, which in effect is a 100% subsidy with the EEC minimum price at £179.51.

The minimum support price last year of £179.61/tonne has been reduced by 10% this year to around £160.00/tonne. However, last year due to currency fluctuations and demand from the remainder of the EEC, prices in the UK were up to £250/tonne for peas and £230/tonne for beans. While the minimum price was set at £179.51 for July and August, this was then increased by increments of £1.13/tonne.

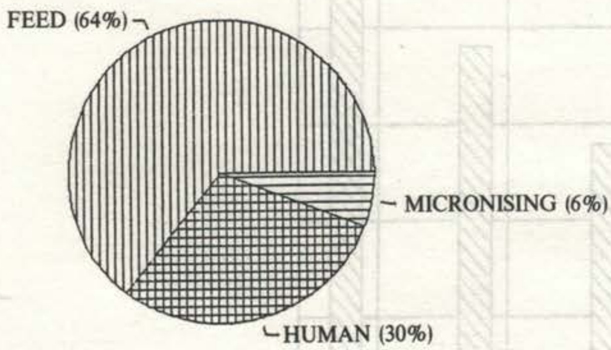
With a reduction in the minimum guaranteed price for 1987 of 10% and an increase in the area sown to grain legumes in the UK of 25%, it is not anticipated that prices received by growers will be as high as last year, but while the Pound remains weak against other European currencies, notably the German DM and the Dutch Guilder, these countries will continue to purchase large quantities of UK peas and beans keeping prices well above the EEC minimum price.

It seems likely that the EEC Commission will introduce a complex financial arrangement called Monetary Differential Amounts (MDA's) to adjust the rates of aid payable to compensate for the differences between the green and the market rates of exchange of currency between EEC countries. This will in effect deter UK exports of peas and beans to other EEC countries and reduce any export incentive and keep rices to around the EEC minimum level.

(b) USE OF PEAS IN THE UK — 1986 CROP

FEED/EXPORT	217,500 tonnes
HUMAN CONSUMPTION	100,000 tonnes
MICRONISING	20,000 tonnes

USE OF PEAS IN THE UK
1986 CROP



The market for human consumption peas is less affected by the pricing policies of the EEC, as while the general pricing is determined by EEC policy, the demand for good quality peas in a stable market ensures those growers a premium for their product. This premium is usually from £5 — £20/tonne, but can be as high as £100/tonne. The relative stability of the human consumption market makes the growing of peas for this market quite attractive, although the very high quality standard limits the number of growers who can supply this market.

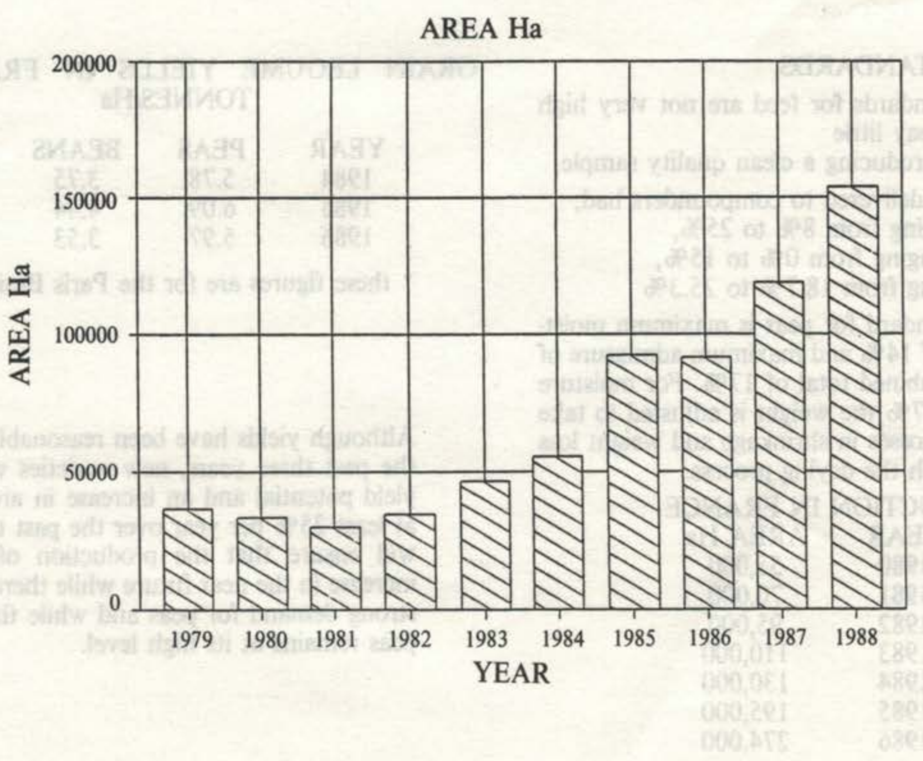
The micronising sector, although quite small, is nevertheless quite important as it offers growers a premium over the GMP. Micronised peas need to be of a higher standard than those for feed, but do not have to meet the high standards required for human consumption. Micronised peas are used for cattle and pet food.

(c) UK PEA PRODUCTION

Year	Price	Area Ha	Tonnes	Yield T/Ha
1979	126	36,400		
1980	140	33,300		
1981	151	29,700		
1982	169	34,400		
1983	180	46,600		
1984	179	55,600	225,000	4.05
1985	175	92,400	173,000	2.95
1986	179	91,600	366,000	4.0
1987	160	119,000	476,000*	4.0*
1988	152*	154,000*	618,000*	4.0*

* Estimate

UK PEA PRODUCTION 1979-1988



Production figures are based on data of yields from 1984 listed varieties. However assuming that these varieties are replaced with current higher yeilding varieties in the future, like Solara, then production levels and yeilds will be much higher than estimated.

(d) DISPOSAL OF THE UK PULSE CROP

1) BY COMPOUNDERS

The potential usage of peas by compounders is estimated at 1.5 million tonnes (current production .25 million tonnes) and of beans is estimated at 0.82 million tonnes.

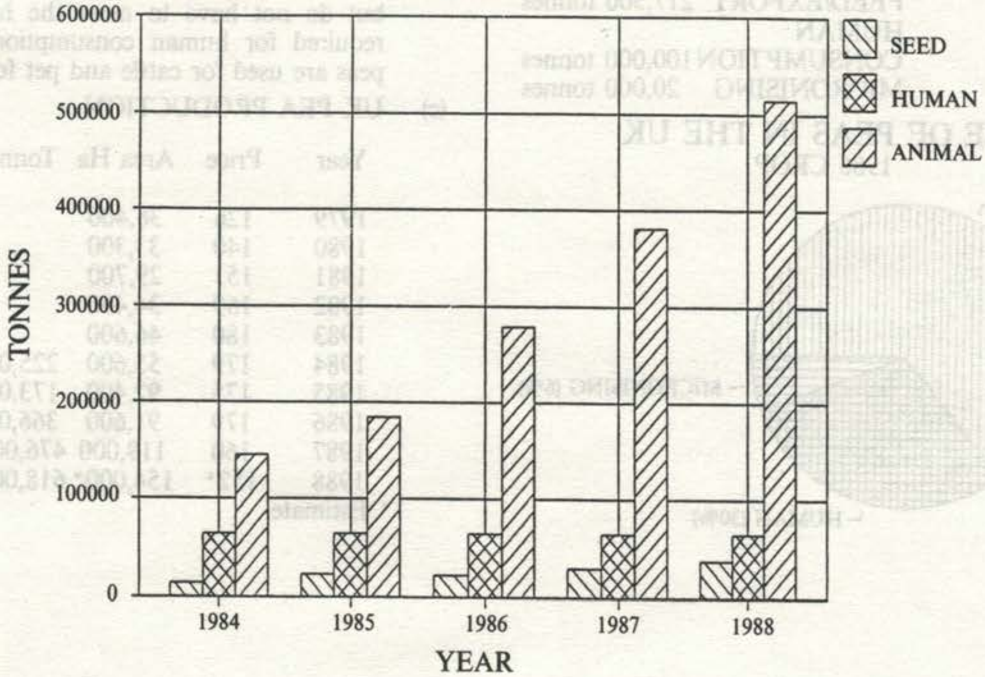
2) HUMAN CONSUMPTION

This is a very stable market and has accounted for approximately 65,000 tonnes/year over the past 4 years.

3) SEED

The requirement for seed has increased from 13,700 tonnes in 1984 to a predicted 38,000 tonnes in 1988 for peas and an estimated 19,000 tonnes of beans in 1988.

DISPOSAL OF THE UK PEA CROP
1984-1988



(e) QUALITY STANDARDS

The EEC standards for feed are not very high and growers pay little attention to producing a clean quality sample.

In 1985 peas delivered to compounders had; moisture ranging from 8% to 25%, admixture ranging from 0% to 15%, protein ranging from 18.7% to 25.3%

The EEC standard for peas is maximum moisture content of 14% and maximum admixture of 3%, or a combined total of 17%. For moisture in excess of 17% the weight is adjusted to take into account losses in shrinkage and weight loss associated with the drying process.

(f) PEA PRODUCTION IN FRANCE

YEAR	AREA Ha
1980	55,000
1981	70,000
1982	95,000
1983	110,000
1984	130,000
1985	195,000
1986	274,000

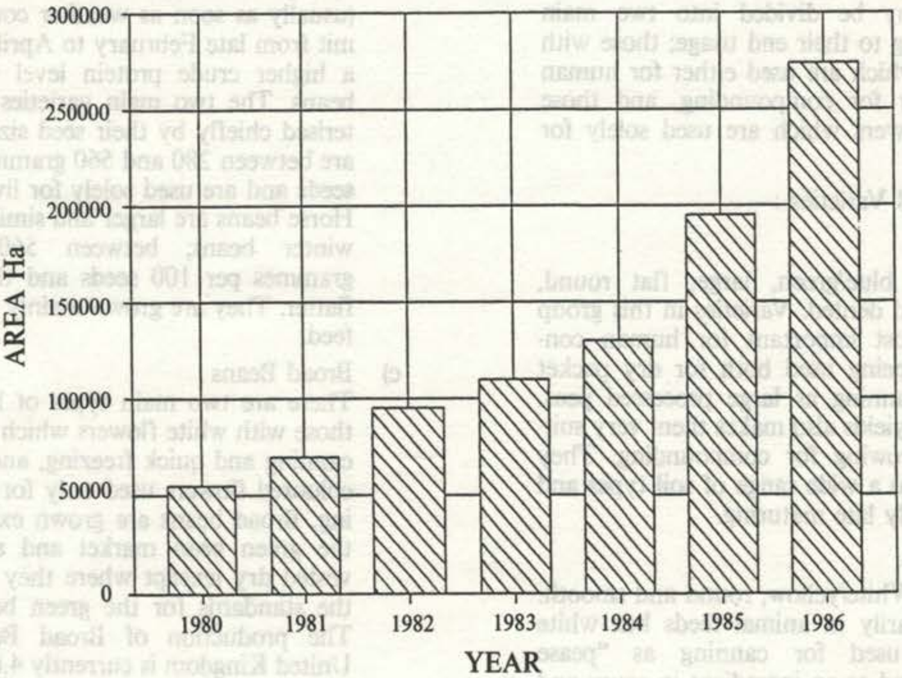
GRAIN LEGUME YIELDS IN FRANCE — TONNES/Ha

YEAR	PEAS	BEANS	LUPINS
1984	5.78	3.75	3.01
1985	6.09	4.44	2.95
1986	5.97	3.53	3.07

* these figures are for the Paris Basin Region

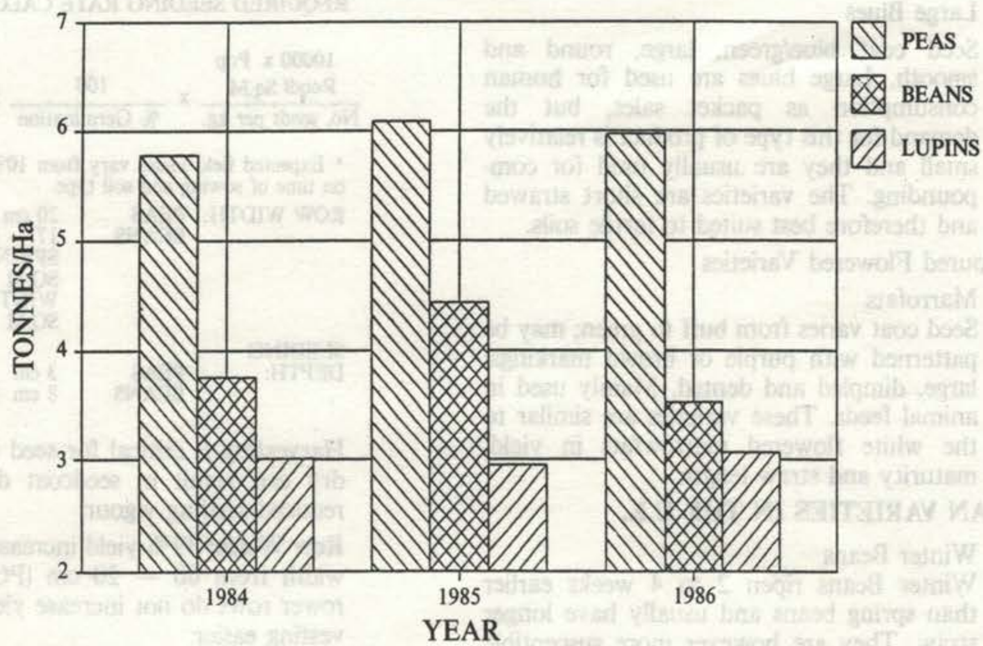
Although yields have been reasonably static for the past three years, new varieties with higher yield potential and an increase in area sown of at least 25% per year over the past three years, will ensure that the production of peas will increase in the near future while there remains a strong demand for peas and while the price for peas remains at its high level.

PEA PRODUCTION IN FRANCE



GRAIN LEGUME YIELDS IN FRANCE

PARIS BASIN REGION



3. GRAIN LEGUME PRODUCTION:

(a) PEA VARIETIES IN THE U.K.

Varieties of combining peas (those that are harvested dry) may be divided into two main groups according to their end usage; those with white flowers which are used either for human consumption or for compounding, and those with purple flowers which are used solely for compounding.

White Flowered Varieties :—

a) Marrofats

Seed coat blue/green, large, flat round, dimpled and dented. Varieties in this group are the most important for human consumption, being used both for dry packet sale and canning as large processed peas. Their high yields also makes them very suitable for growing for compounding. They are suited to a wide range of soil types and are relatively late maturing.

b) White Peas

Seed coat White/yellow, round and smooth. Used primarily in animal feeds but white peas are used for canning as "pease pudding" and as an ingredient in soups and prepared meals. They are suitable for a wide range of soil types.

c) Small Blues

Seed coat blue/green, round and small and smooth. Small blues are used on a limited scale for canning as small processed peas. They are early maturing and of short to medium straw length, with the shorter types being best suited to the more fertile soils.

d) Large Blues

Seed coat blue/green, large, round and smooth. Large blues are used for human consumption as packet sales, but the demand for this type of product is relatively small and they are usually used for compounding. The varieties are short strawed and therefore best suited to fertile soils.

Coloured Flowered Varieties

a) Marrofats

Seed coat varies from buff to green; may be patterned with purple or brown markings; large, dimpled and dented. Mainly used in animal feeds. These varieties are similar to the white flowered marrowfats in yield, maturity and straw length.

(b) BEAN VARIETIES IN THE U.K.

a) Winter Beans

Winter Beans ripen 2 to 4 weeks earlier than spring beans and usually have longer straw. They are however more susceptible to chocolate spot than spring beans and in areas where this disease is prevalent, spring beans are more reliable. As their name implies, winter beans are grown over winter and are usually sown in Autumn in October. They are sown at low seeding rates to give 18-20 plants/square metre and have 4-5 branches per plant.

b) Spring Beans

Spring Beans are sown in early spring (usually as soon as weather conditions permit from late February to April. They have a higher crude protein level than winter beans. The two main varieties are characterised chiefly by their seed size. Tic beans are between 280 and 560 grammes per 1000 seeds and are used solely for livestock feed. Horse beans are larger and similar in size to winter beans; between 560 and 840 grammes per 100 seeds and the seeds are flatter. They are grown mainly for livestock feed.

c) Broad Beans

There are two main types of broad beans; those with white flowers which are used for canning and quick freezing, and those with coloured flowers used only for quick freezing. Broad beans are grown exclusively for the green bean market and are not harvested dry (except where they fail to meet the standards for the green bean market). The production of Broad Beans in the United Kingdom is currently 4,000 — 5,000 Ha per annum.

(c) SEEDING RATES AND FERTILIZER REQUIREMENTS

TARGET PEA PLANT POPULATIONS

	PLANTS/M2 Seed @ #550/t	Seed @ #400/t
MARROWFLATS	55	65
LARGE BLUES	60	70
SMALL BLUES	85	95

REQUIRED SEEDING RATE CALCULATION

$$\frac{10000 \times \text{Pop Reqd/ Sq.M}}{\text{No. seeds per kg.}} \times \frac{100}{\text{\% Germination}} \times \frac{100}{100 - \text{Field Loss}}$$

* Expected field losses vary from 10% — 25% depending on time of sowing and soil type.

ROW WIDTH:	PEAS	20 cm MAXIMUM
	BEANS	17 — 35 cm
		SPRING: 35-40 PLANTS/SQ.M
		WINTER: 20-22 PLANTS/SQ.M
SEEDING DEPTH:	PEAS	3 cm
	BEANS	8 cm MINIMUM

Harvesting is critical for seed as harvesting too dry can result in seedcoat damage and thus reduced seeding vigour.

Row Width: 39% yield increase in reducing row width from 60 — 20 cm (PGRO Trials), narrower rows do not increase yield but make harvesting easier.

Plant Density: Maximum yield at 95-100 plants/M2 and maximum Economic yield at 65-100/M2 depending on Seed cost i.e. type of pea.

Date of Sowing: Yields fall by 100 kg/Ha/week after 1st March sowing.

Irrigation can be used to improve pea yields but is little practiced. (Some crops are irrigated in Norfolk, U.K., with good results).

FERTILIZER REQUIREMENTS

Soil Test P ppm	P Reqd. Kg/Ha	Soil Test K ppm	K Reqd. Kg/Ha
0-9	50	0-60	150
10-15	25	61-120	50
16+	0	121-240	40
		241+	0

Fertilizer is commonly applied broadcast on the soil and ploughed in well before sowing the crop, and incorporated at a level below the sowing depth.

Some nitrogen Fertilizer is often applied at seeding to obtain good early seedling vigour especially when sowing late or in wet and cold conditions. A maximum of 20 units/Ha of Nitrogen is applied.

SEEDING

Most seeding is done with a normal grain drill up to 4m wide, and usually have covening harrows fitted behind the drill. Peas are rolled with Cambridge rollers immediately after seeding, although this can be delayed until the peas are 150mm high if the soil is too wet to roll and the risk of compaction is high.

Beans are not usually rolled after seeding, especially Winter beans which rely on the frost and rain over winter to break down the soil lumps on the surface. Occasionaly Winter beans are harrowed with heavy harrows in spring time if the ground is too rough or if the plant population is too high.

This is now being tackled with release of leafless and semi-leafless pea varieties (which possess the Afila Gene). However this still does not improve straw (stem) strength and will still occur. Work on growth regulators to improve straw strength Improved design of Pea lifters needed.

2) **Sensitivity to Water Stress**

- main problem is the shallow root system can be helped by earlier sowing — Autumn sowing in U.K. can be very risky due to failure of crops to survive over winter.
- semi-leafless types are more efficient at water usage in dry conditions versus standard leafed types
- irrigation could solve this problem (irrigation is now used in Norfolk for this)
- too much water can be a problem as both peas and FABA beans require some water stress to trigger off the change from the intermediate to more determinate growth habit which results in a greater pod set and retention.

There are three main end uses for peas each of which has different criteria and thus different factors to be considered when improving yields.

1) **Vining Peas**

Peas harvested at the tender green stage with specialised mechanical pea vining harvesters which remove the peas from the pod. The peas must be frozen or canned immediately to avoid spoilage (within 1 hour of harvesting)

2) **Combining Peas**

Peas are harvested at the Dry seed stage (usually 15-17% M.C.) Peas are sold for seed, compounding for animal feedstuffs (to replace soya meal) for packeting or for canning after rehydrating (depending on the variety)

3) **Forage Peas**

Peas harvested green at the flat pod stage and ensiled or made into hay — high levels of tannin in the haulm.

Vining Peas:

- canners require even sized seed
- plants must stay upright for harvesting
- slow maturing from optimum maturity to allow for ease (or spread) of harvesting
- high sugar content, acceptable flavour

Combining Peas:

- Yield potential 6T/Ha
- seed size not important & higher yields could be obtained from producing (more) smaller seeds.
- higher yield potential from plants having larger stipules.

Higher yields are obtained from the leafless types at higher planting densities due to the effect of reduced light interception by these types — also reduced growth rates versus the convential pea types.

Primary determinant of biological yield is the amount of sunlight intercepted by the plant over the season. It is important in this context for for crop to have good early growth vigor.

Crop growth rate depends on: —

1. Individual plant growth rate
2. Planting density.

Peas with larger seeds have higher growth rates. (Note that most of the U.K. varieties are larger seeded types versus Australian).

Plant size within the crop is important as small plants have a lower proportion of seed weight to plant weight (Harvest index). Therefore crops with a large proportion of small plants will have a lower yield.

This can be affected by planting density and planting pattern. The more uniform the pattern and the lower the density the less variable will be the plant size. The larger the seed size the greater the variation in plant size.

Most common seeding technique is with a standard cereal drill. This will result in uneven row spacings. To improve the chances of plants being more evenly sized, pea plants should ideally have an equal growing space and this can only be achieved using a precision drill.

Winter Beans are usually broadcast on the soil surface and ploughed in to a depth of up to 200mm. This reduces the risk of chemical damage from Simazine and puts the seed out of reach of birds, who will dig down into the soil up to 100mm to find seeds over winter.

(d) IMPROVING PEA YIELDS

Highest yields in U.K. — Vining Peas
France — Combining Peas

However yields in the U.K. are now declining and areas for Dry Pea production increasing due to EEC support schemes. Yields are declining due to shortening of rotations and growing peas closer than 1 year in 5 — Peas and beans need to be treated as one crop in rotation planning, as well as oil seed rape.

A survey undertaken by the Pea Growers Research Organisation showed that where peas or beans were grown only once or twice in 9 years, the incidence of soil borne diseases was low; that cropping 3 times in 9 years resulted in a marked increase in disease levels, whereas 4 times in 9 years resulted in the incidence of disease being much greater still.

Most growers in the U.K. adopt a rotation of 1 year in 5 so as to reduce the likelihood of any disease build up. It should be noted that peas, beans, vetches and oil seed rape should be considered as one and the same crop, from the point of view of rotation as these crops all host the same diseases.

Since 1940 Wheat yields in U.K. have increased at twice the rate of yields of Peas and FABA Beans. Peas are less stable in yield from year to year (V.V. Wheat).

Main problems with increasing yield are:

1) Poor standing ability
   - — crops lodge
   - — hard to harvest — cutting of pods — cannot pick up all the crop
   - — lying on ground increased disease (botrytis)
   - — uneven drying

Edge effect of trial plots means that plants on edges of long thin trial plots will have a compensatory growth factor due to lack of competition at plot edges and will result in plots having higher yields than would otherwise be obtained in field conditions. Of interest is the fact that crops with a high harvest index show less tendency to have an increased yield in outer rows (due to their less vegatative growth habit).

(e) FACTORS AFFECTING PEA YIELDS

1. Planting Density — has no affect on yield from 50-200 plants/m². Protein Mobilisation — variation between varieties in the total plant protein yield and the amount of protein in the seed — no direct correlation between the two. Nitrogen Fixation (Symbiotic) is not correlated with Nitrogen assimilation. Nitrogen fixation is negatively correlated with earliness of maturity. However Nitrogen fertilizer will increase the yield of some varieties.
2. **Protein Content**
   Wrinkled seeded variety protein content 26-33%
   Smooth seeded variety protein content 23-31% (Higher starch content).
   No correlation between seed size and protein content. Increasing yields will not produce reduced protein content.
3. **Disease Resistance**
   Varieties can be bred with disease resistance.
4. **Water Use**
   Peas are very sensitive to water deficit during flowering and pod development seed production in weight as a proportion of total plant weight is fairly consistant (40-60%). Dry weight of the vegetative structure at the onset of flowering gives a fairly reliable prediction of yield. Therefore to increase yield the aim should be to increase total DM production. This depends on canopy expansion, duration and senescence which are affected mainly by water deficit.
   The ability to intercept as much radiation as possible will be enhanced by earlier sowings with adequate plant populations and choosing later maturing varieties.
5. **Emergence Problems**
   Few farmers ever achieve target plant populations (U.K. surveys) main problem is poor emergence. Main cause is compaction, cultivating and sowing when too wet. Post sowing compaction can reduce emergence by 50% with similar results for dry and wet soil conditions. Plants grown in compacted soil (with reduced emergence) do not have the ability to produce compensatory growth.

(f) GROWING OF PEAS WITH BARLEY

Barley is sown with the peas at a seeding rate of 35-45 kg/Ha and at this rate offers very little competition to the peas. In fact due to the upright growing habit of the peas in the barley, the yield of the peas can be significantly increased, especially in wet years.

ADVANTAGES

1. The barley tends to lift the peas off the ground making harvesting easier and in wet seasons reduces strawing and combine losses as well as reducing the incidence of disease in the peas.

2. The pea/barley mixture flows more easily through augers.

3. Barley helps to improve the air flow through the peas during drying which can be done with cold air. As the barley ripens first and is therefore drier, it helps draw moisture out of the peas and helps reduce splitting of the peas (usually associated with drying with hot air).

4. The sale of the barley which usually yields 1.25 — 2.5 T/Ha covers most of the variable costs of growing the pea crop.

5. The straw/haul mixture makes a fairly good quality feed for sheep and cattle.

Separation of the two seeds is carried out first before the seed is sold and can be done with any seed cleaning plant at a cost of around £5/tonne. Pea yields have increased where peas have been sown with barley with one farmer reporting a yield increase from 3.4 T/Ha to 5 T/Ha. This is mainly due to reduced losses at harvest time.

After broadcasting the barley at 40 kg/Ha and harrowing the peas are sown to give a plant density of 65-70 plants/m² (200-350 kg/Ha seed rate).

Weed Control — Stomp at 4L/Ha is the only chemical that is recommended for use in both peas and barley.

(g) HERBICIDES

As most crops are sown in the spring, weeds can usually be controlled with one spray application. Recent changes in herbicide usage regulations means that there are very few post emergent herbicides for peas and most growers use pre-emergent herbicides.

General weed control — pre-emergent herbicides.

The most commonly used herbicides are:

1. CYANAZINE
   This gives a good control of a wide range of annual weeds. Some restrictions on soil types and varieties.
2. PENDIMETHALIN
   Can be used on all varieties and most soil types. Rates vary depending on the weed spectrum.
3. PROMETRYN
   Can be used on most soil types, but is less persistant than other chemicals.
4. TERBUTRYN/PROMETRYN
   Can be used for all varieties except vedette and on all soil types.
5. TERBUTRYN/TERBUTHYLAZINE
   This chemical is very widely used and controls a wide weed spectrum. Can be used on all soil types except very light soils and sands. Aplication should be made at least 3 days prior to emergence.
6. TRIETAZINE/SIMAZINE
   Widely used with a good weed spectrum. Not recommended for lighter and sandy soils, but can be used up to stage when 5% of the crop has emerged.

POST-EMERGENCE CHEMICALS

1. MCPB
   This chemical is used specifically to control thistles and docks. It only controls a limited range of annual weeds and other chemicals are required to control them.
2. BENTAZONE & MCPB
   Gives good weed control including volunteer Oil Seed Rape and Cleavers but is expensive.
3. CYANAZINE & MCPB
   This is the most widely used post-emergence treatment and controls a wide range of weeds including volunteer Oil Seed Rape.
4. ALLOXYDIM-SODIUM
   Gives excellent control of wild oats up to early tillening stage.
5. DICLOFOP-METHYL
   A widely used chemical for wild oat control, for use when the wild oats are from the 3 leaf stage to early tilling. (Rates are double that used in Australia).
6. SETHOXYDIM
   For control of wild oats in vining peas only. Will also control volunteer cereals and sterile brome.

(h) PEA LEAF WAX ASSESMENT

One of the main problems associated with post-emergence spraying of peas is to know whether the peas have enough leaf wax to enable them to be safely sprayed. A simple test developed by the Pea Growers Research Organisation uses a 1% solution of crystal violet which will indicate the level of leaf wax deposits as well as giving a general indication to the general health and vigour of the pea plants.

The plant to be tested must be handled gently and removed from the soil by gripping the base of the plant with a large pair of forceps or tongs. The plant is then immersed in the dye solution and removed, shaking off any surplus dye. The areas of the plant retaining the dye are where the wax deposit is either deficient or has been damaged.

A plant safe to spray will show less than 5% of the upper leaf surfaces and 10% of the lower leaf surfaces showing dye retention. If the level of dye retention is above these levels, then spraying of the plant should be delayed until the plants, when tested, show a normal amount of dye retention.

(i) NAVY BEANS (PHASEOLUS VULGARIS)

Use:—

1. Use in the U.K. in the canning industry to produce baked beans. Over 80,000T are imported each year, mainly from Michigan and Ontario in U.S.A.
2. An alternative type of bean would be red kidney or pinto beans for direct human consumption without processing.
3. Another use would be for a protein source for extraction and manufacture into meat substitutes.
4. As an animal feed source (if the toxicity problems can be overcome).

Varieties: —

Existing varieties in use in the U.S.A. are not well adapted to use in the U.K., although research work is now being undertaken to assess the suitability of various varieties for the U.K. climate.

Soil Types: —

Most productive on well drained fine textured soils, can be grown on sandy loam soils high in organic matter. The plants are very sensitive to excess water and drought.

Fertilizer: —

Beans respond best to fertilizer placed in a band 25mm to the side and 50mm below the seed. The crop is very susceptible to damage if the fertilizer is placed close to or in contact with the seed. On neutral or alkaline soils, beans frequently need manganese. 5 kg/Ha at seeding. Zinc deficiency may occur on alkaline soils or where high levels of phosphorus was applied to the previous crop. Fertilizer containing 3-6 kg/Ha zinc prevents a deficiency from developing.

Seed Quality: —
Bean seed is highly susceptinble to both seedcoat damage and internal injury. Beans where the seedcoats have a crack or break have both a lower germination and reduced seedling vigour. Even where there are not visable external signs of injury beans that are damaged internally also suffer from much reduced germination rates and seedling vigour.

Innoculation: —
This is not usually necessary and field trials have shown no increase in yield from innoculation.

Seeding Rates: —
Highest yields have been obtained with row spacings of 70cm and an inter plant spacing along rows of 75mm. This corresponds roughly with a seeding rate of 35 Kg/Ha for Navy beans but will vary depending on germination % and soil type.

Diseases: —
Diseases are a major problem in bean production. The most serious disease of beans is blight. Other diseases such as Anthracnose and Mosaic virus can also seriously affect beans.

Insects: —
Beans are attracted by a wide range of insect pests including beetles, aphids and worms all of which can be controlled by the appropriate insecticides.

Harvesting: —
Beans must be harvested when the seed moisture context is relatively high (17-18%) in order to reduce any chance of damage to the seedcoat.

Specialist bean harvesters are often used which have special screens and rubber coated bars and grates to reduce seed damage.

(j) HERBICIDE RESISTANCE IN WEEDS:

Worldwide over 48 weed species have developed resistance to the triazine group of herbicides (e.g. simazine, atrazine).

Simazine is the most widely used herbicide in horticultural crops and grain legumes. After 25 years of use there are now resistant populations of several important weeds in the U.K.

Resistance has been confirmed in American willowherb (Epilobuim ciliatum), Annual meadow grass (Poa annua) *Winter Grass, Canadian Fleabane (Erigeron canadensis), Groundsel (Senecio Vulgaris), Pinapple weed (Chamomillia saaveolens).

Resistant populations occur in most of the fruit growing areas of England. Resistance is extreme: applications of 100 kg/Ha of simazine failed to kill resistant willowherb, 100 times the dose lethal to susceptible plants.

Simazine resistant plants are also resistant to other triazine herbicides (e.g. atrazine, cyanazine) and to some extent to herbicides (e.g. Gromacil, lenacil). Response to other herbicide groups is not affected.

Solutions
To overcome the problem it is necessary to be able to identify resistant plants to monitor their spread, and to develop alternative control strategies. With triazine resistance, alternative residual herbicides are available but generally are more expensive e.g. dichlobonil, diphenamid diuron, napropamide, oxadiazon.

Herbicide Resistance in Black Grass (Alopecurus Myosuroides)
Black grass is a major weed problem in cereal crops as it requires very selective and expensive herbicides to control it. The most commonly used herbicides in the U.K. for black grass control are chlorotoluron and isoproturon to which black grass is resistant to up to 10 times the normal dose rate as well as showing resistance to these chemicals, resistant black grass has shown a degree of cross resistance to many other herbicides all with different modes of action.

Herbicide Resistance in Chickweed (Stellavia media)
Chickweed has been found in the U.K. that is resistant to normal rates of mecoprop. However other alternative chemicals are available to control this weed.

(k) DISEASE CONTROL

1. Damping Off Diseases
These soil borne diseases attack newly sown seeds, especially in cool, wet conditions which are conductive to slow germination and emergence. Fungicides are available which give good protection to peas and beans and usually all commercial pea seed is treated.
2. Ascochyta
a) Peas
This is a seed borne disease caused by any of three very similar fungi. Infection can start when the plant is emerging and then spreads up and down the plant as it grows. This infection, once of the leaves of a growing plant can spread to other plants. It is not possible to see the infection on the seeds and seed must be tested to determine levels of infection. Ascochyta can be controlled by a systemic fungicide and is considered economic to treat with levels of infection from 5% to 30%.
b) Beans
Ascochyta Fabae will cause similar effects to beans, although seed treatment is less effective in controlling the disease. It is generally recommended that farm grown seed have a disease level of less than 1%.

3. Downy Mildew

This fungus is soil borne and very persistant and when established in a crop can result in poor plant growth and significant plant growth. It is usually associated with early sown crops in paddocks with a history of pea cropping. Infection takes place during seedling emergence and can be controlled with a systemic fungicide.

Chemicals for Disease Control

The following chemicals are used as seed dressings. The dressing is usually done by seed merchants and most seed is sold dressed. Some interest has been shown in a Polymer coating for seed dressing which leaves the surface of the seed smooth and shiny with the chemical bound to the seed by the Polymer film. This is a very expensive process and has shown no tangible benefit to farmers except from the ease of handling of treated seed.

Disease	Chemical Control
Damping Off	Captan Drazokolon Thiram
Aschohyta	Thiabendazole and Thiram
Downy Mildew	Fosetyl Aluminium & Captan Metalaxyl & Captan

(l) PESTS

1. Pea Weevil (Sitona Lineatus)

These may cause damage if large numbers appear when the plants are small and in cold wet conditions. Leaves of attacked plants show characteristic "V" shaped notches around the edges, but the main damage occurs as a result of the larvae feeding on the root nodules.

Spraying when leaf damage is noticed will control further leaf damage, but is too late to control the larvae. Larvae can be controlled by using phorate granules at seeding and seed treatments contaning Bendiocarb will reduce weevil damage.

2. Field Thrips. (Thrips Angusticeps)

These feed on emerging seedlings and can cause the transmission of viruses which can result in severe yield losses. Plants affected usually recover when sprayed but yield potential is lost.

3. Pea Aphids (Acyrthosiphon Pisi)

These can cause severe yield losses when present in large numbers and should be sprayed immediately they are found forming colonies in the crop. Best time for control is usually when the crop starts flowering.

4. Pea Moth (Lydia Migricana)

The larvae of the pea moth feed on the developing seeds in the pod and can cause severe damage to seed and reduce the weight of seed. Phoromore moth traps are used widely to detect pea moth activity and to enable decision on timing of spraying to be made. When 10 or more moths are found on either of two traps over 2 days then spraying is necessary (usually 2 sprays are required 14 days apart).

5. Pea Cyst Nematode

Can cause severe losses and is usually associated with frequent cropping of peas and beans. At least 5 years between legume crops is recommended to reduce the incidence of pea cyst nematode. Nematicides can be used to control the nematode at seeding time if a problem is known to exist.

(m) HARVESTING PEAS

Most peas are harvested with "open front" type harvesters with crop lifters attached. Due to the large bulk of dry matter there appears to be no difficulty in harvesting peas with this method as long as the paddock has been rolled after seeding, and that the crop is harvested at right angles to the direction in which it has lodged.

1. Moisture Content:

Crops are harvesting with moisture contents as high as 25%. For long term storage peas should have a maximum moisture content of 14%. To achieve this moisture level, carefull slow drying is required so that the seed coat is not cracked. Merchants will accept seed that has a moisture content of less than 16% and usually if it is above this level it will still be accepted by the merchant but will have to be dried and the price paid to the farmer is reduced accordingly.

2. Dessication:

Due to uneven ripening and weeds present, peas are often dessicated prior to harvest using diquat at 2-3 litres/Ha. Harvesting can start from 2-7 days after spraying depending on the weather conditions. Peas can be sprayed when the lower pods are grown and dry and the moisture content is below 45%. Roundup is also used prior to harvest to control grasses and weeds when the moisture content of the peas is below 30%. A minimum time of 7 days is required between spraying and harvesting.

3. Pod Sealants:

The use of pod sealant sprays has been investigated to determine if pod shatter can be reduced. However, there does not appear to be any advantage in applying pod sealants as no yield increases have been achieved.

4. Swathing

There is no advantage in swathing the crop rior to harvest due to the large number of pods that are cut during the swathing process and the lack of suitable specialist machinery.

5. Variety Choice:

Most of the harvesting losses are due to wet weather at harvesting causing the pods closest to the ground to become stained and rot. Timing of harvesting is crucial to minimise the risk of damage. However, taller more upright varieties and semi leafless varieties which tend to stand up and not fall flat, will often result in a higher yield due to less harvest losses and not due to their yield potential per se.

(n) STORAGE AND HANDLING

1. **Storage facilities on farm:**

   Most farmers in the U.K. have considerable on farm storage facilities associated with drying equipment, as most of the grain is harvested at moisture contents above the meximum level for long term storage.

   The most common type of storage facility is multi-purpose sheds that are used for storage and drying of grain, storage of fertilizer and machinery storage at different times of the year. Multi purpose sheds are also used during the winter months for housing livestock. Due to the multi-purpose nature of the storage sheds, any grain stored is usually only held by the farmer long enough for the grain to be adequately dried and is then sold.

2. **Co-operative Storage:**

   There are very few grain co-operatives in the U.K. They are not considered by most farmers as an alternative to on farm storage. However in France most farmers belong to Co-operatives through which they do the majority of their buying and selling of produce. French Co-operatives tend to serve farmers within a small area and have very good centralised bulk handling facilities for both grain and fertilizer.

3. **Grain Merchants:**

   The amount of storage space owned by grain merchants is very small in relation to the total tonnage of grain that they handle and they rely on the farmers on-farm storage and a fast turnover of grain through their own facilities.

4. **Handling:**

   Sample appearance is of prime importance for grain that is to be sold for human consumption and every effort is made to keep handling of the grain to a minimum. Augers and pneumatic systems can damage the seed coat and are not often used for grain legumes.

   Rubber belted conveyors and front end loaders are normally used for handling of seed and cause little damage and are well suited to the type of storage facility normally found on the farm.

4. GROSS MARGINS:

An analysis of various crops grown in the United Kingdom shows the Gross Margin of Peas and Beans to be well above the other main crops; Wheat, Barley, Oats and Oil Seed Rape. This, and the beneficial effect Peas and Beans have as a break crop in a Cereal cropping programme, has meant that there is a steady increase in the area sown to these crops both in the U.K. and France.

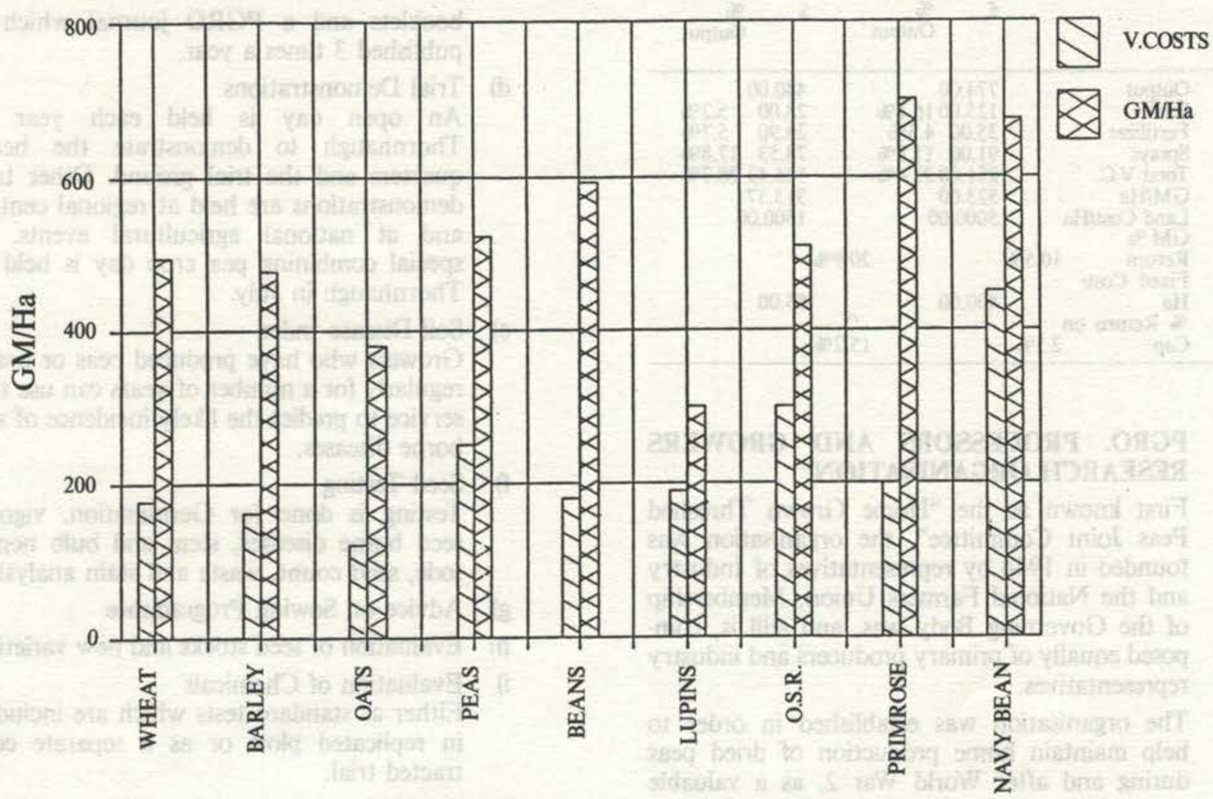
While Peas and Beans have a higher Gross Margin than Wheat, they are a higher risk crop to grow with yields being less stable from year to year than wheat and they also have crop rotational limitations in that is is recommended that they only be grown one year in five to minimise disease build up risk.

U.K. CROPS — GROSS MARGINS

Crop	Yield	£/T	V.Costs	GM/Ha.	F.Costs	NFI/Ha.
WHEAT	6.7	110	177	495	400	95
BARLEY	6.4	108	162	478	400	78
OATS	5	100	120	380	400	−20
PEAS	4.3	180	251	523	400	123
BEANS	4.3	180	180	594	400	194
LUPINS	2.5	196	190	300	400	−100
O.S.R.	3	270	300	510	400	110
PRIMROSE	.45	2000	200	700	400	300
NAVY BEAN	2.5	450	450	675	400	275

While Gross Margins/Ha are high for all crops, the level of Fixed Costs/Ha on most farms are also high and a level of £400/Ha would be average for cereal farms (University of Newcastle survey results). Thus for crops such as Wheat and Oil Seed Rape a Net Farm Income/Ha figure of around £100/Ha is achieved. However beans are almost double this figure at £194/Ha making them an attractive crop to grow and Lupins at £100/Ha are not considered an economic proposition and in fact are grown only on an experimental basis in the U.K.

UK CROPS — GROSS MARGINS



A proportional analysis of variable costs as a % of output for peas and beans for both the U.K. and Australia shows very similar levels of input in relation to output. It is interesting to note, however, in the case of peas, that the cost of seed in the U.K. is proportionally much higher than the seed cost in Australia. This is due to the fact that farmers in the U.K. and most of Europe do not save their own seed but purchase fresh seed every year. This is to maintain purity, germination and seedling vigour. All purchased seed also has seed dressings applied which gives the farmer one less operation to worry about at seeding time.

COMPARATIVE GROSS MARGINS

	UNITED KINGDOM £	% Output	AUSTRALIA $	% Output
Output	774.00		351.00	
Seed	67.50	8.7%	24.00	6.8%
Fertilizer	25.00	3.2%	15.82	4.5%
Sprays	88.00	11.4%	46.87	13.4%
Total V.C.	180.50	23.3%	86.69	24.7%
GM/Ha	593.50		264.31	
Land Cost/Ha	5000.00		1500.00	
GM % Return		11.9%		17.6%
Fixed Cost/Ha	400.00		85.00	
% Return on Cap		3.9%		12.0%

BEAN GROSS MARGIN

Yield T/Ha		4.30
Price £T		180.00
Output £Ha		774.00
Variable Costs/Ha		
Seed	150 kg/Ha @ £450/Tonne	67.50
Fertilizer	20 units N at seeding	25.00
Herbicides	Trietazine/Simazine 1.2 l/Ha Hoegrass 3.5 l/Ha or Suffix 3.2 l/Ha	40.00
Insecticides	Synthetic Pyrethroid	23.00
Fungicides	Carbendazim 1 l/Ha	25.00
Total Variable Costs/Ha		180.50
Gross Margin/Ha		593.50
V.C./Tonne		41.98

PEA GROSS MARGIN

Yield T/Ha		4.30
Price £/T		180.00
Output £/Ha		774.00
Variable Costs/Ha		
Seed	250 kg/Ha @ #500/Tonne	125.00
Fertilizer	20 Units N at seeding + P	35.00
Herbicides	Trietazine/Simazine 2.4 l/Ha Hoegrass 3.5 l/Ha or Suffix 3.2 l/Ha Cyanazine 1 l/Ha + MCPB 1 l/Ha	54.00
Insecticides	Synthetic Pyrethroid	17.00
Fungicides	Carbendazim 1 l/Ha	20.00
Total Variable Costs/Ha		251.00
Gross Margin/Ha		523.00
V.C./Tonne		58.37

COMPARATIVE GROSS MARGINS

	UNITED KINGDOM £	% Output	AUSTRALIA $	% Output
Output	774.00		440.00	
Seed	125.00	16.1%	23.00	5.2%
Fertilizer	35.00	4.5%	24.90	5.7%
Sprays	91.00	11.8%	78.53	17.8%
Total V.C.	251.00	32.4%	126.43	28.7%
GM/Ha	523.00		313.57	
Land Cost/Ha	5000.00		1500.00	
GM % Return	10.5%		20.9%	
Fixed Cost/ Ha	400.00		85.00	
% Return on Cap	2.5%		15.2%	

5. PGRO. PROCESSORS AND GROWERS RESEARCH ORGANISATION:

First known as the "Home Grown Threshed Peas Joint Committee", the organisation was founded in 1944 by representatives of Industry and the National Farmers Union. Membership of the Governing Body was, and still is, composed equally of primary producers and industry representatives.

The organisation was established in order to help maintain home production of dried peas during and after World War 2, as a valuable source of vegetable protein, by improving the general efficiency of production through research, development and the collection and dissemination of information.

Through a large programme of applied research, PGRO aims to further improve the yield, ease of production and harvesting of peas and beans for all uses.

Trials are undertaken at Thornhaugh and across the country to fully assess agronomic and climatic effects on new developments. Currently trials are being undertaken to evaluate new varieties, herbicides, fungicides and seed protectants; to determine the optimum plant density for new varieties and assess the value of new mechanical and chemical aids to harvesting.

Farmers can become members of the PGRO for an annual subscription of £10 plus a levy of 32p per tonne of dried peas grown, and then have access to information and services provided by the PGRO. These services include;

a) Free Advisory Service.
   This covers all aspects of production including the husbandry and economic value of the crop, choice of variety for specific markets and areas, weed, pest, disease and disorder problems and advice on harvesting and drying. full laboratory services are available for the identification of pests and diseases. A telephone information service is provided to give up to date information on the control of insects.

b) Talks and Lectures
   A large number of illustrated talks are given each year to give current crop information to growers and merchants.

c) Publications
   These cover all aspects of production and include information sheets,
   booklets and a PGRO journal which is published 3 times a year.

d) Trial Demonstrations
   An open day is held each year at Thornhaugh to demonstrate the headquarters and the trial ground. Other trial demonstrations are held at regional centres and at national agricultural events. A special combining pea crop day is held at Thornhaugh in July.

e) Soil Disease Index
   Growers who have produced peas or beans regularly for a number of years can use this service to predict the likely incidence of soil borne diseases.

f) Seed Testing
   Testing is done for Germination, vigour, seed borne diseases, stem and bulb nematode, seed count, waste and stain analysis.

g) Advice on Sowing Programmes

h) Evaluation of seed stocks and new varieties.

i) Evaluation of Chemicals
   Either as standard tests which are included in replicated plots or as a separate contracted trial.

6. CONCLUSIONS:

1. The current increases in Grain Legume production in the U.K. and France will continue in the near future but will not be able to meet the growing demand for protein in the EEC for use mainly in livestock rations.
2. Grain Legume yields in the past have not increased at the same level as yields of wheat and barley have. However as many new varieties are being released each year by many seed companies the yield potential of peas and beans will continue to rise and perhaps reach the same level of increase as that of wheat.
3. Many varieties of Peas and Beans now being grown in Europe may be suitable for the Australian environment as they are currently being grown in New Zealand. However as there is currently no Plant Variety Rights legislation to cover these crops in Australia, seed merchants will not release these varieties in Australia.
4. If Australian farmers are to get the same benefit from plant breeding in Australia as their counterparts in Europe now enjoy, much more effort and money needs to be put into plant breeding. Each seed company in Europe has budgets for plant breeding exceeding £100 million and are very competitive, resulting in better plant material being available to farmers (at a cost). It is interesting to note that the main variety of peas currently grown in Australia is over 50 years old.

5. The quality standards of our grain legumes is much higher than those for the EEC and this gives Australian produce a real marketing edge both in the EEC and the rest of the world. We are world leaders in Lupin production and should continue to be so for some time, until new varieties suitable for Europe can be found.
6. European farmers have a good knowledge of crop husbandry and make very effective use of the resources available to them. We can learn a lot from them in terms of attention to detail, time of sowing, depth of sowing, fertilizer use and herbicide use. While the climate may be different to most areas of Australia, the crops that are grown are basically the same, have the same diseases and pests and same requirements in terms of fertilizer and chemical usage.
7. The yields of Grain Legumes in Europe are much higher than in Australia and this is due to a combination of two main factors.
   a) Efficiency of water use
   b) High yield potential varieties.
   In France 10 kg of peas are produced per Hectare per millimetre of annual rainfall. In Australia the figure is around 5 kg/Ha/mm of annual rainfall.
8. Many different types of Peas and Beans are available to European Farmers, depending on their end use. Australian farmers have a very limited choice of Peas and Beans to grow and thus a limited market for their produce. A similar range of variety types would give Australian farmers greater marketing scope.
9. The cultural practices of European farmers are not much different from those practices in Australia and perhaps Australian farmers should pay more attention to the details of growing their corps and in particular in recording what is done on a paddock by paddock basis.
10. Chemical and pesticide regulations in the EEC have had a considerable impact on the farming community and has forced farmers to change their own codes of practice. Similar legislation will inevitably be enacted in Australia, which will mean restrictions and changes to the way farmers now apply herbicides. Before farmers in Australia are forced by legislation to change their work practices in relation to chemical usage, positive steps must be taken by farmers to show that they are responsible users of chemicals who care for their environment. This involves careful recording of all chemical usage, not exceeding recommended rates, and taking care when applying chemicals and disposing of empty containers.
11. Simple plant tests, such as the Pea Lead Wax assessment developed by the Processors and Growers Research Organisation, are simple tools that can be adopted by farmers to make better use of crop chemicals.
12. Navy Beans for temperate climates could provide a viable alternative to existing grain legume crops, if suitable varieties can be identified.
13. Herbicide resistance in weeds is a worldwide problem and is evident in Europe not through mis-use or over-dosing, but through a long history of using the same herbicide for weed control. Herbicide resistant weeds have been identified in Australia and very little is known how to overcome this problem. It is an area of immediate concern both in Europe and in Australia.
14. Grower funded research centres such as the Processors and Growers Research Organisation provides farmers with the information they want that has some direct relevance to what they are currently doing on the Farm. While grower funded research centres could not possibly hope to cover all aspects of crop research, they do provide a good alternative information source to the Government and Industry Funded research work.