AUSTRALIAN NUFFIELD FARMING SCHOLARS ASSOCIATION

REPORT OF VISIT TO THE UNITED KINGDOM

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Acknowledgements.

The past and continued efforts of the dedicated group of men that run continue the Nuffield tradition deserve more recognition than I can give. I knowthat their efforts are inspired by the wish to give to others the chance they had, a chance which obviously affected their lives as profoundly as I am beginning to realise it has affected mine. I thank them for the opportunity to represent Nuffield and thus for the faith and confidence they placed on an individual that they barely knew. I will try to pass these benefits to other Australian farmers and present this report as a first attempt in that direction.

I would like to particularly thank the Cysters and the Stewarts, the four people who cared for our every day needs in England and whose patience, tolerance, hospitality and example provided the basis for the benefits of the scholarship.

Special mention must also be of those magnificent men, the Nuffield class of 1983. It would be impossible to find a better group of travelling companions and I am honoured to count them as friends and to have benefited from their experience and wisdom.

Many others who helped myself and my wife deserve special thanks. The Tuer family provided a home and a source of advice and companionship that form the basis of my feeling for England as home. Other's contribution I cannot mention for reasons of space, but include their names with thanks, knowing that they are aware of their part in the education of this colonial.

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Preface

The following report covers the three aspects of my studies under the 1983 Nuffield Farming Scholarship award. This study embraced a period of four and a half months in the UK and Europe studying wheat production and farm computers. During this period an insight was also gained into the basis of agricultural trade in the EEC. The operation of this body is poorly understood in this country and a summary of the basic principles and their likely effects on the future viability of Australian agriculture is also included.

The various topics have been researched differently and some explanation of the methods employed may allow the reader to better interpret the information presented.

1) The EEC.

The operation of the EEC was studied intensively during a three day period of interviews with heads of departments, senior diplomats, the Chairman of the Agricultural Committee, leaders of COPA (the European farm lobby) and journalists during an official visit in March. This was reinforced by a two-day course given by the Director of European Studies at Wye College and by meetings with the National Farmers Union executive and regional groups during the tour. This information was further enhanced by constant talks with leading farmers both in the UK and on the Continent during the course of the scholarship, so that the report presented is a brief summary of the conclusions reached from a large amount of data.

Many of these conclusions will be controversial and many will often be criticised as being biased. I do not refute these accusations, but present the report as a fair reaction of an Australian to a system that unfairly compromises his source of livelihood. It is an attempt to put the major principles and problems of the CAP in a form that can be understood by Australian readers and so anticipates their reactions and queries.

The tone of criticism evident in this report is often less scathing than that in many articles I have read on the topic in the British farm press. It also reflects the attitude of many of the farmers I talked to, who were worried about the long term future of a system they sensed as being too good to last.

2) Wheat

This report attempts to review the voluminous data collected during all stages of the scholarship. Not all issues are fully reviewed, as an attempt is made to include only those factors which may be applicable to Australian conditions, or demonstrate principles that may be worth investigating. Most of this data originated in research establishments, which does not belittle the huge contribution that many farmers made in interpreting and validating the results presented.

I would like to express my admiration for the management skill and foresight of the farm managers I met during my studies. The complexity and scale of their operations, coupled with their understanding of the basic issues of their production and marketing presented a facet of farming that is only just developing in Australia. I would like to thank so many for sharing their time, knowledge and hospitality so completely with a stranger and potential competitor.

3) Computers in Farming

The aim of my studies in this area were to determine whether computers were, or would become, useful tools for the farmer. A secondary goal was to determine the role of bureau operations in servicing the needs of farmers. This meant that my studies concentrated on farmers rather than computers. The survey presented, although small, was an attempt to summarise the opinions of selected farmers on this question. The scholarship requirement for a minimum of one month study in Europe limited the number of farmers I could interview, and personal tragedy in the affairs of Mike Christian who joined me in this study further restricted the sample size.

Little comment is presented on the relative merits of the different products available. There are several reasons for this, the first being that I did not have time and am not qualified to assess products meant for other markets. Added to this I found considerable conflict of interests between my scholarship status and my commercial involvement in the industry. Although this rarely affected my access to other companies it did mean that I was given access to a considerable quantity of sensitive commercial information which I am bound not to reveal. Whilst on this topic I would like to record my appreciation for the faith that was so freely given in my honesty on this context. This can only reflect on the reputation of the Nuffield scholarship.

I attempted to allot my study time in proportion to the commercial success of the various firms visited, which meant many firms were not contacted. This report therefore cannot be a complete review of farm computing, but attempts to be representative.

These comments should explain why the topic that consumed my main study effort should be represented by such a brief report. Taken in total I believe that this probably reflects the youth of the industry. It certainly does not detract from the value of the information gained.

The Role of the EEC

The role of the European Economic Community (EEC) has always been to prevent another war. The original aim was to provide a close economic and social framework for cooperation in Western Europe. Its main purpose in the current European context is to provide some political unity to reinforce the military co-operation aginst the threat that these nations see Russia presents.

Whilst it is impossible to doubt that Russia is pursuing a deliberate policy of offensive re-armament no European could argue that the current NATO policy is a near parallel. From an independent viewpoint is is hard to distinguish the difference between the unstable alliance of dissimilar states that make up the EEC and the situation in the Warsaw Pact. Perhaps the main difference is one of approach, in that the Russian rulers use force more readily than their European neighbours as a means of control. Given the lack of communication, integration and the more fuedal social system that exists within the Warsaw Pact this may in fact be the more appropriate reaction. Not that it is acceptable, but that, without the benefit of a European Parliament and economy it may be the only possible political response to the threat that the Russians see in the NATO re-armament.

In this light it is hard to distinguish between the motives for the Hungarian and Czechoslovakian campaigns and those for the Vietnamese and the many other conflicts where the superpowers have intervened in local conflicts in an attempt to limit the spread of the opposing ideology. The major difference is not the war but the location of those wars. It seems that Russia may be the only nation willing to go to war in Europe and that may be the real source of the fear she engenders. (It is worth noting that America seems quite willing to fight on European soil.)

This view of European politics would be called cynical and mis-informed by the EEC bureaucracy, who would then present arguments to justify their policies that would sound very similar to the Russian justification for their present response. In the long term it is entirely possible that the EEC may be seen as the instrument of alignment that prevented real communication with the emerging Russian colossus and lead to the cold war, detente and perhaps finally another European conflict.

Given this background to the current European situation it is not surprising that the one common policy operating within the EEC, the Common Agricultural Policy (CAP) is supported with such vehemence. This support continues despite the realisation that it is often absurd and untenable in its operation, which flies in the face of international trade and treaties (such as GATT). This stems from the attempt to force 10 entirely different agricultures and societies to operate under the same pricing system. This causes serious distortions within the system and has had the effect of dissociating supply and demand for most major agricultural commodities.

To quote the former French Prime Minister, M. Raymond Barre : "I have heard it said that the CAP is absurd. I am inclined to answer with the wisdom of Lord Balfour: 'it is better to do an absurd thing which has always been done than a wise thing which has never been done'". (27)

The prime absurdity of the CAP is that it now depends on Russia to absorb the excess production that has resulted from its policies and so provides its main enemy with a source of cheap food, releasing funds within Russia for military use and encouraging population growth in its competitor.

What is the CAP?

The CAP resulted from the freeing of trade within the EEC. The removal of border restrictions placed the less efficient farmers within Europe at a disadvantage. This was not politically acceptable, due to the political influence of the farm sector in

France and Germany, the two largest economies in the EEC.

The farm sector in France was numerically powerful because of the rural base to the French economy. A large part of the French population lives on the land (15%), with an equally powerful part of the aristocracy deriving their income from rural property. A large part of the rural population is poor, especially those from the south of France and Normandy where the land is not arable and holdings are small. It has been said and often quoted that every farmer leaving the land is a vote for the Socialists and the ruling class in France is terrified of the success that Socialism has had in recent years.

The problem in Germany is more strategic. There a large part of the population lives in the country, but a high proportion of these are only part-time farmers, gaining most of their income from decentralised industry. This is particularly true of Southern Germany, where land ownership has more a real estate value than a value as a source of income. As a result many farms are less than 1 hectare. If these farms lost any value as a source of income the resulting depopulation of the countryside would remove a large proportion of the population from the East German border zones, removing obstacles to a European invasion.

These two countries (particularly the French) have therefore fought for high support prices for agricultural production under the CAP, to support these smaller farms. This policy has resulted in a boom in agriculture in the more productive regions, especially those in the North of Europe where more favourable conditions and more bracing climates have lead to a much more vigorous agriculture. (Table 1).

The resulting flow of EEC funds to the Northern Countries has further stimulated their growth, causing revaluation of their currencies both in relation to the Southern Countries and against the European Currency Unit (the ECU). This has been countered by introducing another rate of exchange for agriculture, the green rate.

Variations in the value of the green rate between countries due to further currency movements caused the introduction of Monetary Compensatory Amounts (MCAs) which were introduced to ensure that farmers received payment with the same purchasing power in each country. However the net effect of these manipulations was to separate the agricultural sector finances from the total ecomony in many countries, particularly those with the weaker (and more often devalued) currencies.

An example of the effect of this separation is that a tractor now 'costs' 30% more wheat in France than it does in Germany. This is only one effect, but as agriculture in Europe is intensive and is becoming more so it draws more of its inputs from the industrial sector. Thus agriculture in the poorer countries continues to be disadvantaged. This has the effect of continuing to weaken their exchange rate as the money markets reflect the real alignment of currencies, despite the compensation handed out by the CAP policies. It has also meant that farmers are leaving the land at the rate of one every two minutes within the EEC. This rate has slowed from the one every minute seen in the 70's, (due largely to the fact that fewer remain) but is the opposite effect to that intended for the CAP. Most of those leaving have come from the Southern Countries and have contributed to the rising unemployment and Socialism in these areas.

These changes have forced politicians to continue supporting high prices for agricultural commodities in the hope of stemming the tide of rural unemployment. This has caused continued high production in the efficient countries, resulting in surpluses which must be purchased and sold on world markets at a loss. This level of support has absorbed 95% of the funds of the CAP, 50% of which were meant to support the structural reform of European agriculture. The net result is that the CAP now discourages restructuring of the rural economies of Europe, so prolonging the social and economic hardships it was originally meant to alleviate.

The Principles of the CAP

"There are three basic ways of treating farmers.

a) Do nothing and let them get what they can for their crop in the market place.
b) Let them sell their crop for what they can get in the market place, but top up the farmer's incomes out of taxpayer's money to the level necessary to keep the industry healthy.
c) Intervene to support the price the farmers receive for their crops by guaranteeing to buy it from them for a certain price and protecting them from cheap imports.

NO ADVANCED COUNTRY FOLLOWS THE FIRST COURSE (my capitals), because food is such a staple commodity, and - because of the natural characteristics of agriculture - a completely unregulated market place would be subject to severe price fluctuations.
(European Democrat Brief 8 - The CAP, by David Curry, MEP.)

This quotation summarises the commitment of the 'Eurocrats' to continued price support for farmers. Politically it encourages voters to vote for the party in power. (The British Labour Party platform embracing retirement from the EEC cost the party votes at the last election.). Economically it underpins the economy by providing for a stable agriculture and retaining foreign exchange by reducing imports. Socially it encourages decentralisation and may help to spread the unemployment problem more equally over the electorate. All this comes for the cost of a 1% VAT surcharge and less than 1% of GDP taken over Europe as a whole. Thus politically it is a highly successful policy and one to be encouraged. Luckily for the European politician the voters have become used to high food prices following the war. That and a sympathy with farmers have slowed the emergence of a strong and vocal consumer group.

What then is wrong with the CAP?

The problem arises from its very success. Farmers have used a combination of modern technology with ideal climates to increase production so rapidly that many commodities are now in excess - some in excess of world demand.

In guaranteeing a common price for agricultural production the CAP committed itself to purchasing produce sold on the open market below this 'intervention' price. It is therefore committed to financing the difference between the intervention price and the world price for excess goods sold on the world market. Some of this difference is made up by levies paid by importers who are forced to pay the reverse difference as an import levy. However the CAP budget has been sorely stretched by this commitment and in fact is presently in deficit.

There seems little doubt that the participating countries will vote to increase the CAP budget for the reasons outlined above. However in doing so they aare encouraging further overproduction. This in turn will further depress prices, so increasing the intervention payments. Senior European politicians are aware of this 'Catch 22' situation and will almost certainly require some constraint on CAP activities if the budget is to be expanded.

The second problem is one of international relations. Here the problem becomes involved and bureaucratic. Some commodities are not subject to import levies. The two main problems are American soyabeans and cereal substitutes imported from America and the ACP (African, Caribbean and Pacific) countries, who maintain privileged access by virtue of their colonial status.

The ACP countries import significant quantities of manioc, maize gluten and other feedstuffs which are rightly termed cereal substitutes. In fact the amount of these products imported at world prices closely approxiamates the cereal exports from the EEC. European farm leaders naturally want this inflow halted, but to do so would repudiate long-standing agreements with poor countries, many of whom might then seek assistance from Russia. Furthermore the price of livestock products would rise, which would have have an effect in the electorate, so that politicians are unwilling to take any action in preventing these imports. However some tightening of the terms of access is likely, particularly in the case if New Zealand lamb which is imported under this type of agreement.

The soyabeans are an essential part of intensive livestock production in Europe and in fact are the basic protein source for their housed livestock. Because of its climate Europe is unable to produce cheap, high quality protein and so must import soya at world prices. Many European farm groups view this as direct and unfair competition and politicians deplore the negative trade balance with America which results. They point out that the actual cost of production of soyas in America is much higher than the export price and in fact the level of subsidies given to American farmers is almost identical to that offered in Europe. However if Europe was to alter the terms of trade for soyas then the Americans would take them to GATT and begin actively undercutting them on other markets, beginning a trade war that neither side wants.

The story does not end there. New varieties of rapeseed have been developed (double zeros) which have improved protein quality. Rapeseed is already subsidised to about 30% as a protein source and as such is now the most profitable broadacre crop in England. If - or when - Spain enters the EEC (for defence reasons) the CAP will be forced to accept large and uncontrolled supplies of olive oil. This will immediately create an overproduction of vegetable oil when placed alongside the rapeseed oil. The inevitable effect will be for the CAP to cease promoting rapeseed production, so increasing the amount of soya needed. The resulting outflow of funds will be amplified by the inevitable increase in cereal production as farmers return to their traditional forms of production, increasing the intervention stocks which must be financed by the CAP.

The CAP currently maintains huge surpluses of these products, which are expensive to store or export. In fact the cost of exporting barley last year was equal to the world price, so that after the handling and transport costs were met it would have been cheaper to destroy it at source! This is even more true of dairy products which are perishable and which have a limited world market.

The alternative of exporting these surpluses to developing countries is not tenable for two reasons. First, it would tend to suppress development of those countries own agriculture. Secondly most developing countries cannot afford to buy these products, do not have the distribution systems to handle them and more importantly (in the case of dairy products in Asia) cannot even digest them!

Faced with these facts the CAP would seem to have little option but to reduce production to a level near self sufficiency. This is unlikely to occur in the near future because of the political nature of the EEC government.

Who Controls the CAP?

The final policy of the CAP is set by European Commissioners appointed by their respective member governments. These men are advised by the European Parliament, a body with no legislative power elected by the peoples of the EEC on a regional and Democratic basis.

This parliament comments on reports prepared by the European Commission, the bureaucratic arm of the EEC, which again has no direct power. In the case of agriculture about 200 staff in Brussels prepare all the reports commissioned and carry responsibility for perhaps the biggest multinational organisation existing.

Thus the whole structure of the CAP depends on the indirect influence of a handful of men. This further increases the power and responsibility of the Commissioners, which tends to ensure that the solutions offerred will be political rather than economic in nature. It is worth noting that this danger is appreciated by the senior bureaucrats in Brussels, who strive to exert their influence in every way possible.

The decisions that result have historically been easy, as all decisions must be unanimous. In this context the French have never been known to lose an argument. This system does not encourage change and makes it unlikely that any permanaent solution will be found for the problems of the CAP unless such change is forced by external political and economic pressure (such as a food war with America.)

What can be done?

The CAP is an ideal policy for agricultural production in a closed economy, which are the conditions it met originally. It therefore follows that the only real problem it must solve is over-production, (in this case defined as exportable production) that interfers with established world trade. It seems sensible that some form of production control should be introduced (such as the American PIK program) to prevent such over-production.

Some steps have been taken in this direction, but they are tentative ones. To quote David Curry again "The new system, now being slowly accepted for the cereals and dairy sectors, will limit the guarantee to a "target" quantity. The price will be cut for extra production above the target, in some cases by as much as is needed to finance the surplus."(27)

This policy is already operating for sugar and dairy production, the "co-responsibility" levies supposedly making the farmer and CAP both share responsibility for financing exports. This works well internally, reducing the CAP Funds required. However farmers average the two (or three) prices they receive from the different quotas and continue to find the resultant price attractive. It is notable that the above quote (from the Chairman of the Agricultural Council of the European Parliament) makes no mention of production controls per se, which makes continued exportable surpluses inevitable from the EEC.

At present the CAP is trying to reduce production by marginally reducing the real prices paid for those products in surplus, especially grains and dairy products. however the absolute price is still allowed to rise, encouraging the bulk of farmers who operate on a cash basis to continue producing. Furthermore the rate of increase in productivity for these items is often higher than the fall in real prices offered under intervention, further encouraging continued production.

The main problem with limited price reductions is that the only response that can be made by farmers with limited production alternatives is to increase production to maintain income. For all these reasons any attempt to limit production using price mechanisms is likely to fail.

There is a further danger in selective reduction of prices. At present the poultry and pig industries are not under CAP protection and are foundering under the burden of high feed costs. The dairy industry would also benefit from a reduction in the price of feedstuffs (mainly grain) so that a reduction in grain prices at the expense of dairy prices is likely to result in the transfer of production between surplus commodities rather than an overall reduction in intervention costs.

Any attempt to solve the problem by imposing national or farm-based quotas will be difficult. Resolving the actual quotas would be difficult political exercise for the Commissioners to resolve, given problems such as the proven militancy of the French farmers and the very unequal productivity and farm incomes in the different countries. These problems are further complicated by of internal subsidies which vary between countries and in most countries equal the value of the CAP protection. This emphasises the fact that the CAP is a common policy in name only. For example Belgium farmers are encouraged to produce more milk (because Belgium is not self-sufficient) whilst the cost of maintaining the European butter mountain and milk lake exceeds the value of the produce contained.

A world food war?

On this basis appears inevitable and it may have already begun in a limited fashion, with America aggressively entering the world grain markets, and Europe selling grain to China at prices well below market levels. It seems that the only defence against the CAP policies is political pressure from NATO allies and it may take a food war to force the EEC to take the hard decisions necessary for reform.

The Australian problem in this context is the lack of any assistance to exports (despite David Curry's statement.) In a price war we will inevitably become price takers and finally bear the full impact of the conflict initiated by the Northern Hemispere producers whilst the farmers responsible are isolated from its effects.

Our only weapon in this conflict will be our low cost of production. The sensitivity analysis discussed later in the Wheat Report shows that the fixed costs for English (and therefore European) cereal production will increase at a faster rate than returns. Given that the cost of producing wheat in Europe is nearly 75% of the final return this will have a significant effect on the profitability of farming there before the end of this decade. The intervening period is one for concern. The final paradox is that the technology imported from Europe may increase Australian production sufficiently to help compensate for the expected price decline for cereals.

MICROCOMPUTER SYSTEMS WITH AGRICULTURAL PROGRAMS

TABLE 1 cont.

FIRM	EQUIPMENT	Tailor Made	Financial	Payroll	Farm Budget	Cash Flow Budget	Stock Control	Dairy	Pig	Arable	Specialised Horticulture	Poultry	Ration Cows	Ration Cattle	Ration Pigs	Ration Poultry	Ration Sheep	Least Cost	Dairy Forecast	Pig Forecast	Pedigree Cattle	Pedigree Pig	SUNDRY CODES	PRICE RANGE £
		SEPARATE PROGRAMS AVAILABLE																						
Holbrook	Commodore		*																					3500
Hunday	Superbrain		*	*	*	*	*	*		*									*		*			3750-7000
Isis	Commodore		*	*					*															2800-7500
Manus	Manus							*					D					D	D					2850+
Microfarm	Tandy		*	*			*	*	*	D			*	*	*	*	*	*	*		*	*		2950-4500
Micronet	Zenith Z89/Alpha Micro	*	*	*	*	*	D	D		D									D		*	*		Rental from £215/month + £800 Joining Fee
Northern Pig Development	Apple II or CP/M								*											D				3350-4850
Parwest	Tandy/Televideo	*	*	*	*	*	*	*	*	*	*				*				*	*				4000-7925
Pigtales	Tektronix/Alpha Micro								*						D							*		System on Application Bureau £4/Sow/Year
Semex	Onyx		*	*				*	D	D														7000+
Upthorpe	Commodore		*	*				*					*						*					1500+

KEY: * Standard Programs Available.
D Program being developed.

SUNDRY CODES:
(a) Fertiliser best buy.
(b) Spray calculations.
(c) Packing/despatch.
(d) Beef cattle.
(e) Dairy replacements.
(f) Labour profile.
(g) Liveweight gain.
(h) Vet practice records.
(i) Pig profit and bank balance.
(j) Pig marginal cash flow.
(k) Pig housing planner.
(l) Arable for consultants.
(m) Rabbits.
(n) Sheep
(o) Rent ledger.
(p) Landscape.
(q) Separate project accounting.
(r) Nursery production recording and monitoring. (D)
(s) Nursery stock-control and order processing.
(t) Decision aids.

NOTE: Specializing in programs for veterinary practices but above available if required.

TABLE 3

MICROCOMPUTER SYSTEMS WITH AGRICULTURAL PROGRAMS

TABLE 1

FIRM	EQUIPMENT	Tailor Made	Financial	Payroll	Farm Budget	Cash Flow Budget	Stock Control	Dairy	Pig	Arable	Specialised Horticulture	Poultry	Ration Cows	Ration Cattle	Ration Pigs	Ration Poultry	Ration Sheep	Least Cost	Dairy Forecast	Pig Forecast	Pedigree Cattle	Pedigree Pig	SUNDRY CODES	PRICE RANGE £
		SEPARATE PROGRAMS AVAILABLE																						
Agrarian B.I.S.	Osborne/Dec/Sirius	•	•	•	•	•	•	•	•	•	D	•	•	•	•	•	•	•	•	D	•	•		2500-25000
Agric. Computer Services	Commodore		•	•	•	•	•	•	•	•			•	•							•	•	d, l	3500-7000
Agriday Computers	Superbrain/Caltext/Durango		•	•				•	•	D			•					•	•		D		h	See note below
Alfa-Laval	Alfa-Laval							•					•	•										1500-30000
Alveronic Computers	Dec	•							•															13000 +
Amplan	Commodore	•	•	D				•		D											D			4000 +
Bartholomews	Dec/Commodore		•	•		•	•	•		•		D	•						•		•			3500 +
H M Boot	Apple II with CP/M		•	•				•	•	•								•					i, j, k	300-10000
Borders Computing	Altos	•	•	•	•	•	•	•		•			•	•	•			•	•		•		d, n, m	3750-5500
B P Nutrition	Apple II																	•						3300
Cattle Code	Cattle Code		D					•	D				D		D									On application
Cleanacres	Apple II									•														2500 or Bureau
Comput-a-crop	Any 64K with CP/M		•	•	•	•	•	•	•	•														3000-15000
Daisy	Any with Microcobol		•	•			•	•	D				•						•					5000+Bureau 1.75-5.45/cow
Dataface	Own Dataloggers							•																675-1700
ECMS (Computers)	Data General		•	•			•				•												s, r, o, p	15000+
Ellesmere Electronics	Masterfarm		•	•				•	D	D														4850-6100
Farmdata	Onyx	•	•	•	•	•	•	•	•	•	•		•	•	•			•					c, d, e	8500-35000
Farmfax	Any 64K with CP/M		•	•	•	•	D	•	•	•			•	D	•	D	D	D	D	•	D	D	q, t	2500-7000+Large Systems
Farmplan	Apple II		•	•	•	•		•	•	•	•		•		•			•	•		•	•	a, b, f, g	3445-9000
Gascoigne	Gascoigne + Various							•																On application

Table 2: The Average Levy Charged on Imports to the EEC as a % of the World Price

	1977	1978	1979	1980	1981
Wheat	64.1	59.8	49.8	43.6	38.1
Barley	51.2	65.2	54.5	41.8	35.1
Sugar	67.9	62.2	68.3	9.9	33.1
Beef	51.8	54.5	51.1	50.7	52.1
Butter	80.7	81.6	83.1	75.6	53.5
Skimmed milk powder	NA	91.1	90.6	64.9	47.4

Source: Hansard 2/4/82, Rt. Hon Alick Buchanan-Smith M.P., quoted in (27)

WHEAT GROWING IN THE U.K.

Introduction

Cereal growing is now one of the most profitable enterprises in British agrriculture. The price structure guaranteed under the CAP umbrella ensures that the most profitable strategy for most farmers is to aim for maximum yields, knowing that the marginal cost of extra yield is unlikely to be exceeded. This situation has arisen in a climate that is optimum for cereal production. The combination of these two factors has lead to the development of production systems that exploit the high productivity of cereal plants, so that yields in excess of the theoretical maximum have recently been achieved.

This increased productivity is reflected in the annual average yield figures, which have increased by nearly 5% annually since 1970 (1). The figures for the more productive Eastern Counties are even more spectacular (2), as shown in Table 1

TABLE 1. Winter Wheat Yields and Economics (Aust. dollars)

Year	Yield t/ha	Price	Gross Income	Variable Costs	Gross Margin
1970/71	4.11	55.92	229.87	40.36	189.51
1972/73	4.50	64.07	288.51	53.58	234.93
1974/75	5.26	106.43	560.01	85.43	474.58
1976/77	3.92	150.41	997.13	131.23	865.90
1978/79	5.65	167.24	1323.11	207.97	1115.14
1980/81	6.42	191.86	1231.34	287.43	943.91

Wheat yields over the 10 year period shown increased at an average of 5.6% annually, with both current prices and margins rising concurrently. In real terms the margins also increased by 25% during this period (2), so the incentive to produce can be understood. To quote 'the remarkable feature of winter wheat growing (in the Eastern Counties) is that while the area has increased by 44 per cent since 1975, the output of wheat has increased by ...100 per cent' (1).

The advent of new technology, particularly in agrichemicals, has allowed this increase to continue during the latter half of this decade. This has been reinforced by the introduction of shorter-strawed varieties and growth regulators which allow the use of very high Nitrogen applications without lodging.

More recently the much emphasis has been placed on the development and management of optimum systems designed to utilise this new technology. This report will concentrate on analysing the principles behind these systems, with the aim of suggesting which may be used in Australia to advantage.

Principles of Modern Wheat Production

The recent yield increases in the UK depend on two factors, i.e.

1) Time of Sowing

Wheat yields in the UK began to improve with Britain's entry into the EEC. The relative profitability of cereal production under the pricing policy of the CAP caused a swing away from livestock production to cereals. The area released from pasture production became available for winter sowing of cereals, with a higher yield potential than those sown in Spring (Table 3).

Average Crop Yields (Eastern Counties) 1973-1981 (2)

	Winter Wheat	Spring Wheat
1973	4.31	3.72
1975	4.46	3.14
1977	5.20	4.64
1979	5.46	4.29
1981	6.29	3.95

The consistent and increasing difference in favour of Winter Wheat is obvious and underpins the recent expansion in cereal production.

2) Crop Density

Studies of the yield components of the wheat plant show that
1) the main yield determinant is the number of heads per unit area and
2) the first two tillers produce a high percentage of the total yield

It is therefore not surprising that the one consistent feature of the crop yielding above 10 tonne in the ICI Winter Wheat Survey was a plant density above 350 plants/square metre. At this density most plants produce about 2 surviving tillers.

Modern wheat production techniques aim to keep this number of tillers alive and healthy through to harvest. This involves high inputs of fertiliser and chemicals. The principles and techniques involved in their use and application form the basis of this report.

FACTORS AFFECTING WHEAT YIELDS IN THE UK

Water Supply

Rainfall in Britain during Winter and Spring is most often excessive, causing waterlogging in undrained sites. Water tables less than 30 cm from the surface can depress yields, both by causing poor oxygenation of the roots and by increasing the leaching of nutrients. Waterlogging for 5 to 6 days before emergence can reduce plant populations by up to 80%. Waterlogging after emergence depresses tillering and thus ear number at harvest (5).

At the other end of the growth cycle Spring drought can also depress yields (6), although this is not common as shown by the negative response to irrigation in Table 3 above. This could be partly due to the fact that lysimeter studies at Letcombe laboratory have shown that roots can extract moisture at depths of up to 1.5 metres.

Rotation

The prior cropping history can have a large effect on the yield of a field, due mostly to the control of soil pathogens, mainly Take-all and Fusarium spp. (7). Rothamstead showed an increase of 60% for wheat following oats rather than wheat after wheat (8). Similarly wheat following sugar beet yielded 40.3% more than continuous wheat at the ICI Arable Demonstration Site (9). Many farmers report similar responses after rapeseed crops. This effect disapears after the first year due to the rapid increase in take-all in subsequent crops (10) and is no benefit to farmers following the highly profitable continuous wheat rotation.

An 8 year trial at High Mowthorpe EHF has shown a 0.3 t/ha yield aadvantage for winter wheat and 0.13 t/ha for winter barley sown alternatively compared with continuously. In this trial take-all and eyespot have not affected yields.

Soil-borne pathogens can cause dramatic yield losses, as shown by the following data (7):

Table 4: Mean percentage loss in grain yield per ear for 3 severity categories of stem-base and root diseases in Winter Wheat, 1975-1980.

Disease	Disease Category		
	slight	moderate	severe
Eyespot	-0.1	9.8	36.1
Take-all	0.6	15.6	53.1
Sharp Eyespot	5.0	6.5	21.7
	Symptom type		
	nodal	internodal	both
Fusarium	0.6	6.0	21.7

Source: Clarkson and Polley 1981

The benefits resulting in controlling these pathogens by introducing suitable break crops are obvious. The length of the break necessary for control varies, with Australian sources suggesting that 18 months may be necessary for control of take-all (11).

Cultivation

Any discussion of cultivation methods must revolve around the merits of direct-drilling. Before adding to this debate the terms must be defined, as there are considerable differences in interpretation. Most farmers assume direct-drilling means not ploughing, whereas research staff use it literally to mean sowing into undisturbed soil. For the purposes of this discussion direct drilling will be taken literally. Any other method will be termed reduced cultivation.

Methods of reducing cultivation probably attract more research effort than any other subject in the UK at present. Without reviewing the complex topic fully the following generalisations can be made:

1) In the first year comparitive yields from direct drilling and conventional cultivation are variable and appear to be related to previous history, soil type and fertility.

2) The benefits of direct drilling tend to increase over time. This increase appears linked to the increase in the soil porosity, which is reflected in reduced bulk density and increased crumb stability.

3) These benefits can be rapidly destroyed by ploughing and reduced by any form of cultivation (5).

4) Direct-drilling is not compatible with systems which involve stubble or trash retention, perennial weeds, heavy clay soils or soils with toxic levels of cations (5).

5) The early establishment and growth of direct-drilled cereals is usually lower than under conventional systems, which makes direct drilling more suitable for early sowings (6).

6) Direct drilling shows most advantage over conventional systems in dry years.

7) There is general agreement among farmers that consistent high yields of wheat only come from conventional cultivation under field conditions. This may be partially explained by the fact that the highest yields seemed to occur on heavy clay soils unsuitable for direct drilling. The increased incidence of persistent weeds such as blackgrass with prolonged direct-drilling may also influence this opinion.

The broad conclusion that can be drawn from these comments that there are benefits in reducing cultivation to the minimum consistent with good weed control and crop emergence.

Stubble Management

This is another contentious area, with vocal advocates claiming rapid improvement in soil structure and organic matter. One farmer claimed to have achieved an increae of 0.5% organic matter in 5 years by incorporating stubble. This must be weighed against the disadvantages, i.e.

1) Reduced timeliness due to the extra time involved in incorporation and the delay necessary to prevent phytotoxicity. Acetic and other organic acids produced in the early stages of stubble breakdown can have a serious phytotoxic effect on wheat seedlings. These acids concentrations fall rapidly during the first 3 weeksafter harvest (5).

2) Stubble retention is associated with increases root and stem disease (5), specifically Fusarium and Pythium and colonisation of the root cortex by bacteria, which can have marked effects on yields (Table 4) and increase the production costs.

3) The capital and operating costs associated with straw incorpation are high. Proponents agree that the straw must be finely chopped and well spread at harvest. Incorporation is then achieved either by inversion during ploughing or by mixing using a variety of implements.

Inversion by ploughing can result in a thick layer of undecomposed straw at plough depth which acts as a barrier to root penetration. This layer can be phytotoxic (12) and carry disease inoculum leading to root trimming.

Mixing is usually carried out with implements such as the Glencoe Soil Saver, which use a twisted blade on the shank of a chisel plough to cause severe soil disturbance. A measure of the disturbance is the requirement for 30 b.h.p. per tyne. Two passes with this implement are often necessary (13), raising the possibility that the damage done to the soil during incorporation may outweigh the benefits from increased organic matter.

The American and Australian technique of leaving the stubble on the surface is also being investigated (5) but suitable drills have yet to be developed which can handle the large quantity of straw from high yielding crops.

Despite all these factors it is likely that pressure from environmental groups will place severe restrictions on stubble burning in future so that methods of stubble retention may have to be developed.

Soil Compaction

Intensive cropping of small areas using narrow equipment can expose up to 90% of a field to traffic and the resulting compaction. The degree of compaction depends on the contact stress between tyre and soil. It is increased by tractor weight, wheel slip, tyre inflation pressure and number of passes. Tractor forward speed has little effect due to the low speeds involved. Fitting dual tyres to tractors can increase the volume of soil compacted whilst only slightly reducing the degree of compaction.

High levels of traffic on fields can reduce the uniformity of the surface, This can lead to uneven sowing depth and poor emergence.

Compaction has a serious effect on grain yield. This is often visible as reduced growth of the wheat plant and yellowing of the young seedlings along the compacted rows. Examples of these effects can be seen in Table 5.

Table 5: Effect of number of wheel passes at normal and reduced (R) tyre pressure on winter barley grain yield (tonnes/ha.) in 1982 (14).

Number of wheel passes	0	1R	1	2	4	6
Chisel ploughed	5.9	6.7	5.7	5.8	5.6	5.4
Direct drilled	6.1	5.4	5.6	5.4	5.3	4.1

Source: D.J.Campbell, Scottish Inst. Ag. Eng.

The results show that with increasing levels of traffic there is an increasing risk of yield loss following direct drilling. This result also occurs after chisel ploughing to a depth designed to minimise the effect of soil compaction due to ploughing. In these results the reduced pressure treatment seemed to limit the compaction to the upper levels so that it was reversed by the chisel ploughing.

The cure is to reduce the number of passes to a minumum, reduce tyre inflation pressures and vehicle weight and increase implement working width (14). The combine harvester was shown to have a similar effect to tractors and some farmers are fitting dual wheels to these as a result (15). Metal cage wheels fitted either alone or outside normal tyres are effective in reducing compaction without reducing traction. However they are unlikely to gain widespread acceptance as they seriously reduce driver comfort and roadability.

Seed Placement

Sowing depth can have a marked effect on yield, i.e. (6)

Table 6: Effect of sowing depth on yield of wheat.

Drilling depth (cm)	2.5	5	7.5	10
Relative yield	100	85	67	46

Source: Bland, Crop Production Cereals and Legumes

Deeper sowing causes lower germination, irregular emergence and weaker plants. This is particularly noticable with the shorter strawed varieties which have shorter coleoptiles.

Precision drilling has shown little advantage in wheat (3,6). There is however a trend towards narrower row spacings amongst leading cereal farmers (10) following research which has shown some small advantage from this practice (Table 7). Some farmers interviewed had even broadcast their seed and harrowed it in in order to achieve a more even distribution (16).

Table 7 : Effect of row width on wheat yield (tonnes/ha.).

	Row Width (cm.)	
	10cm	20cm
1978	10.26	9.91
1979	7.80	7.55

Source: ICI Jealott's Hill Research Station

Narrow rows are associated with a higher ear density, smaller ears and a similar 1000 grain weight.

Seeding Rate

In several trials (3,6,14) yields have not been very responsive to seeding rate, provided that plant density was above a target of 250 plants/sq. metre (6,17).

Table 8: Effect of plant density on ear number and Yield of Winter Wheat 1976.

Plants/sq. metre.	Ears/sq. m.	Yield (t/ha.)
50	322	8.5
100	430	9.9
400	582	10.0

Source: A. Darwinkel, 1978. Neith.J.Agric.Sci.,26 (383-398)

The seeding rate necessary to achieve this density varies with seed size (thousand grain weight) seed vigour, soil temperature, seed treatment, winter kill and general seedbed conditions.

Seed vigour varies between samples and affects the emergence and subsequent growth of the plant. High vigour samples usually have a high germination and grain size. A target 1000 grain weight between 40 and 60 gms. is considered ideal (6). This factor is assessed by some seed producers.

Seed treatment is essential and the type used will depend on the disease and parasite spectrum present.

Soil temperature reflects sowing date. Seed sown in September can be expected to show 85% establishment, falling by 15% per month to only 40% in December. The plant density achieved affects the degree of winter kill (usually about 20%) (6). A small seeding rate trial at Cirencester Cereal Centre showed that a seeding rate of only 60kg/ha. was almost totally eliminated during winter due to frost heave (author). Winter kill is also accentuated by poor seedbed conditions and drainage (18). These effects can be severe enough to be reflected in final yield.

Tramlining

This practice is now almost universal in European cropping. It involves closing off appropriate rows corresponding with the wheel tracks for subsequent passes.
This has the advantages of allowing accurate application of fertiliser and sprays on tracks which become firm from such operations and therefore alow more timely operations. Area losses of 3-5% are compensated by the increased accuracy and timeliness and by the edge effect along the tracks. Trials assessing the value of this practice have shown yield increase which varied from nil (21) to 7.5% (in a survey of 982 farms (6)).

Sowing Date

Early sowing has a marked effect on yield (Table 2). The advantages lie in

1) Better establishment
2) Better root development reduces frost heave.
3) Increased timeliness allows better chance of good sowing conditions.
4) Early crops show a higher yield. Figures from the ICI Winter Wheat Survey highlight this effect:

Table 8: Effect of Sowing Date on Yield

Sowing Date	Autumn 1976	Sowing Date	Autumn 1979
1st Oct	7.1	1 Oct	7.2
21st Oct	6.4	9th Oct	6.9
5th Nov	6.1	17th Oct	6.8
24th Nov	5.8	3 Nov	6.5

Source: ICI Winter Wheat Survey 1977-79

The benefits from early sowing are more evident in seasons with long, cold winters such as 1976.

Table 11: 1983 NIAB Variety Selection Table.

	Rapier	Avalon	Longbow	Huster
Agricultural Characters:				
Yield as % of control	104	102	105	99
Standing Power	6	8	6	7
Shortness of straw	6	7	7	8
Earliness of ripening	6	8	7	7
Resistance to:				
Mildew	4	7	5	5
Yellow Rust	7	7	6	4
Brown Rust	9	7	4	9
Septoria nodorum	7	5	5	6
Eyespot	5	6	6	8
Loose Smut	9	5	NA	8
Resistance to shedding	7	7	7	7
Resistance to sprouting	7	7	8	6
Latest safe sowing date	mid Feb	mid Feb	mid Feb	end Feb
Grain Quality				
Bread making	1	6	2	2
Biscuit making	6	3	7	3
Ease of milling	5	7	5	7
Endosperm Texture	soft	hard	soft	hard
Grain protein	5	6	4	4
Hagberg Falling Number	6	6	3	5
Specific weight	5	5	5	4
1000 grain weight	6	6	7	7

Source: NIAB

Varieties respond differently to time of sowing (19), e.g.

Table 9: Yield and rank of selected Winter Wheat varieties at different sowing dates.

Variety	13th Oct.	Rank	11th Nov	Rank
Rapier	4.27	1	3.37	1
Brigand	3.99	6	3.28	2
Fenman	3.82	14	3.15	3

Source: Cotswold Cereal Centre 1982

Variety

The choice and diversity of varietal types in the UK is huge and draws from other EEC countries as well. This report will not dwell on the specifics of any one variety but examine the principles and information available to the farmer inflencing his selection.

1) Performance

The following summary of varietal characteristics is published by the National Institute of Agricultural Botany (NIAB) at Cambridge and is available to all farmers. Only 4 of the 15 varieties listed will be used as examples.

Presented with this data a farmer can design a husbandry system to fit both his needs and his farm. The National Ssed Development Organisation (NSDO) has produced a boolet to this end called 'Wheat - a guide to varieties from the Plant Breeding Institute (20). This booklet presents the breeders aim behind each variety and recommendaations for the husbandry of each. It does not however attempt to develop a 'blueprint' for growing each variety, an approach favoured in Northern Germany. This result is considered too rigid and often wasteful in that it allows little room for management skill in reducing inputs.

Results from the Chaddleworth Agronomy Centre demonstrate the varietal resonses to differing management systems(7):

Table 12: The Yield and Gross Margin for selected varieties under different growing programs 1981/2

Treatment	Rapier	Fenman	Avalon	Tabor	Average (12 varieties)
LOW					
Yield (t/ha)	9.4	8.1	7.9	8.0	8.0
Margin ($/ha)	1421	1147	1128	1158	1269
MEDIUM					
Yield	9.5	8.6	8.2	8.4	8.8
Margin	1385	1187	1234	1180	1276
HIGH					
Yield	9.8	9.5	9.0	9.2	9.5
Margin	1388	1312	1347	1399	1368

Source: N. Waddington, BASF.

This shows that, although Rapier showed the highest yield the extra inputs it required reduced its margin with increases yield. Tabor, a pemium milling wheat showed a greater response to inputs than its sister milling line Avalon.

2) Long or Short Straw?

This question is often debated in England. A recent article summarised the arguments as follows (7): "the short-strawed semi-dwarf varieties respond more to better growing conditions than the conventional longer strawed varieties. But under lower-yielding conditions, the longer-strawed varieties perform as well or better than the semi-dwarfs. Our general advice is that the longer-strawed wheats are better on marginal fertility soils and the semi-dwarfs on the fertile soils or under intensive management."

Blending Varieties

This practice has evolved in an attempt to combine the often incompatible goals of high yield and disease resistance. It involves sowing a mixture of resistant varieties with other higher yielding or more susceptible varieties in an attempt to increase the overall resistance of the crop.Table have been prepared on this basis (7). Experiments at Bridgets EHF and other locations have shown small advantages for this practice, either with or without fungicides (6). In fact the highest recorded commercial wheat yield of 13.1 tonne/ha. was grown in Scotland using a 3-way blend.

Varieties for the Future

Most of the yield increases gained by plants breeders in recent years have been due to increasing the harvest index (i.e. grain weight/total dry matter weight) of the plant. R.A. Bayles of the NIAB (14) suggests that 67% of the genetic gain since 1947 was due to improved varieties.

However in an interview the Director of the NIAB stated that the sources of useful variation in wheat yields were running out and suggested that further increase would probably come via genetic engineering. He cited Triticale as an example of this method, where genes from unrelated plants would be included in the wheat genome.

Fertilisers

Nitrogen is the most important nutrient applied in Europe, with little attention being given to Phosphorus (P) and Potassium (K). These will be dealt with together.

1) Phosphorus and Potassium

General practice is to maintain soil P above about 20 ppm in the soil. This corresponds to soil status 2, which is considered adequate for maximum wheat growth. Phosphate and Potassium are usually applied as a base dressing broadcast before sowing.

A summary of the soil index system is included below (Table 14):

Table 14: ADAS Soil status classifications for P and K.

Index	ppm P	ppm K	General Status
0	0-9	0-60	Very deficient
1	10-15	61-120	Deficient
2	16-25	121-240	Acceptable reserves
3	26-45	245-400	Adequate reserves
4	46-70	405-600	High reserves

Source: ADAS

The ICI Winter Wheat Surveys have shown little response to P and K applications, i.e. (6)

Table 15: Effect of Soil Index for P and K on Winter Wheat Yield (t/ha)

Soil Index	1976 (dry autumn)		1978 (good autumn)	
	P	K	P	K
0-1	6.0	5.8	6.9	6.7
2+	6.4	6.5	7.0	6.8

Source: ICI Winter Wheat Surveys

2) Nitrogen

A vast quantity of literature exists confirming the relationship between N input and wheat yield in the UK. Nitrogen fertiliser has the following effect on the wheat plant during growth (14):

Nitrogen increases leaf area
leaf area duration
plant height
* survival of tillers
number of grains per ear
water use by the crop
dry matter production
* grain yield

Nitrogen decreases grain size
grain fill

This is well illustrated by the following data (14):

Table 15: Effect of N on Yield Components 1979

N applied (kg/ha)	Ears/sq.metre	Grains/ear	Yield t/ha
0	240	35.0	4.27
40	324	37.5	6.00
80	370	39.4	6.88
120	409	39.3	7.36
160	455	36.5	7.33
200	466	36.7	7.31

Source: ICI Jealott's Hill 1979

This table demonstrates the over-riding relationship between ear number and yield. Other trials (14) show that nitrogen works by increasing tiller survival. Each plant may produce up to 6 tillers, giving tiller counts over 1200 in typical crops. All but 2-3 of these die without producing useful yield in dense crops. Nitrogen is necessary for the survival of the maximum number of tillers.

The loss of a large number of secondary tillers does not depress yield, as the contribution to total yield falls rapidly with tiller number on the plant, i.e. (14) the percentage of yield contributed by the various shoots has been measured as

1) Main shoot 62%
2) Tiller 1 22%
3) Tiller 2 11%
4) Remainder 5%

Very high seeding rates do not necessarily increase yield because the competition between tillers for nutrients in very dense crops is extreme and results in smaller heads.

The supply of Nitrogen to the growing crop is therefore critical to growth. Crop uptake of N can be estimated by the following equation, derived from analysis of the nitrogen content of different components of the plant (14):

$$\text{Crop Uptake (kg of N)} = (\text{Yield t/ha} \times 22.7) + 25$$

However the uptake of nitrogen is not linear and increases rapidly after the start of stem elongation. The rate of uptake depends on the concentration of nitrate in the soil solution, as uptake occurs both as a result of transpiration, (i.e. in solution in the water absorbed by the roots) and by diffusion of nitrate from the soil solution to the roots. Crop husbandry practices must therefore aim to maintain sufficient nitrate in the soil solution at all times, especially in the latter growth stages (19). For this reason too the uptake of N in drought conditions is reduced, which helps explain the loss of yield in spring drought conditions.

The amount of N which must be applied to meet the plant requirements depends on the proportion absorbed by the plant. This depends on several factors, but is usually in the range of 50-65% of N applied, i.e. (8)

Table 16: Fate of fertiliser N applied to wheat crops

	%
Crop uptake	55
Soil organic matter	25
Denitrification	10
Leaching	10

Source: Dr. R. Dodwell, Letcombe Laboratory, Wantage

The proportion of available N taken up by the plant increase under ideal conditions, but is decreased by waterlogging, drought and also influenced by soil properties.

Many trials have studied the timing of N application to wheat. There seems to be some marginal advantage in applying a small amount of N at sowing, with the main application needed at or near Growth Stage 30-31, i.e. near stem elongation. This is illustrated by results from Boxworth EHF (21)

Table 17: Effect of timing of application of spring N on yield (t/ha.)

Growth stage	1978	1979	1980	Average
Beginning of tillering	5.91	7.20	7.54	6.88
Stem extension	6.16	6.74	8.23	7.04
Both	5.88	7.28	7.98	7.05

Source: Boxworth EHF

The ICI Booklet 'Growing Cereals' summarises the situation well, to quote 'Cereal crops show a response to spring top-dressing of up to 30 kg grain per kg N applied. At current costs this makes the application of N very profitable as the economic break-even is about 3 kg grain per kg N. Most trials indicate that the most economic N rate is almost the same as that rate giving maximum yield.' (6)

The response to N applications varies with soil type, from 8-12 kg grain per kg N on clay soils up to 15-20 kg grain on sandy soils (6). The optimum rate may vary considerably with site and seasonal conditions, usually within the range 125-225 kg N/ha. The most economic responses to N applications are obtained under conditions of good husbandry, i.e. freedom from disease and logding.

Weedicides

These are specific to the UK and bear little relation to Australian practice. As the aim of this review is to analyse the UK system with a view to assessing Australian aplications discussion of the weed control program is not relevant. Two interesting side issues were raised, however. they concerned the method and timing of weedicide application. As both topics are the source of some contoversy in both countries an attempt will be made to review them.

Method of Spray Application

Modern developments in spray technology are based on the simple fact that halving the diameter of the average droplet creates 8 smaller droplets. This meaans that the volume of spray can be reduced for the same droplet cover by reducing droplet size, or alternatively a more adequate cover can be obtained from a given volume by using smaller droplets.

Several methods of producing smaller droplets have been developed. One of these, the Contolled Droplet Applicator (CDA) system uses a spinning toothed disk which throws off uniform droplets with diameters depending on the speed of rotation and the fluid flow to the disk.

Another system, the Micronair, uses a spinning wire cage to produce droplets with a small variation in diameter. These are forced into the crop by an integral fan.

The conventional (hydraulic) boom uses accurately shaped orifices in a nozzle to produce a spray with a comparitively wide spectrum of sizes.

The aim of all these systems is to get a certain minimum cover of chemical onto the plant target with the minimum cost and risk to the operator. Several trials haave been carried out to assess the minimum specifications needed for effective weed and disease control.

The effect of droplet size and water volume is well demonstrated by the following data (22):

Table 17: Droplets/sq. cm. from different drop sizes and water volumes.

Drop size (microns)	Volume applied (l/ha) 15	60
135	116	465
170	55	219
265	15	61

Source: High Mowthorpe Annual Review 1982

The optimium number of droplets per sq.cm. varies with the pesticide and the target. Large droplets have greater penetrating ability and are preferable where the target is at the soil surface. About 20 droplets/sq.cm. has been found ideal for soil acting pesticides. Contact herbicides and fungicides on the other hand need 70-100 droplets /sq.cm. to obtain sufficient coverage. In general a range of droplet sizes is necessary for most applications in cereals, where penetration of the surface canopy is required in almost all cases (27).

In practice the CDAs have proved equal to the hydraulic nozzles when weed growth is small, but have proved inferior on large weeds. Table 18 shows the weed control comparing three volumes of water through a conventional boom compared with a CDA unit on 6 sites. Hormone weedicides were used on sites 1-5 and a residual on site 6. (22)

Table 18: CDA v Conventional Sprayers

	% Weed Cover remaining on Site no.					
Treatment	1	2	3	4	5	6
Nil	43	53	22	40	32	54
Conv. 200 l/ha	10	7	7	6	1	1
Conv. 100 l/ha	11	9	6	9	1	1
Conv. 50 l/ha	18	7	7	10	1	2
CDA 20 l/ha	17	8	7	15	17	4

Source: High Mowthorpe EHF 'Cereal Husbandry 1981'

Another trial comparing the two systems using fungicide against mildew showed the same trend.

Table 19: Control of Mildew in Spring Barley 1977

	Nil	Conventional		CDA	
		275 l/ha	55 l/ha	25 l/ha 250 micron	25 l/ha 150 micron
% Mildew on 2nd leaf	9.6	0.5	0.05	2.07	4.6
Yield (t/ha)	5.76	5.87	5.87	5.86	5.87

Source: High Mowthorpe EHF Annual Review 1979

In this trial yield was not adversely affected by the lower control from the CDA unit due to the low level of disease, but the degree of control was significantly poorer.

These results suggest that whilst the CDA units can give adequate control, the higher cost and complexity of the machines make them less cost effective. New hydraulic nozzles offering narrower droplet spectrums at relatively low volume application will probably remain the most cost-effective method of chemical applicaton on broadacres. In fact the spread of droplet sizes offered by hydaulic booms may give a useful safety margin in all conditions.

The major disadvantage of hydraulic booms at low volumes is the drift due to the lower droplet sizes. This can be reduced using deflecters such as curtains or aerofoils behind the boom. Drift is not as pronounced with the more accurate CDA units and their use may be preferable where drift could cause major problems.

The frequent claims by CDA manufacturers that herbicide and fungicide rates can be halved for the same effect using CDA machines must be viewed cautiously. It would seem that similar claims, if true, would apply to low volume hydraulic boomsprays. The only experimental work assessing the effect of CDA application on weed control showed that the rate needed was affected by the chemical used and the weed sprayed and no consistent recommendation for reduced rates could be justified (26).

Electrostatic Spraying

This is a variation on the hydraulic principle where the emerging droplets are charged negatively, so that they are attracted to the nearest earthed target, usually the upper leaves. They have the advantage of reduced drift, more accurate droplet size and the ability to cover both surfaces of the target. However they have the problem of a stream of larger positively charged droplets which form in the centre of the fan. Their poor penetration of the sward can also be a disadvantage with non-systemic chemicals. Both these problems are the subject of current research and may be solved. (23)

Double Spraying

This technique is being used by many farmers interviewed in the UK. Half rates of weedicides and fungicides are applied with a short interval between. This has the effect of prolonging the action of the chemical and often of increasing its efficiency. More research is needed in this area.

Controlling Leaf Disease

As already mentioneed the control of leaf disease has given the greatest single yield response of any management operation, given that no other factor was limiting the growth of the crop (3). The fungicides for this control have only recently become available and at present they are often surrounded in a certain mystique. A large part of the attempt to develop crop 'blueprints ' stems from this uncertainty.

Like weedicides the specific techniques and chemicals used in the UK are not applicable in Australia, but the advent of Stripe (yellow) rust in Australia has made the use of fungicides manadatory for the future.

The diseases that affect wheat can be divided into three classes, based on the method of control, i.e.

1) soil-born diseases affecting the roots and stem base.
2) Diseases infecting the plant early in its development
3) Disease of the leaf and ear affecting the plant after the end of tillering.

The first group can be controlled by rotations, burning and seed dressings. It is the control of the later two groups that is now possible. Two approaches exist. The first is to spray to eliminate disease from the crop, either prophylactically or as soon as it is detected.There is some doubt that this is the most economic course of action. Research at the Cotswold Cereal Centre suggests that early disease may not be economically important, provided that the plant is healthy and the level of disease remains controllable, to quote 'the autumn treatments often gave a yield response. However in terms of cost effectiveness, the full program from the spring onwards was as rewarding (19). Later in the growth cycle, i.e. after the onset of stem elongation it seems vital to maintain the top 3 leaves healthy (24).

The following table presents a summary of the likely benefite of disease control.

Table 19: Percentage of Winter wheat crops where disease severity would repay fungicide treatment costs.

Disease	% crops repaying treatments costs ($/ha) of $10	$20
Mildew	18	9
Septoria nodorum	13	8
Stripe Rust	3	2
Eyespot	8	4

Source: ADAS Disease Surveys 1970-79

An essential feature of the management of these diseases is proper crop monitoring on a regular basis. Although the chances of a response are relatively low by comparison with other inputs the speed and severity of an outbreak far exceed the range normally associated with cereal production. A new occupation of 'crop consultant' has emerged to fill this need and advise farmers on their control programs. Similarly various computer models have been developed and will be discussed below.

The ADAS recommendatons for fungicide use (26) suggest 3 different systems of disease control, i.e.

1) Disease Risk Assessment - this system involves regular monitoring of each crop and a treatment is applied only when there is a risk of disease developing sufficiently

to cause yield losses. The criteria for treatment of the most common diseases are as follows :

Mildew - spray as soon as more than three per cent of the flag leaf is affected during the period from flag leaf emergence to ear emergence.

Eyespot - spray as soon as more than 20% of the main tillers bear eyespot lesions.

Stripe Rust - the decision to spray depends on the disease susceptibility and the weather. Susceptible crops should be sprayed immediately the disease is detected, as long as the average nightime temperatures are below 15 degrees C.

Septoria spp. - the best control of Septoria is obtained by spraying at or soon after flag leaf emergence. Spraying should be contemplated if the disease is present on the older leaves or when a period favouring disease development has occurred. This is defined as 4 or more days of more than 4mm rain in the previous 2 weeks.

Barley Yellow Dwarf - a single spray with aphicide in the late autumn period is usually sufficient. This is probably better treated as a routine prophylactic measure.

2) Routine Prophylactic Treatment - this system is unlikely to be economic for more than 40-60% of crops. Crops associated with two or more of the following factors are most likely to respond,i.e.

* sown before mid October
* mild winter
* variety which responds well to fungicide in NIAB trials
* moisture retentive soils.

It is worth noting that all these are likely to be associated with high yielding crops, which tend to be most susceptible because of the high humidiity under their dense leaf canopy.

A suggested prophylactic program for winter wheats is :

Late October - spray to control yellow dwarf virus.
First Node (Growth Stage 31) - spray for eyespot as well as mildew and Septoria.
Flag Leaf Emergence (G.S. 39) - spray for leaf diseases such as stripe rust and Septoria.
Ear Emergence (G.S.59) - leaf and ear disease control if necessary.

At each stage the fungicide(s) can be selected to fit the disease spectrum present.

3) Managed Disease Control - this incorporates aspects of both the above systems. One or two prophylactic sprays will be included depending on the assessment of disease risk and further treatments will depend on constant crop monitoring. This is the system most likely to give profitable results.

Growth Regulators

The chemical Chlormequat has the effect of both shortening and strengthening the stems of cereal crops. The value of this is twofold;

1) to prevent yield loss associated with lodging. In this sense it is an insurance, but as lodging is most likely to occur in the highest yielding crops is often prudent.

2) To increase yields by maximising other inputs such as nitrogen fertiliser to achieve maximum possible yields.

3) To increase yields directly in the absence of lodging. These increases are typicaally in the order of 3-5% and occur in about 60% of the treated crops (24). These effects are variously claimed to be increased root development, tillering and ear size. However they are usually small and inconsistent, but can help alleviate the relatively low cost of application.

Typical results for growth regulators are as follows (25):

Table 20: The use of Plant Growth Regulators and associated yields.

Variety	No. of Crops		Top Dressing kg N/ha.		% Yield increase. due to PGR
	PGR	Nil	PGR	Nil	
Hustler	12	35	142	166	13
Mardler	71	110	150	160	8
Hobbit	18	86	139	154	15
Huntsman	20	89	131	156	17

Source: ICI Ten Ton Club Survey 1980

The effects are more noticeable on the longer strawed varieties and negligible in the absence of lodging. For this reason some ADAS officers do not recommend their use, but most leading farmers regard them as a good investment.

Crop Monitoring

High input farming systems such as this demand high levels of management time and skill. To monitor the growth and condition of the wheat crop several orders of recording and analysis have been developed.

1) Assessment by eye: This is an historical system, in that it assesses changes that have already occurred and may therefore sometimes miss the optimum timing or wrongly assess the economic consequences of control measures. This is less likely to occur when professionals do the assessing, as has begun to happen in both England and America.

2) A more comprehensive system which aims to analyse the dynamics of the crop yield is being used on some farms. An example is listed below:

```
                         Total grain sites/plant
                              =376.4 (100%)
    !---------------------------------------------------------!
Tiller death losses                               Surviving tillers have
= 149 grains (39.8%)                                226.8 grains (60.2%)
    !                                                        !
Spikelet abortion losses                          Surviving spikelets have
=31.6 grains (8.4%                                  195.2 grains (51.8%)
                                                             !
                                                  Losses due to failure
                                                     to set grain = 104.6
                                                               (27.8%)
                                                             !
                                                  Final Yield = 90.6 grains
                                                                (= 24%)
```

This approach can isolate sources of yield loss (14). It is a detailed and time-consuming analysis and one which can be circumvented by computer modelling.

3) Crop Models

Several firms and research establishments are attempting to describe the wheat plant using mathematical models run on computers. These models vary in their sophistication according to their intended use. The simplest are just databases of the recipe type, where the farmer is asked a series of questions and given an answer based on expert evidence. The BASF CASP system and the Cleanacres systems both appear to be of this type.

The next level of model actually calculates the probable cost/benefit relationship for any input, or suggests the relevant input for any specified disease level. This may also involve modelling the disease growth patterns as well.. The Dutch EPIPRE system marketed in the UK by Comput-a-Crop (26) in Lincolnshire attempts this approach. It seems a very simple model, which does not take current weather into account. It does however give the farmer a useful method of collecting and analysing data about his crop and has performed well in ADAS trials, mainly by reducing the prophylactic element in the farmers' expenditure and so increasing his margins.

The final and most complex models use large computers and attempt to 'grow' a plant mathematically. They are at present mostly research tools. However in the near future they should become useful monitoring tools, giving advance warning through the media of likely outbreaks and recommending specific actions.

The Future for Cereal Production in the UK

The future for cereal farmers in the EEC depends entirely on the level of price support that is maintained under the CAP. As this body has currently exceeded its budget for the first time this could be expected to fall in the near future. However because of the political pressures applied (by Germany and France in particular) to maintain their peasant population some form of production restraint is more likely and would have a more profound and stabilising influence on the structure of the CAP system. In the short term the EEC is likely to increase the CAP budget beyond the 1% VAT, so that the UK farmer can expect a continuation of high prices.

The stated CAP policy of letting the price of wheat drift towards world parity will have little impact on the UK in the short term. This is because the maximum rate of price reduction politically tolerable (4% at the last budget) is less than the rate of production increase that the UK farmer has maintained for the past decade (5.6%). Even though it is unlikely that this level of productivity increase can be maintained the productivity increase that is likely will nearly compensate for the lost revenue for some time. This is true on the natioonal level, as the majority of farmers are beginning to use the techniques pioneered by the innovators. These more efficient farmers will therefore feel the effect of the price cuts before the bulk of farmers, but their level of marketing ability will allow them the compensate.

Furthermore, whilst the British Government continues its internal taxation and depreciation policies most farmers will be attracted to cereal production. Furthermore, while the price of grains remain as volatile as they are at present the opportunity exists to increase margins through marketing. These fluctuations also provide the incentive to stay in the market hoping for 'a better price.'

The fact remains that, because of the climate, the British farmer is one of the most efficient wheatgrowers in the world today. The more efficient half could survive - just - at present world parity prices, a position they will never have to adopt because of the high domestic consumption.

Statements have been made that wheat production could be reduced by taxing nitrogenous fertilisers. This is ludicrous, because the marginal yield increase for this input is about 10 times its value and that order of increase is unlikely to be applied as a tax.

However a sensitivity analysis using data for the Eastern Counties (2) (Table 26 opposite) shows clearly that the real enemy of the UK farmer is of his own making. It is in fact the high cost of his productivity. This analysis (Appendix 1) demonstrates that it is inflation of the fixed cost component of wheat production in the UK that is going to cause a rapid decline in profitablity within this decade. This decline will occur in spite of any reasonable increase in productivity or change in real or absolute price for wheat.

The most probable outcome . of the present overproduction is a continuing overproduction on the world market, caused by the uncontrolled policies of the EEC, with European producers isolated from its effects. A system of production controls will probably be introduced over the next 5 years, with provision within this for a permanent overproduction of about the current level as a form of insurance against low yields. The main pressure forcing this change will be the USA, who will naturally be unwilling to maintain the expensive PIK program to subsidise overproduction in Europe.

Given these scenarios the world production is most likely to be maintained at a level greater than the world demand for the next few years, barring natural disasters. Beyond this time production controls, increasing demand from the developing countries and perhaps increasing fuel prices (according to the Club of Rome) will lead to some stability in the market.

Australian Application of these Techniques

It is obvious that Austrailain farmers can never use all the techniques that are routine in the more favourable physical and economic climate of the UK. However most of the techniques described have application to some areas in some or most seasons, particularly the cooler Slopes and the irrigation areas. As the main factor limiting yields in Europe is high temperature the wheat belt can be expected to move into the cooler Slopes and Tablelands over the next decade, helped by the falling profitability of the grazing enterprises.

The advent of winter (or semi-winter) wheats will allow the application of many of the UK methods. The following areas should be investigated urgently if the potential of these wheats is to be realised.

1) The optimium time of sowing and seeding rate policies. Under irrigation at least it should be possible to specify target plant and ear populations for specific goals, whether quality or yield. In many years these will also apply to the more favourable dryland areas.

2) The timing and rate of application of nitrogenous fertilisers will have to be re-evaluated. The recommendation for spring and winter wheats in the UK are totally different and this shoould also be true in Australia. As most of the work on nitrogenous fertiliser was done before semi-dwarf wheats became popular there is even more reason the re-open this line of investigation. This work should be done in conjunction with the assessment of seeding rates and varieties.

3) Very little research has been done into the control of leaf disease in Australia. This has suddenly become relevant with the advent of stripe rust. However work already done has shown the potential for yield increase that exists with the control of the 'older' leaf disease. These older diseases can do more damage to the leaf area of a plant in some seasons than stripe rust. It is therefore reasonable to assume that they may have as serious an effect on yield. The cost of preventing such diseases is low, especially using modern application techniques which allow the regular use of half rates of fungicides, even under the high disease risk conditions of the UK.

4) Another factor which makes such research potentially useful is that these treatments are often applied late in the development of the crop, when a more accurate assessment of yield potential can be made. This decreases the level of risk involved in their use. A system of sequential applications of fungiciges and nitrogen could be made when justified by the season and disease risk. This may involve an early application of both at tillering using low rates, followed by another and heavier application at the beginning of stem extension if the season had sufficient potential. The aim should probably be to keep the plant healthy, as fungal diseases will be most prevalent in those seasons favouring high crop yields.

5) It is important that these factors are investigated together and not in isolation, as it is the combined effect of all treatments that has resulted in the advances seen in the UK. This explains their present resaearch into the evaluation of systems of wheat production, aimed at producing guidelines for farmers, an approach seen at all levels of research. This approach is not as scientifically 'nice', in that it would be impossible to control and measure the interactions operating. However it does provide commercially useful information, hopefully to the extent where systems specific to different Australian varieties will emerge as in Europe.

6) Because of the commercial bias of this research it would be important to establish very close cooperation between farmers and the extension and research services. In the first instance this would best be done using select groups of innovative farmers willing to put resources into testing and developing these more intensive systems. This approach is used in the UK, with ADAS sponsored discussion groups of 10-12

farmers meeting at critical times to discuss and evaluate strategies.

The aim of this research and extension effort should be to develop guidelines for the application of these new techniques related to the season and expected crop yields. Such guidelines should allow the very selective use of the techniques at critical stages of the crop development on a sequential basis, so that the risk can be evaluated at any stage. This should result in the full potential of the good seasons being realised, which is the most logical way to increase average farm yields.

The Products Available

"...the range of computer hardware and software available now on offer is staggering. To the layman trying to decide between them, the problem must really be like the housewife trying to decide which soap powder really does wash the whitest. The sales pitch is professional and intensive. Add this to the inevitably mesmerising effect of modern computer technology and the farmer interested in buying a computer system faces a difficult task indeed.

This is not to belittle the potential value of these systems. As a microcomputer user myself I know the worth of these 'machines'.

The Scottish experience has been that power and machinery costs have been allowed to get out of control on most of the farms that found themselves in trouble with overdrafts. While a good up-to-the-minute accounting system might not in itself cut .... costs, it can certainly help to control them."

(Piers Welkins, Power Farming Jan 1983, p5.)

Computers in British Agriculture

Introduction

Farmers all over the world have always shown a reluctance to utilise the huge amounts of data they generate. This reluctance is due to a lack of training, staff and management time, rather than a lack of appreciation of the benefits of using the data in business management.

The advent of the personal computer has, for the first time, given farmers a tool with the necessary power and skills to allow this analysis in the time available , by automating both the collation and reporting functions. This has freed the farmer of the time-consuming analysis that is involved in processing data by hand, allowing rapid access to data in a predetermined and useful format.

However many problems have existed in transfering this benefit to the far. The main problem in this regard has been the reliability and suitability of the computer programs that were available (the software) rather than any problems with the computers (the hardware) themselves. A general appreciation of these problems, coupled with a high price, has slowed the rate of acceptance of microcomputers by farmers. Being both realists and good businessmen, farmers realised that better and cheaper products would soon be available.

Both problems reflect the youth of the industry. The unreliability was a result of commercial firms being forced to market unfinished products to generate cash flow and the high price was necessary to cover the extraordinarily high development costs of the early products. These problems are common features of any new products.

The British farmer was ideally placed to bear these development costs. The intensiety of British agriculture and the high profitability under the EEC helped bear the costs and justify the use of computers. The high level of internal communication meant that the problems could be overcome more easily than in a larger country such as America. Furthermore the British market seems more willing than others to tolerate lower standards of presentation of products than some other countries, which allowed the pioneering firms to more rapidly recover their early costs.

Furthermore a large proportion on British farms employ full or part-time office staff. This has the effect of removing the manager from the problems associated with the early systems and of providing trained office staff more used to organising office procedure than the average farmer. These two factors would have considerably reduced the problems associated with the early software, whilst maintaining the advantages of better reporting and perhaps reduced office costs that would have motivated the initial purchase.

For all these reasons there are proportionately more computers on British farms than in any other country. The British industry is therefore leading the world in farm computer system development at present and may do so for some time. A detailed look at the products available and the way they are used by famers should therefore give some insight into the likely developments in other agricultures.

The Uses for a Farm Computer

This will vary with the size and complexity of a farm, i.e. on the amount of information that is produced and the perceived benefits in analysing that data. From this point of view the most obvious benefits would come from financial analysis and the closer control of the intensive livestock enterprises, perticularly dairy and pigs.

Computer specialists within ADAS suggest that the benefits accruing from computerising different enterprises are in the order;

1) Financial
2) Dairy
3) Pigs
4) Arable Crops

They stated that enough extra income could result from computerising a combination of accounts and either of the intensive livestock enterprises to justify the purchase of a computer. Less benefit was likely from arable enterprises until predictive programs are evolved as the data stored was not likely to increase management efficiency.

It is interesting to realise that both the two largest software firms began from ideas generated at a Dairy conference at Reading University, a conference which also launched the first dairy bureau called Daisy.

The following pattern of use emerged amonst the farmers interviewed.

Table 1: Computer use by Enterprise

Program	% All farms (7 in sample)	% of farms with that enterprise
Financial	100	100
Payroll	78	78
Dairy	67	100
Pigs	33	100
Arable	33	72
Beef	11	NA

This illustrates both the relative use of the different programs and the high utilisation of these programs on suitable farms. In most cases the computer was being used for all likely applications on each farm. The exceptions, i.e. Payroll and Arable, both occurred because of the lack of suitable programs at the time of purchase. This illustrates a very high useage rate for a new product. In fact six of the seven farmers indicated their intention to computerise all their enterprises.

Most farmers also expressed a high level of satisfaction with the products they used. Six of the seven interviewed claimed that their system had equalled of exceeded their expectations, with the seventh qualifying his approval on the basis of one program only.

The Benefits

Most (71%) saw the main benefit being the increases analysis of their information. Another advantage offered was the saving in office time.

In reply to a specific question on the time input all were unanimous that it offeed advantages. Four of the seven said their microcomputer saved time in absolute term. The remainder claimed an equal or greater input for a much greater benefit.

Some comments by different farmers are worth repeating verbatim, as they give some insight into the benefits perceived:

* "Now have a better chance of being on top."
* " In a better position not to miss opportunities."
* "The accounts used to be a boring job; now it's more interesting."

The Products Available

These are best listed according to the hardware they use. The hardware classification broadly defines the price and capability of the hardware-software purchase. The major problem of incompatibility between different brands of hardware has restricted the purchaser to a narrow hardware-software range. This restriction is particularly relevant when the most suitable software programs for any one farm are incompatible with each other and/or with any one brand of computer. However it must be stressed that within each group the purchase should be made on the software suitability.

Group 1 - Mini-microcomputers

This type of machine is a recent development in the market, introduced largely for the amateur hobbyist and to support computer games. It usually costs less than $500 and is mostly designed to use the home television screen. It may or may not be connected to a printer.

Recently one firm has begun marketing agricultural programs for this type of computer. Farmfax has written a series of simple 'spreadsheet' type programs for the Dragon computer. The significance of this product is that many more farmers can now afford an 'agricultural' computer. By entering the mass-market Farmfax will expose a much larger proportion of the farming population at all levels to the uses of computers. This greater general awareness should help create a more objective evaluation of the uses for a farm computer amongst potential buyers, who can then decide the product most suitable for their uses.

The second significant innovation in the Farmfax product is the use of RAM-packs (plug-in non-mechanical cartidges) to carry the program and store recorded information. This innovation frees the user from the expense and complexity of mechanical storage systems, markedly reducing the price and reliability of the product. At present only limited amounts of data can be stored using these products. However developments under progress in the hardware industry should ensure that this approach to non-mechanical data storage will be available on larger microcomputers in future. This would impart the advantages of lower price and greater simplicity to all farm systems.

Group 2 - Microcomputers

There are about 600 microcomputer systems currently in use by British farms at present (2). Most of these sell in the range $4000-$8000, as shown in Tables 3 and 4.

Within this group there is considerable variation in the range and capabilities of the products available. However the concentration of sales is notable, two firms holding the majority of the market.

Table 5 : Numbers of Microcomputers on Farms in the UK 1983

Firm	Estimated Sales
Farmplan	400
Farmfax	200
Remainder	100

Source- ADAS Estimates

Thus 85% of the market is controlled by two of the 32 firms selling software. This concentration is unlikely to continue with more specialisation likely to occur in future.

The advent of powerful generalised programs, such as databases (filing systems) and spreadsheets, for microcomputers is likely to change the structure of the microcomputer software industry in the near future. These progams allow unskilled users to rapidly develop their own data-handling systems. Although these systems tend to be less sophisticated and flexible than the specialist programs they often offer similar facilities for much lower prices. They have the further attraction that many are available for a range of computer makes, allowing the farmer choice of both hardware and software specific to his own needs.

These types of programs will increase in popularity and power and may dominate the total software sales in the near future. They allow the user very cost-effective automation of office systems, often easing the transfer to computer useage.

Group 3 - Systems for Larger On-Farm Computers

Large Estates and farm businesses often have requirements exceeding the capacity of the microcomputer. Several firms offer purpose-written software for these applications, but such products will not be reviewed in this report.

Group 4 - Bureaux

Bureaux have historically formed the basis for computer use. Older systems were more expensive and troublesome, requiring expert attention and multiple users to justify their use. Recent developments have overcome both these problems, so that the original role of bureaux is changing.

Modern bureaux must offer services that outweigh the disadantage of remote operation and lack of immediate access, which is "80% of the value of an on-farm computer" (3). Successful bureaux operations must therefore be either cheaper (3),or offer more services than personal computers.

A consistent feature of the successful bureaux interviewed was the level of expert interpretation and advice that was available to the user. The best examples showed simplified data collection as an added advantage.

This advice stemmed in all cases from access to huge amounts of data. An example is Pigtales, a firm near Hull which has the records for nearly 2 million sows on file. Analysis of this accumulated data allows many hypotheses to be tested without trial work. The operator is a qualified vetinariaan who uses the data to develop insights, the benefits of which are immediately passes on to his clients. The client is therefore removed from the problems of handling data yet given access to more than would otherwise be available, making this bureau operation very attractive.

The increasing power and speed of the microcomputer has seen the development of a smaller bureau type service . These ranged from services operated by farm consultants to pig and arable farmers to small bureaux run by wives. Other services included those offered by travelling secretaries, including one firm which had set up a land-rover as a traavelling farm secretarial service. All these offered cheap, prompt and regular service to a limited number of clients.

For these reasons bureaux are likely to remain a common feature of farm computer use. However there is room for the linking of the farm computer to the larger bureau, so that the user then obtains some of the advantages of immediate access whilst perhaps reducing the cost of membership of the bureau by entering his own data.

Group 6 - Large Databases

These are information sources, usually based on very large computers. The typical examples are Videotext and Viewdata. Some of these allow the entry as well as the retrieval of data and so become interactive.

These have obvious aplication in the large-scale distribution of information, either to television sets in the home or other computers, including farm computers.

Extension services such as ADAS and the NFU have established systems that provide information to the farmer using the established commercial operations mentioned. Information on the weather, prices of commodities etc. can be readily obtained this way. Future extensions of this service will allow the farmer to enter information, thus making such developments as computerised selling of commodities likely.

In this vein several commercial firms are currently refining computer models of farming practices such as cereal production to allow a cost/benefit analysis of any farm operation before it is undertaken. This type of database would also issue warnings to farmers of anticipated epidemics allowing prophylactic treatment. The CASP system offered by BASF to its clients is an example of this approach.

Why do farmers buy computers?

The media has been remarkably successful in convincing farmers of the inevitability of the farm computer. All farmers interviewed, whether they owned a computer or not thought that they would have a computer in the foreseeable future. The recurring reason for not purchasing a computer stemmed from a basic fear that the computer might threaten their management role. Many were obviously ignorant of the function of computers and their purely analytical function.

The most common reason given for purchasing a computer was the analytical power it offered. A secondary factor was the promise of reduced operating costs through both increased efficiency and reduced office charges.

All farmers interviewed took a passive interest in computers at first. Most followed their development in the general media for a considerable period before actively moving to purchase. The period between initiation and purchase varied from 0 to 2 years, with an average of 10.1 months.

Half of those interviewed systematically inspected the products available. The other half either accepted the recommendation of advisors (such as ADAS) or bought after a demonstration. A consistent and vehement opposition to hard-selling methods was apparent, with two farmers changing firms as a result. All farmers considered after sales service was important, with 37% giving as the major consideration in the choice between systems.

None of the farmers thought their system expensive. This was surprising as there was a large variation in farm size, productivity and apparent wealth amongst those surveyed.

All farmers bought on the basis of the software available. None had previously bought hardware. All found that their hardware was reliable and had few if any complaints about its function.

Which farmers buy computers?

Lack of previous computer experience was the only common factor among the farmers interviewed. Only one of the users had any training in computing before purchasing. In this case the farmer had married a programmer, who now operates the computer.

Table 6: Physical Characteristics of Farms with Computers

	Average	Range
Sample size	7	
Size (acres)	1964	800-3900
Nominal Value	$6.35 million	1.6-7.02
No. Employees	24	6-100
Prev. computer experience	0	0

Enterprises	% of farms
Dairy	72
Pigs	29
Arable	100
Beef	43
Sheep	43

IP

It became apparent during the interviews that all those interviewed had a need for better management information. This does demonstrate that there is a need for an analytical tool on farms and that these farmers were aware that analysis of their business operation could yield benefits large enough to cover the cost of the computer.

How well do the farm computers perform?

All users interviewed were asked to rank their programs (on a scale of 1-5 on increasing merit) on the following criteria;

Table 7; Program Evaluation

Program	Financial	Payroll	Dairy	Average
Sample size	7	6	4	
Months experience	10.9	10.8	19.3	13.7
No. records	2060	34	290	
Utility	4	4	4.8	4.3
Ease of Use	3.5	4.1	5	4.2
Documentation	2.3	2.4	2.3	2.3
Service	3.9	4	3.8	3.9
Reliability	4.3	4.1	4	4.1
Speed	4.5	4.2	4.8	4.5

This table indicates a generally high level of acceptance of all programs by farmers. As would be expected tose products which have been in use the longest seem to have a slightly higher useage rating. This would be due both to familiarity and to constant product improvement. It is generally accepted that most problems occur in the first year of use and this trend could be expected to continue.
This is suported by the fact that he relatively low score for ease of use for the Financial programs was entirely due to one inexperienced user of 1 month who rated it 1 out of 5.

Those products more familiar to farmers also have a higher rating, (i.e Dairy rates better than Financial) as would be expected. The interesting conclusion is that the differences in acceptability is so small between programs. This must reflect a high standard of presentation of the more complex programs (e.g. financial), where the farmers training was generally low.

The high score on reliability indicates the products have become commercial and that newer users can expect few problems. The scores for both reliability and service were significantly lowered by the performance of one firm, which scored an average of nearly two points lower on both categories than its competitors.

However there was no difference in scores between firms on the standard of documentation, which was consistently poor. This could be expected for new products that were under development, but is the one major area that obviously needs improvement. As the standard of documentation would influence all other categories to some extent there would seem to be a basic marketing requirement for a high standard of documentation if the product is to win general acceptance without requiring massive personal support for each user. It is significant that the more popular general database programs are all supported by excellent documentation, so that the agricultural market will have to meet that standard to compete. It will also be a necessary requirement for entry to a larger market, where the cost of more personal support would be prohibitive.

The high rating for speed is surprising, as most of the programs reviewed are written in Basic, which by industry standards is very slow at data handling. It does indicate that the microcomputers are generally being used at less than their capacity, so that speed is not important for the programs reviewed. One bureau operator estimated that an Apple microcomputer using Farmplan Dairy programs could process records for 2000 cows in a bureau situation. No single user interviewed approached that figure. Another user was prepared to wait for 25 minutes for one report in a Pig program, yet still ranked the program 4 for speed. This probably shows exceptional patience on the part of that operator, rather than a general acceptance of that low speed.

This small survey indicates that the hardware and software available are a useful and efficient tool on those farms. Given the age of the industry and the fact that the average user interviewed had only been operating their system for a little over a year these results would be good for any new product, especially in the light of the inexperience and lack of training of the operators.

The Future

During the course of this investigation it became apparent that the larger software firms were in transition from a development to a marketing phase. They were obviously aware that they had viable products that needed more promotion and sales had increased to a level sufficient to support more positive marketing.

This change will ensure that volume sales will occur, lowering the unit costs and increasing the standard of presentation. The opening quotation indicates that this has begun and that good, reliable and cheaper products are becoming available.

Hardware

The number of manufacturers entering the microcomputer market is astounding. This will force them into some commonality if they are to capture volume sales as they will need to be able to run a wide range of software to be attractive to buyers.

Most now support a common operating system called CPM. This is the first attempt in this direction and others, such as Micro-cobol are appearing. Thus the problem of incompatibility is disappearing as the industry matures.

The unit price of the products is also falling. The price of the farm system is now largely determined by the mechanical peripherals such as printers and disk drives. These peripherals are unlikely to become much cheaper than at present and a large fall in the unit costs of the farm system will probably not occur until these mechanical systems can be replaced electronically.

Whilst the price is not falling very rapidly the power of the systems available is increasing, so that a given level of processing can now be carried out by cheaper models. The Farmfax Dragon and the Farmplan Secretary both indicate this development.

The power of the farm computer will expand with the national computer industries. The advent of more sophisticated and specialised database systems will then allow the computer access to much larger information sources. Systems for computerised livestock trading, commodity purchasing etc. are already operating in different countries. These will have an important bearing on the size of the farm computer market, as farmers become aware that they are a management tool which can rapidly expand the level of services and analysis available to the farm.

Software

Two new products available in Britain indicate some of the development patterns that can be expected. The first is the EPIPRE system developed in Holland as a simple crop management model. This can be run on a microcomputer as marketed by Comput-a-Crop at Louth. It allows the farmer access to an expert cost/benefit analysis of any application to his cereals. This has had a direct effect on the user's production costs (as measured in ADAS trials) (29). This type of model is now being developed for other crops and livestock industries, allowing much more effective control of inputs. This approach gives farmers an obvious and measurable benefit from owning a computer.

The second notable product was the Programplan operating system developed by Farmplan. Programs written in this system show a dramatic increase in speed and processing power. (For example the report quoted above that took 25 minutes would be produced faster than it could be printed using a Programplan program.) This product also systematises the production of programs, allowing more flexible programs to be written in much less time. Programplam can be made to run on a large cross-section of the micro-computers available, so reducing the problem of incompatibility.

Other systems of this type will probably soon appear. Software changes of this type will have more impact on the utility of the farm computer than aany other factor.

Farm computer programs will become easier to use as they are developed in the near future. Furthermore they will become more compatible with each other, so that they will begin to use common data. This will ease the burden of data entry, as data should then only have to be entered once to be used by all programs. This has begun to be available in more general programs but is still to be developed for agricultural use.

These developments will soon allow farmers to prepare budgets, crop forecasts and predictions very easily. The present software range suffers from the disadvantage that it is limited to analysis of historical data. Access to larger databases and crop models will rapidly expand the predictive power of the farm computer, giving the manager a powerful tool for risk assessment and for planning improved management.

This predictive role began with the use of generalised spreadsheet programs. Farmers wrote their own predictive programs (usually referred to as 'what-if programs') using these spreadsheets. Newer programs such as the Farmplan Milk Monitor take this development further and it should become the main line of development of all agricultural programs in the near future.

Conclusion

The farm computer systems now in use have shown a high level of reliability and application on British farms. This is likely to increase rapidly, as the range and quality of the products increase.

The role of the farm computer will expand with the development more specific farm services in the computer industry at large. These developments will include direct trading and forecasting using the power of larger computers.

These two developments will allow the farm computer to become a predictive as well as an analytical tool. This development will make it more useful and therefore more generally accepted.

This report indicates that the farm computer has become a useful and reliable management tool. Future developments will ensure that it becomes an even more useful and common component of the farm office.

HIP

BIBLIOGRAPHY
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1) The Director, Centre for European Studies, Wye College (pers. com.)
2) Report on Farming in the Eastern Counties of England 1981/2 - M.C.Murphy (Univ. of Cambridge Agricultual Economics Unit.)
3) Rothamstead Multidisciplinary Trial Results as presented.
4) E. Tuer - Nuffield Scholar 1981, pers. com.
5) Letcombe Laboratory Annual Report 1981 (A.R.C.)
6) Growing Cereals, ICI Publication
7) The Agronomist, No.1 1983 (BASF Publication)
8) A.R.C. Better British Wheat, Ed. J. Hardcastle.
9) ICI Arable Demonstration Site Report 1982.
10) M. B. de Ponteves, pers. com.
11) Mr. D. de Kantzow, Leturer in Agronomy, Sydney University.
12) Staw Utilisation Stand, Royal Show
13) Farmer and Glencoe Soil Saver user, Royal Show.
14) Yield of Cereals, Course Papers 1982 (NAC Cereal Unit)
15) NIAE Technical Report No. 5
16) Mr. T. Williams, farmer, Holderness, Hull.
17) Winter Cereals at Boxworth EHF, 1981 (ADAS)
18) ICI 1980 Winter Wheat Survey
19) Cotswold Cereal Centre Results, 1982.
20) Wheat, a guide to varieties from the Plant Breeding Institute (NSDO)
21) Boxworth EHF Annual Review 1980
22) High Mowthorpe EHF Annual Review 1979 & 1982
23) NIAE results as presented.
24) Use of Fungicides and Insecticides on Cereals 1983 -ADAS Booklet 2257 (83)
25) The Food War, by David Curry MEP.
26) Low Volume Aplication of Post Emergent Herbicides in Cereals, N.L.Richardson, N. Brooks and R. Britton, Roseworthy Ag. College, South Australia.
27) Nozzles: The Critical Factor, by Tom Robinson. Power Farming, Jan. 1983
28) Mr. H. Westlake, ADAS, Reading
29) Ms. S. Wilson, Computa-a-Crop, Louth, Lincs.