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AGRICULTURAL ENGINEERING EDUCATION IN THE U.K. : THE SILSOE EXPERIENCE

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ABSTRACT

The paper describes the major developments in agricultural engineering education at Silsoe College in the U.K. over the period 1960 to the present. It seeks to relate these developments to the profound changes which have taken place in the agricultural, agricultural engineering, food and allied industries during the past three decades which are outlined. The emergence of deep public concerns about environmental and animal welfare issues combined with the reform of Europe's Common Agricultural Policy (C.A.P.) now in train have had a major impact on the evolution of educational provision within the College and on the profile of its research. It is concluded that prospects for the discipline and profession remain healthy provided the new agenda is addressed.

INTRODUCTION

Your conference organisers have invited us to address the issues inherent in the development, dissemination and application of agricultural engineering knowledge with special reference to the United Kingdom experience. This we attempt to do from a background of lengthy association in the U.K. with one particular institution, Silsoe College (formerly the National College of Agricultural Engineering), which forms part of Cranfield University. An appreciation of the events and circumstances which led to the foundation of this College in 1960 and its evolution since this time serve to reflect the profound changes which have taken place in the agricultural engineering, agricultural and food industries, both nationally and internationally, during the past thirty years or so. These changes have demanded constant adjustments in educational provision within the College and in the related training, research and consultancy services offered by the College; it is our experience which is outlined and briefly discussed in this paper. The agricultural statistics included broadly refer to the lifetime of the College, i.e. the 30 or so year period from 1960 to the present day. The data reveal a period of unprecedented change in the structure, performance, role and political context of U.K. agriculture.

AN HISTORICAL PERSPECTIVE

It was in the immediate post-Second World War period, during the late 1940's and early 1950's, that a growing awareness of the necessity for professionally qualified agricultural engineers became apparent in the U.K. Shortage of labour during the 1940-45 period led to a very rapid development of the mechanisation of agriculture. There was additionally a strong need to increase the aggregate production of temperate agricultural commodities (grains, meat, milk, milk products, etc.) in the U.K. using indigenous resources and also to improve production efficiency, especially the productivity of labour.

By the end of the 1950's only one U.K. university (the University of Newcastle-upon-Tyne) offered agricultural engineering education opportunities and this at postgraduate level only. Thus, it was against this background that visionary people within the Institution of Agricultural Engineers, the Agricultural Engineers Association and the Agricultural Machinery and Tractor Dealers Association (now known as the British Agricultural and Garden Machinery Association) persuaded the Government of the day to found the National College of Agricultural Engineering which was agreed to in 1960. It was located at Silsoe in Bedfordshire in close proximity to the National Institute of Agricultural Engineering, now the Silsoe Research Institute. The College and the Institute are to this day funded by separate bodies and managed independently although strong collaborative links are in place.

At the time of foundation it was envisaged that the College would develop and grow in size to a steady state total registration of 200 students, this being considered to be appropriate given the size of the agricultural engineering industry in the U.K. at that time. (It is near 500 today but by no means are all of these studying what might be properly described "agricultural engineering".) A crucially important strategic decision was made at this time, viz. that the College should seek to make education and research contributions to agriculture and food production internationally, particularly in tropical countries. The underlying reasons for this were many and complex but they certainly included U.K.'s heavy participation in world trade in agricultural inputs (including tractors and machinery), agricultural commodities and in food products; there were also political and linguistic considerations.

In 1975, N.C.A.E. merged with nearby Cranfield University and it adopted a name change, to Silsoe College, in 1983. It was generally agreed at that time that the new name would better facilitate the broadening of academic subject coverage which had begun to unfold during the late 1970's; to have "agricultural engineering" in the name was deemed to be too restrictive in terms of the future development of the totality of the College's work.

THE EARLY YEARS

The key academic programme of the College during the early period was a single 3-year B.Sc. programme in agricultural engineering and this programme, subject as it has been to continuous up-dating, is still on offer today. It is not necessary to describe in detail the curriculum except to mention that the programme allowed students to major in the final year in soil and water engineering, agricultural machinery engineering and in environmental control and crop processing. The initial selection and organisation of the staff of the College broadly

reflected these three electives.

Postgraduate courses were developed and offered at an early stage in the College's development within these three subject areas. Initially, the postgraduate courses were predominantly of the taught format but research degrees were soon made available, too. Postgraduate courses duration were (and still are) as follows:

Postgraduate Diploma	- 9 months
Taught M.Sc. courses	- 1 year
M.Phil. research degrees	- 1-2 years
Ph.D. programmes	- 3 years

Given the pivotal role the agricultural engineering industry played in bringing the College into being it is useful to list the ways in which the industry continued to influence, and contribute towards and make use of it during the first decade of its existence. The following are worthy of mention:

- representation on the Governing Body
- financial contributions toward the development of student accommodation
- loan of tractors and farm machinery
- provision of prizes for academic achievement
- creation of vacation employment opportunities for students
- commissioning of short, professional up-dating courses

The award of research contracts to the College by industrial companies was very slow to develop largely because it took several years for the College to build a competitive research capability, quite apart from the fact that at that time most companies preferred to manage their R&D in-house. Industry made it quite clear that its association with and allegiance to the College could not interfere with research commission placement decisions, i.e. no special concessions were made to the College.

Our graduates in the early years were pioneers in the sense that they represented a new product hitherto not available. Our first cohorts of graduates, however, successfully found employment, particularly but by no means exclusively, in the agricultural machinery and mechanisation industry - with manufacturers, distributors, in the extension service and on farms. But, it is important to stress that at that time, the general prosperity of agriculture in the U.K. was at a high level and there was a presumption that this would continue; young people at that time sought an agricultural or agriculturally-related education in comparatively large numbers in anticipation of life-time careers within the industry. Events and circumstances over the past 15 years or so have combined to change this situation.

THE CONTEXT OF AGRICULTURAL ENGINEERING EDUCATION IN THE 1990'S

Opportunities for professionally qualified agricultural engineers in the U.K. in the 1990's are arguably no less today than was the case 30 years ago, but without doubt their formation must take into account radically changed circumstances, so too the institutions providing such education. This section of the paper seeks to summarise the nature and extent

of the changes which have and are taking place in the agricultural, food and allied industries, also in the broader field of natural resources engineering and management. The pace and scale of change has been enormous, nothing short of a revolution has occurred. Agricultural engineering as an academic and professional pursuit has had constantly to address new issues and problems. These are listed, and, where considered appropriate, briefly amplified under a number of headings; associated tabular data are confined to Appendix 1.

Political

The U.K. became part of the European Community in 1973, now a community of 12 nations and likely to be enlarged still further within the next decade. The U.K.'s agricultural, food and environmental policies are all firmly integrated with those of the E.C. Agricultural and agricultural engineering education and research has had to increasingly take into account the pan European framework within which we work.

Europe's Common Agricultural Policy, appropriate as it was for the period when it was first agreed upon in the mid-1950's, has been subject to increasing political scrutiny over the past 10-15 years. This is not the time and place to detail its inadequacies, suffice to say that it is in the process of much needed (and painful) reform. The reforms are aimed at reducing the costs associated with the implementation of the policy involving as it does attempts to bring internal community commodity prices more into line with world prices; a key part of the reform is the removal of land from production agriculture.

The structure of U.K. agriculture

The past 30 years has witnessed major changes in the structure of U.K. farming. The total number of farms has reduced from about 475,000 to under 230,000 (c.f. Table 1). The average size of farm has approximately doubled. This rationalisation has brought in its wake much larger mean enterprise sizes on farms for both crops and livestock presenting as this does new mechanisation opportunities: the average herd size of dairy cows is now about 65 and the average sizes of farm cereal, sugar beet and potato enterprises are 45 ha, 19 ha and 7 ha respectively (c.f. Table 2).

One important consequence of this restructuring is that we have far fewer farming families (c.f. Table 3) with children whose farm up-bringing inspires them to seek an agriculturally-related education. Accordingly, agricultural colleges in the U.K. are finding it increasingly difficult to attract students.

U.K. and European agricultural production

Through the steady application of science and technology, improved management and generous market support regimes, crop and livestock yields have in many cases been doubled during the past three decades. Thus, the mean yields of wheat and potatoes now stand at 7.0 and 39.8 t/ha in the U.K. compared with 3.5 and 21.7 t/ha in 1960; average per cow milk yields achieved today approach 5,200 litres compared to about 2,900 litres 30 years ago (c.f. Table 4).

For many years policy makers in the E.C.. have had to grapple with the problem of agricultural surpluses which are widely known to have been costly in their production, storage and disposal. Tax-payers throughout the U.K. are deeply sceptical of Europe's Common Agricultural Policy and this has undoubtedly contributed to a decline in public confidence in the agricultural industry. This, too, has impacted upon the numbers of young people expressing an interest in embarking upon studies in our field.

The U.K. agricultural engineering industry

The structural changes in the U.K. farming industry referred to earlier have also been in evidence in the agricultural machinery engineering industry. The number of agricultural machinery suppliers has declined from over 600 companies in the late 1970's to about 300 in the late 1980's. The number of manufacturers has also reduced sharply and an increasing number of these now form part of multi-national companies.

In the U.K., the concentration of agricultural production into larger farm units has increased the demand for larger, more powerful and sophisticated machines capable of covering larger acreages with fewer operators in less time. The market for agricultural machinery in Europe has been in decline recently leading to heavy competition between companies in the industry, hence the rationalisation (c.f. Tables 5 and 6). There are now fewer employment opportunities within the industry and an increasing percentage of those which do appear demand a preparedness to work and travel abroad, also fluency in more than one language. Academic institutions preparing graduates for the industry must take this into account.

Environmental and animal welfare issues

Intensive methods of agricultural production involving as they do very high levels of fossil fuel energy inputs in the form of agrochemicals and machinery are widely perceived to be environmentally damaging. Field rationalisation to accommodate ever larger machinery has led to the loss of hedgerows (wildlife habitats and corridors) on a massive scale, also to a decline in tree populations. It is guesstimated that about half of the U.K.'s total hedgerow length has been uprooted since 1945. In a recent survey published by the Institute of Terrestrial Ecology the total hedgerow length was estimated to have dropped from 545,000 km to 425,000 km during the period 1984 to 1991. Landscapes have been damaged in the minds of many. Soil and water pollution problems are linked with the heavy and continuous use of inorganic fertilizers and pesticides, farm wastes disposal methods and silage effluents. Rare types of habitats, e.g. wetlands, have all too often been destroyed in the past in attempts to bring new land into agricultural production, ironically in many instances, attracting government provided subsidies with which to affect the changes.

Intensive methods of livestock farming including slaughtering techniques are increasingly (and rightly) being questioned. Animal welfare considerations, hitherto only rarely recognised, are now at the top of our agenda. Exposure of modern livestock production methods in the media generally but especially on television has led to vociferous demands that we house and rear animals in such a way that stress is minimised. Indeed, media coverage of agricultural production technology and its impact on the environment has had enormous impact.

It is difficult to over-estimate the consequences of these issues for those of us responsible for managing education, training and research within the university. Agricultural production per se is no longer the sole goal, production methods must be benign in their effects and demonstrably sustainable; additionally, scientists, engineers and farmers must take into account the growing body of legislation surrounding environmental protection and agricultural production practices and must anticipate to be challenged on the moral dimension of their work. Farmers are now regarded as both producers of food and managers of natural resources and this is also true for those who serve the farmer.

Grants and subsidies for farmers

Until about 1980, much of the financial support made available to farmers by Government in the U.K. was targeted at increasing agricultural productivity, improving farm profitability, and assuring farm income. An increasing proportion of the support provided now is, however, aimed at getting supply of commodities more into line with demand in an endeavour to end the "surpluses" problem, and to achieve environmental protection. This year, U.K. farmers will be paid about 800 million pounds sterling for not growing crops on 600,000 ha of land (termed "set-aside"); some estimates suggest that 20% of U.K. farmland may not be required for food production by the end of this century. More than 17,000 farmers will receive in excess of 40 million pounds sterling during 1993 to manage their countryside, protect wildlife and produce less food in about 30 areas of outstanding natural beauty within so-called "Environmentally Sensitive Areas (E.S.A.'s)". Public access to countryside for recreational purposes is a condition of many of the grants now made available.

THE IMPACT OF THESE CHANGES

It is not easy to concisely and accurately summarise the consequences of 30 years of agricultural, industrial and social change upon an institution such as ours. It is even more difficult to identify more general lessons for those who, like us, are responsible for overseeing the discipline of agricultural engineering within universities elsewhere. Indeed, it may well be that the U.K. experience may only be likened to the rest of W. Europe and not to country situations further afield.

At Silsoe the following general observations would be true:

i) Student demand for education in agricultural engineering has fallen at the undergraduate level. The reasons for this are complex. They certainly include a fall in confidence in the future of the agricultural and agricultural engineering industry for the reasons alluded to earlier. Farming and industrial restructuring has also taken its toll. To this must be added a general awareness that graduates in the future are unlikely to be able to work in a single industry for the whole of their careers, that employment mobility is the likelihood. Thus, university applicants are now more inclined to seek a more general first degree education, not an industry-specific education as was the case 30 years ago.

ii) Student demand at the postgraduate level, however, is holding up well especially in the subject areas which have an environmental as well as agricultural application. Again, the explanations for this are not simple. There are those who possess general first degrees, e.g. in science, geography, engineering, who develop an ambition to work in the natural resources management sphere or in the rural sector - they regard a Silsoe postgraduate qualification as an entry route. There are others who are motivated to contribute towards poverty alleviation in poor countries and postgraduate education at Silsoe in a branch of agricultural engineering is seen as a good first step towards fulfilling this goal.

iii) The client base of the College for our graduates and for our training, research and consultancy services has broadened over the past decade or so especially in the U.K. Some markets have, however, shrunk, most especially in the tractor and agricultural machinery sphere, the underlying reasons being connected to the rationalisation (including internationalisation) which has taken place in this sector of the industry. Had the College not seized opportunities to work beyond the narrow confines of the agricultural engineering industry in recent years its future would undoubtedly have been placed in jeopardy.

In the public sector the Government departments for which we now work include not only the Ministry of Agricultural, Fisheries and Food, but also the Department of the Environment, the Overseas Development Administration within the Foreign and Commonwealth Office, and the Department of Trade and Industry. In the quasi-state and private sectors we find ourselves working increasingly in the fields of land capability assessment, land decontamination, land use for amenity and recreational purposes (including the National Parks), in the newly privatised water industry, within the energy supply industries, in rural infrastructure engineering and within the secondary food processing industry.

iv) U.K. Government funding in support of agricultural and agricultural engineering education and research is less generous now than was formerly the case. We are all faced with working in a much more competitive environment. Furthermore, an increasing proportion of the monies which are spent are being channelled into the environmental sphere, animal welfare work and into the fundamental sciences base of the food chain, especially into molecular biology.

One recent manifestation of this policy change has been the decision to entitle the Agricultural and Food Research Council (A.F.R.C.) differently and to re-define its mission. It is now to be called The Biotechnology and Biological Sciences Research Council (B.B.S.R.C.) and it has been tasked to develop close links with all biologically based industries not including those in the medical and health fields. Dropping the words "agricultural and food" has significance for us.

The response of the College to these changes is briefly outlined and discussed in the final section of this paper. However, before proceeding, it is important to identify one area of our work which has not changed materially during the lifetime of our institution. Opportunities for agricultural engineers in the less industrialised countries have not diminished over time. Sustained high population growth rates, exerting ever increasing pressure on fragile and vulnerable land resources, continue to give rise to intractable problems of rural poverty, and in worst case situations, to food shortages. Global population is set to rise by a further 3-4 billion during the working lifetime of 1993 graduates, thus, the challenges are going to intensify. These challenges include the role which agricultural engineers, in partnership with industry and commerce, can play in creating market opportunities for tropically produced products in northern hemisphere countries. If gross inequities in wealth distribution are to be addressed, two way flows in goods and services will be essential.

SILSOE COLLEGE TODAY

In general terms the College has responded to the changes described earlier by selectively extending its academic territory beyond its initial base in agricultural engineering to include the following related fields:

- natural resources assessment using tools which include space satellite imagery and geographic information systems
- rural infrastructure engineering
- environmental engineering and management
- water engineering and management
- land resource planning and management
- food research and technology
- management and marketing in the context of rural business
- information technology for the rural sector

Perusal of current course titles serve to show how responsive the College has been to the very different circumstances of our industry and its context in the 1990's compared to the 1960's.

Our undergraduate programmes include:

B.Eng.(Hons.) Agricultural Engineering
B.Eng.(Hons.) Environment Engineering (Land and Water)
B.Sc.(Hons.) Agricultural Technology and Management
B.Sc.(Hons.) Environment Management
B.Sc.(Hons.) Marketing and Food Management

Selected postgraduate course titles include the following:

Agricultural Machinery Engineering
Agricultural Mechanisation Management
Applied Remote Sensing
Community Water Supply
Drainage and Land Reclamation Engineering
Engineering for Rural Development
Environmental Water Management
Information Technology
Irrigation Engineering
Land Resource Management
Management for Agricultural Development
Marketing and Product Management
Postharvest Technology
Soil Conservation
Soil and Water Engineering

It is important to stress that the discipline of agricultural engineering at Silsoe College would not have evolved in the way it has had the institution not been founded as a national

college tasked to serve the needs of a particular industry. Had it been established in 1960 within an already existing university, as a university department, its freedom to respond effectively to industrial change would most likely have been severely curtailed. Academic territory disputes within a university would have seen to this!

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Appendix

A selection of statistical information relating to aspects of the U.K. farming and agricultural engineering industry is presented below.

Table 1. Size of agricultural holdings in the U.K. (1960 and 1991 data)

	1960 No. of holdings (000's)	Hectares (000's)	1991 No.of Holdings (000's)	Hectares (000's)
0.1 to under 20 ha	310.2	2015	96.2	803
20 to under 50 ha	91.1	3091	60.3	1991
50 to under 100 ha	44.4	3005	40.9	2877
100 ha and over	29.9	4233	31.2	6109
Total	475.6	12344	228.6	11780
Average crop and grass area per holding (ha)		26.0		51.5
% of crop and grass area on holdings with 100 ha and over		34.3		51.9

Source: M.A.F.F. (1964; 1992)

Table 2. Changes in the average size of farm enterprises in the U.K. (1967 and 1991 data)

	1967 ha	1991 ha
Cereals (excluding maize)	22.2	44.5
Sugar beet	7.6	18.9
Potatoes	2.7	6.6
Dairy cows (average size of herd)	24	63
Breeding sheep (average size of flock)	123	223
Breeding pigs (average size of herd)	10	62
Laying fowls (average size of flock)	275	986

Source: Marks (1989); Burrell et al (1990); M.A.F.F. (1991)

Table 3. Changes in the number of persons engaged in agriculture in the U.K. ('000 of persons)

	1960	1991
Regular workers:		
whole time	505	120
part-time	80	59
Farmers, partners & directors	344	279
% of total workforce employed in agriculture	4.0	2.5

Source: M.A.F.F. (1967; 1992); Marks (1989)

Table 4. Changes in the average yields of major crops and livestock in the U.K. (t/ha unless otherwise stated)

	1959/61 average	1990/92 average
Wheat	3.5	7.0
Barley	3.2	5.5
Potatoes	21.7	39.8
Sugar beet	35.8	42.7
Milk (litres/cow)	2878	5186
Eggs (no./layer)	188	246

Source: M.A.F.F. (1967; 1968; 1992)

Table 5. Agricultural machinery numbers ('000) in the U.K., 1959/66 and 1987

	1959/66	1987
Wheeled tractors		
Up to 7 kw	51	11
7 kw - 40 kw }		11
40 kw - 80 kw }	442	295
80 kw and over}		29
Tractor ploughs	346	174
Disc harrows	100	89
Cultivators: rotary & others	447	397
Corn drills	130	76
Mowers	233	168
Pick-up balers	87	112
Combine harvesters	60	55

Source: Burrell (1990); A.E.A. (1989)

Table 6. New tractor registrations in the U.K. 1982-1991

1982	25,078
1983	28,079
1984	25,892
1985	25,595
1986	19,453
1987	18,818
1988	22,866
1989	20,251
1990	18,573
1991	15,230

Source: McKee (1992)