INTRODUCTION

It was with great pleasure that I accepted this invitation to present the Underwood Lecture. When I commenced my post-graduate studies in 1966, Professor Underwood was Director of the Institute of Agriculture and Dean of the Faculty of Agriculture at The University of Western Australia. Underwood had a depth and breadth of interests in agricultural science which was uncommon in the sixties, but which is almost non-existent in the eighties after two decades of specialization. Underwood was also very interested in post-graduate students and all Ph.D. students were required to outline their progress and future plans to him. He considered post-graduate students as “the most strongly motivated and hard working of all the research people in the country” (Underwood, 1973).

I am writing this paper in February giving my views on the future directions required in agricultural education before beginning a substantial involvement in the Review of Agricultural and Related Education. This review, sponsored by the Federal Departments of Education, Employment and Training and Primary Industries and Energy and chaired by Mr. Jim McColl, will report in November, 1990. By the time I present this paper at the meeting in July, our panel of three will have visited thirty institutions offering tertiary education in agricultural science, horticultural science, soil and water management, forestry, agricultural economics, agribusiness and processing of agricultural products. By that time some of the views expressed here may have been sharply modified.

There are three major challenges facing agriculture. First, prices received by producers are not increasing as fast as costs of inputs. Thus there is a clear need to increase the efficiency of the production, processing, transport and marketing of agricultural products to improve and maintain profitability. The second challenge is to maintain the resource base for sustainable production. The third challenge relates to widespread concerns within our largely urban community with issues such as land degradation, animal welfare and food quality.

What are the implications of these challenges for agricultural education in the future? In this brief review I will consider some of the responses required to these challenges in relation to (i) increasing participation in agricultural education, (ii) the structure and content of courses, and (iii) the provision of resources for agricultural education. I will focus mainly on post-secondary agricultural education and within that sector, mainly on University education.

INCREASING PARTICIPATION IN EDUCATION OR REVERSING THE BRAIN DRAIN FROM AGRICULTURE

Despite the importance of agriculture in the Australian economy and despite our standing as efficient agricultural producers, there is a brain drain from agriculture. Enrolments in agricultural science and agribusiness in Australian Universities and Agricultural Colleges are low and enrollees are not generally the highest school achievers. Very few owners, managers and operators of farms

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participate in tertiary education despite the complexity of modern agriculture and the enormous capital investment in farms. Only 25% of our farmers undertake education past Year 10 compared with 90% in the European Community and 50% in New Zealand and the United States. Only 7% of men and 10% of women from rural areas participate in higher education. The level of agricultural education in managers of industries servicing agriculture (for example, banks) is often quite low.

Why is there not greater participation in education in agriculture? There are several reasons. First, agriculture but perhaps excluding horticulture, is seen as a sunset industry rather than as a sunrise industry. However, agriculture has the characteristics of a sunrise industry: (i) high growth in productivity (3% annually over the last twenty years, (ii) flexible production techniques, (iii) diverse output patterns, and (iv) matching of relative availability (and cost) of land, labour and capital. The second reason is the view that agriculture uses "low technology" and is simple—this view has been fostered by a literary tradition in Australia which extends through "Such is Life" to "Dad and Dave" and which is represented currently by the New Zealand import, "Footrot Flats". The complexity of modern agriculture and the management and integrative skills required by farmers and professionals servicing agriculture are vastly under-estimated.

The third reason limiting agricultural education is the low renumeration in agriculture relative to other similar skill levels in other sectors. The final reason is that while the Australian community has always been largely urban based, there are now relatively fewer urban based people in Australia with close connections with agricultural production.

There needs to be a concerted effort by all sectors of primary industry (producers, processors, professional associations, farmer organizations, academic institutions) to change these perceptions. Some activities that are desirable are (i) "Science in Agriculture" symposia aimed at secondary school teachers and students, (ii) vacation scholarships within academic institutions for upper school students, (iii) industry-funded scholarships to attract high quality undergraduate and post-graduate students, (iv) greater emphasis of achievements in agriculture than on its failures by all involved, (v) greater emphasis on education by producer organizations, and (vi) attempts to gain greater renumeration.

Agricultural education is provided in several institutions (secondary schools, TAFE, Colleges of Advanced Education and Universities) to train quite distinct groups (farm labourers, owner-operators of farms, farm managers, managers in agribusiness, agricultural scientists and agricultural economists). There has been in some instances unhealthy competition between sectors with "academic creep" and the self-proclamation of "centres of excellence". I agree with Smith (1988) who has suggested that there should be a simplification of post-secondary awards in that there are "certificates for skills, diplomas for skills with supporting knowledge, bachelor degrees for knowledge with some skill component, masters for analysis and integration of knowledge and doctorates for research training".

One major problem in agricultural education in Australia is the difficulty in a student transferring between the different sectors. It is difficult to see a solution to this because of the clear differences in the direction of the courses offered in each sector. The need to transfer between sectors frequently arises because of students choosing courses which do not meet their goals. Institutions have a responsibility to be explicit and accurate as to the employment of graduates of their courses.
WHAT SHOULD BE TAUGHT?

There are several key issues and much confusion regarding them.

The first of these issues relates to views regarding theory and practice. It is almost impossible to reach "practical agriculture" other than by developing skills to perform particular tasks (for example, shearing). What can be developed through agricultural education is an ability to examine information critically and an ability to integrate this information into production and processing systems. The much needed flexibility in agriculture comes from these abilities and an understanding of underlying processes (that is, theory). Change in agriculture is extremely rapid, which means that education must develop attitudes and approaches rather than merely transmit practical or theoretical information. Education within tertiary institutions must be regarded as preparation for subsequent vocational training and professional development. Nevertheless, the training within tertiary institutions must encourage professional skills in communication and in dealing with people.

A second major issue is the question of generalization compared to specialization. I do not favour much specialization in the first degree, but consider that specialization is best gained in courses or research degrees as post-graduates. It is only possible within a four year degree to provide both an adequate discipline base in the sciences and economics, and sufficient breadth in animal science, soil science and plant nutrition, and agricultural economics to enable the essential integration required by agriculturists. If the need to develop skills in communication, numerical analysis, extension and research is added, there is indeed a very full curriculum. Thus I do not believe it is possible to provide specialization in one or more of the disciplines underpinning agriculture within the undergraduate degree, which is generally four years. I also consider that it is not possible to train environmental scientists adequately at a bachelor's degree level (as defined by Smith 1988) in a three year degree.

A third issue relates to the training of environmental managers and scientists. A recent review of training in land management by the Rural Development Centre at the University of New England concluded that training in this area should not be within Faculties of Agriculture because of the orientation of these faculties to production. I do not agree with this view, nor the reasoning behind it. Our aim should be to develop sustainable productivity in which production efficiency and resource maintenance are considered together. The scientific and economic discipline base for both efficient production and resource maintenance is the same at the undergraduate level. Different specialist skills may be required and these should be developed at the post-graduate level or in professional training by employers.

A fourth issue relates to the teaching of new technologies. For example, genetic engineering, cell micropropagation, embryo transfer and storage cell receptor manipulation, computer technologies, sensor technologies, mechatronics and material science have been identified as technologies with widespread application in agriculture. The discipline base of these technologies does not lie within existing Faculties of Agriculture. It is also not appropriate or possible to develop these discipline bases within Faculties of Agriculture. It is, however, essential that there be close association between Agriculture and these discipline bases within computer science, molecular biology and engineering. This is required both to make agriculturists aware of the possibilities and to orientate the new technologies to worthwhile applications in agriculture.

A fifth issue relates to the burgeoning area termed "agribusiness". Agribusiness was defined by Davis and Goldberg (1957) as "the sum total of all the operations involved in the manufacture and distribution of farm supplies; production operations on the farm; and the storage, processing and distribution
of farm commodities and the items made from them”. As such, agribusiness involves professional training in engineering, agricultural science, agricultural economics (including farm management), commerce (marketing, accounting) and food and fibre technology. No wonder it is difficult to teach agribusiness in a three year degree. Fairnie (1989) suggests that "agribusiness is a professional description" and "in agribusiness one may come into the profession via marketing, finance or economics". Towns and Anderson (1989) claim that the curriculum offered in agricultural education is one hundred years out of date because it is based on a production model, and suggest that a new model needs to be developed "which is able to solve the problems of over-production and environmental issues, and most importantly to contribute to the increasing needs of a broad spectrum of agribusiness". This view, along with many other statements in their article, is naive and completely ignores the interdisciplinary focus of a good training in traditional agricultural or horticultural science.

I believe the needs of agribusiness can be met by existing traditional professional training. For example, skills in marketing and accounting can be obtained after an orientation towards sustainable agricultural production has been gained in traditional courses. Alternatively, an orientation towards agricultural production and processing can be obtained after completion of a traditional commerce degree. There may also be scope to develop closer links between existing courses in agriculture and commerce.

While there appears to be a headlong thrust to foster agribusiness education, education in farm management appears to me to be languishing. Courses which combine education in production agriculture together with the skills of farm management have been replaced by agribusiness courses. Other current deficiencies in Australian agricultural education include the areas of pasture agronomy, soil and water management within production systems and the science and technology of processing of agricultural products (for example, wool and meat).

PROVIDING THE RESOURCES FOR AGRICULTURAL EDUCATION

Because of their wide discipline base, education in agricultural science, veterinary science and medicine are more expensive than many other sectors of education. Paradoxically, medical education appears to be less expensive than either agricultural or veterinary education because of the provision of discipline base and resources through teaching hospitals and clinics. How can this discipline 'base for agricultural education be provided economically? First, in a similar way to medicine, closer links should be developed between Universities and institutions such as CSIRO and Departments of Agriculture with options such as (i) joint appointments, (ii) secondments and (iii) co-location of institutions. Second, there should be a sharing of academic staff between institutions offering certificates, diplomas and degrees. Third, at least for post-graduate education and perhaps for undergraduate education, there will need to be some concentration of effort with students being required to transfer between states for a particular specialization. Can we justify four Faculties of Agriculture within one state?

Underwood (1973) considered that a "University has not only to teach; it also has to learn. It has a duty to enrich, as well as to transmit and conserve knowledge". Recent trends in the funding of rural research are making it more difficult for academic institutions to meet Underwood’s requirements. The increasing importance of rural industry research funds and their greater emphasis on applied research and demonstrations, coupled with a Government wish to strengthen research and development for the manufacturing sector -at the expense of that for the primary sector, has led to decreased research in on strategic and fundamental aspects of agriculture, particularly in Universities but also in CSIRO. There has been an erosion of our scientific capital. It is pleasing that in the recent call by the Australian Research Council for
applications for special centres, there is a priority area, "Enhancing the Nature and Potential of the Primary Industries". Rural industry research funds have contributed markedly to University education by providing support for academic appointments (for example, in Pig Meat Science at Melbourne University and Pasture Production and Utilization at The University of Western Australia) and by offering post-graduate scholarships with realistic stipends.

CONCLUSION

Agricultural education is facing many challenges. In a Graduation Address, Gladstones defined four levels of knowledge. The lowest level was basic facts or of data which purports to represent facts. The second level is information that is organized facts. The third level was understanding, which Gladstones perceptively pointed out cannot be transmitted and requires a good knowledge of surrounding fields. He concluded that "over-specialization is the enemy of understanding". The fourth level of knowledge is wisdom which Gladstones considered to have two components — first, that "all decisions are governed by ethical and moral concerns" and second, there is "great breadth and depth of understanding based on a lifetime of experience, study and reflection". I believe the greatest challenge in agricultural education is to develop understanding and wisdom in the products of that education. Understanding and wisdom can be gained throughout professional careers if the ground is fertile.

REFERENCES

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