

AGRICULTURAL PLANTS IN THE VICTORIAN ENVIRONMENT*

INTRODUCTION

Man is dependent on plants to provide most of his food and fibre. Plants, or parts of them, may be eaten directly by man or they may supply feed for livestock which, in turn, give food products. In either event, plants are initiators of the food chain. Although a small proportion of man's food comes from the sea, the bulk of it is derived from the land through technologically advanced agricultural production.

The agricultural plants consumed more or less directly by man may be broadly classified as follows:

- (1) Grains and seeds: cereals, e.g., wheat, oats, maize, barley; oilseeds, e.g., sunflower, rapeseed; and legumes, e.g., peas, beans (mature);
- (2) vegetables (some of which are really fruits or immature seeds); or
- (3) fruit.

In some cases, such as wheat for bread, there is a significant processing stage involved, but there is no intermediate animal phase.

The agricultural plants providing feed for livestock may, furthermore, be broadly classified into:

- (1) Forage plants: pasture legumes (clovers and medics) and grasses; also fodder crops (e.g., rape, oats, sweet sorghum); or
- (2) grains and seeds: whole grain/seeds or by-products (e.g., bran, sunflower meal) of human food preparation.

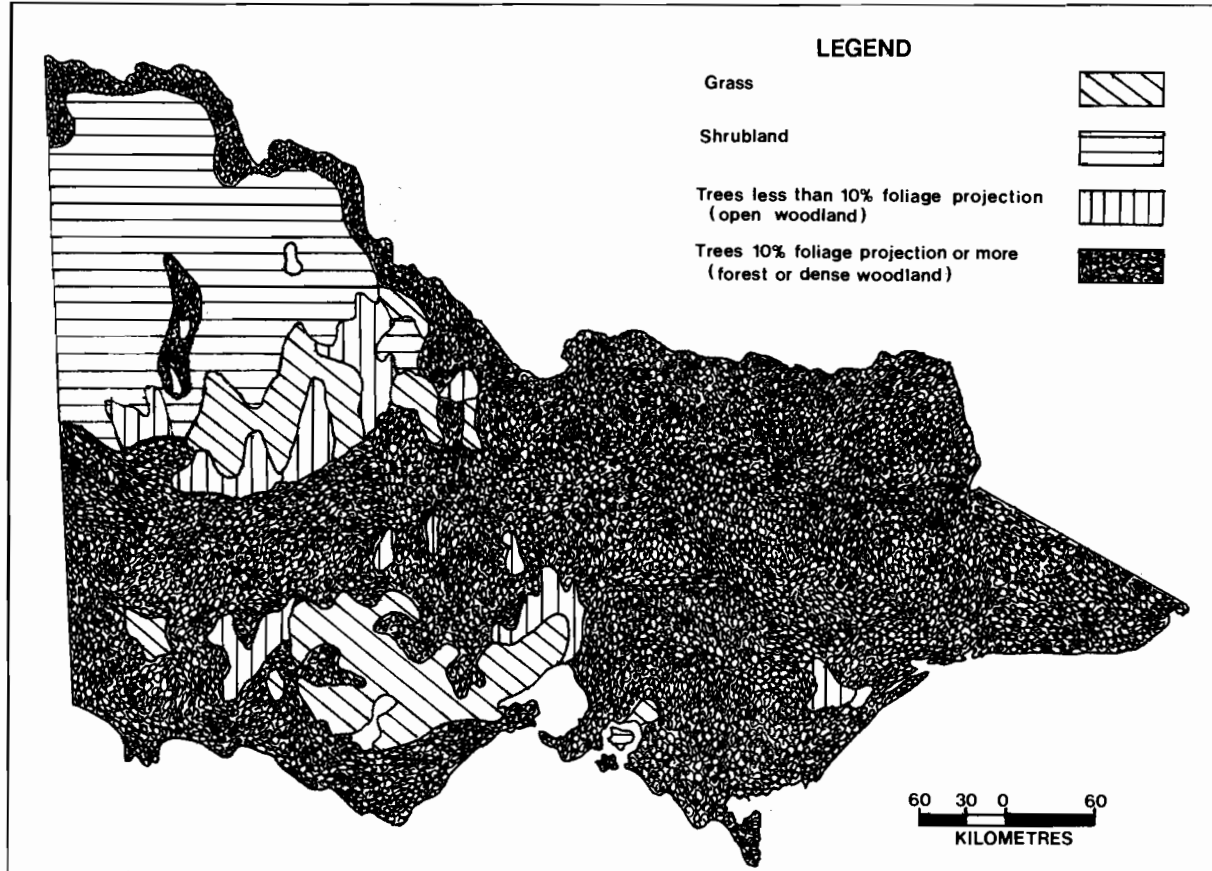
The livestock products derived from these plants and used as human food include milk, meat, and eggs. But livestock also yield materials for clothing, blankets, and home furnishings, mostly through wool for woollen garments and hides for leather footwear, coats, and belts.

Grasses and legumes feature prominently both as pasture plants and field crops, but field crops also include many other diverse species and plant families. Similarly, vegetables and fruit trees are drawn from a very wide range of species and families.

All these plants perform a host of biochemical processes that ultimately give man his food needs. The foremost of these processes is photosynthesis which captures the energy of sunlight to make carbohydrates from carbon dioxide and water. Simple carbohydrates are gathered into the more complex disaccharides such as sucrose, and polysaccharides such as starch, while conversion of the products of photosynthesis into various oils and acids may also occur in particular tissues. Many of the more complex carbohydrates and oils are stored in parts of the plants such as roots, tubers, and seeds which are harvested by man.

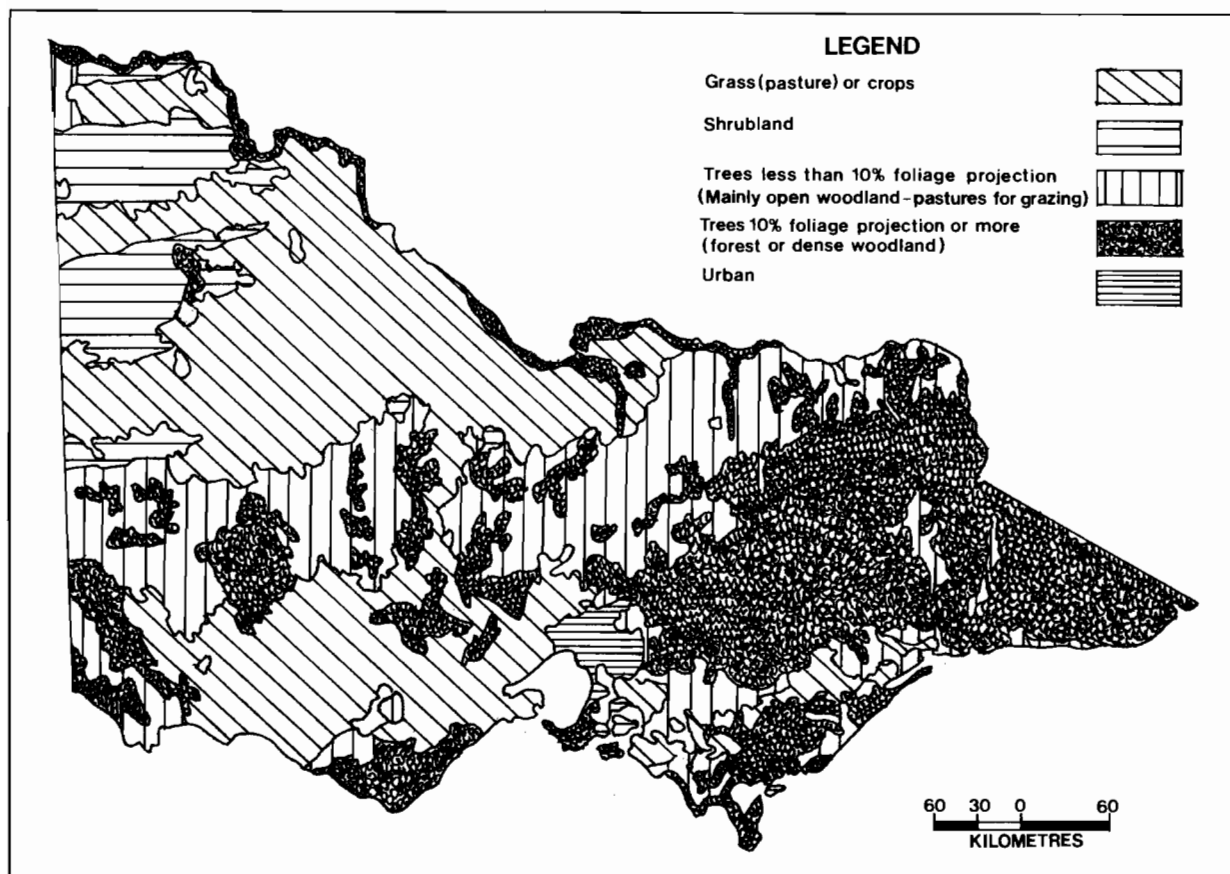
In addition, the uptake of nitrate and ammonium ions by plant roots can result in combinations with photosynthates to produce amino-acids, the building blocks of proteins. In the case of legumes (clovers, medics, peas, beans), the initial source of nitrogen is often the air, since these plants harbour bacteria in the nodules of their roots which can "fix" atmospheric nitrogen for use ultimately in protein synthesis. The benefits of the

* This is the eighth in the series of special articles on Victoria's environment and man. Previous articles have appeared in Chapter 1 of the *Victorian Year Book* since 1976.



Source: Forests Commission, Victoria

FIGURE 1. Victoria—Vegetation prior to European settlement.



Source: Forests Commission, Victoria

FIGURE 2. Victoria—Vegetation in 1980.

biochemical capabilities of plants flow on to the dependent animals and man. If there is a starting point anywhere in the food cycle, it is in the cells of the leaves of plants.

Before European settlement in Victoria, the area now covered by the State was mostly a forest, but with some tracts of open grassland and some areas of savannah woodland where forest and grassland met. Today, large areas of Victoria are under sown (or improved) pastures, crops or fallow. The contrast between the "then" and "now" conditions is depicted in the two maps shown as Figures 1 and 2 on pages 2 and 3, respectively.

The main form of present day agricultural land use in Victoria is sown pasture (44 per cent of total area of agricultural holdings in 1977-78). The area so used has increased from about 0.4 million hectares in 1921, to 0.9 million hectares in 1935-36, 2.1 million hectares in 1947-48, 4 million hectares in 1960-61, to 6.2 million hectares in 1979-80. This pasture, along with "native" pasture, is grazed by dairy and beef cattle and by sheep.

An indication of the advancing area and particularly quality of pastures in Victoria is given by data on the numbers of sheep and milk cows in Victoria as shown in Figure 5 on page 8. Although these pasture improvements have produced spectacular increases in the numbers of livestock carried, the total area of agricultural holdings has changed little in the past 75 years, being around 15 million hectares (including Crown land under lease).

The principal crop grown in Victoria today is wheat, occupying more land (1 to 1.4 million hectares) in recent years than all other crops (excluding pasture cut for hay) combined. The areas sown each year and annual productions of wheat since 1840 are illustrated in Figures 3 and 4 on pages 5 and 7, respectively. Furthermore, Figure 7 on page 10 shows, for the various statistical divisions, the area of wheat as a percentage of the total agricultural/pasture land for 1978. The dominance of wheat in the Mallee-Wimmera districts is indicated. The transport of wheat from the major cropping districts to Melbourne and to ports has been greatly dependent on the Victorian railways network, the development of which is presented in Figure 8 on page 11.

Victoria has always been to the fore, relative to the other States, in regard to irrigation development. Land-use under irrigation is depicted in Figure 9 on page 12. Perennial (spring-summer-autumn irrigated) and annual (autumn and/or spring irrigated) pastures are the main forms of irrigated land-use, these pastures having increased rapidly from 1930 to 1970. The data refers only to land supplied with water for irrigation by the State Rivers and Water Supply Commission. Small areas are also supplied from other sources, e.g., Melbourne and Metropolitan Board of Works, and private catchments.

The value of production of all agriculture in relation to time since 1840 has been estimated by the Department of Agriculture and is demonstrated in Figure 6 on page 9. The values are expressed as 1980 dollars and they are "local values", i.e., gross values on the farm less marketing costs. Over the years, significant proportions of these values have become export earnings when the produce was sold on the markets of the world.

The agricultural plants that have sponsored these large levels of production are set out in more detail in the succeeding sections within the four categories: (1) Field crops; (2) Pastures; (3) Fruit crops; and (4) Vegetables.

FIELD CROPS

General

Field crops are those plants grown from seed and harvested for their mature seed or grain yield after six to eight months growth. The term refers to the form of agriculture, i.e., extensive, usually dryland production on plains or slightly undulating country, as much as it does to specific crops. The cereals, oilseeds, and grain legumes are all field crops. In terms of total area, production and value, field crops represent a major form of agricultural production in Victoria.

Some field crop products, including wheat grain, were frequently imported into Victoria until the 1870s but wheat production reached self sufficiency by 1880, despite a population increase from 10,000 to 850,000 persons in 40 years. By 1900, wheat exports amounted to about one-third of annual production, a trend interrupted only by the two world wars. At the present time, wheat exports from Victoria usually exceed two-thirds of the annual production.

The transformation of a domestic based agriculture to an export industry was the outcome of an expansion of cropping into the mid-north, the Wimmera, and the Mallee between 1860 and 1910, as well as a general increase in crop yields in the past fifty years. The table below indicates this yield trend. Although the area cropped to wheat has been steady since the 1930s, wheat yields (weight of grain per unit of area cropped) have increased.

The underlying basis for area and production increases since 1860 has been the successful negotiation of three basic requirements for a stable agriculture: understanding the environment, farming within the constraints of this environment and, where possible, modification of the environment.

**VICTORIA—WHEAT YIELDS BY
DECADES, 1870-1879 to 1970-1979**

Period	Mean yield per annum (tonnes per hectare)
1870-1879	0.86
1880-1889	0.67
1890-1899	0.54
1900-1909	0.65
1910-1919	0.80
1920-1929	0.89
1930-1939	0.91
1940-1949	0.88
1950-1959	1.36
1960-1969	1.44
1970-1979	1.64

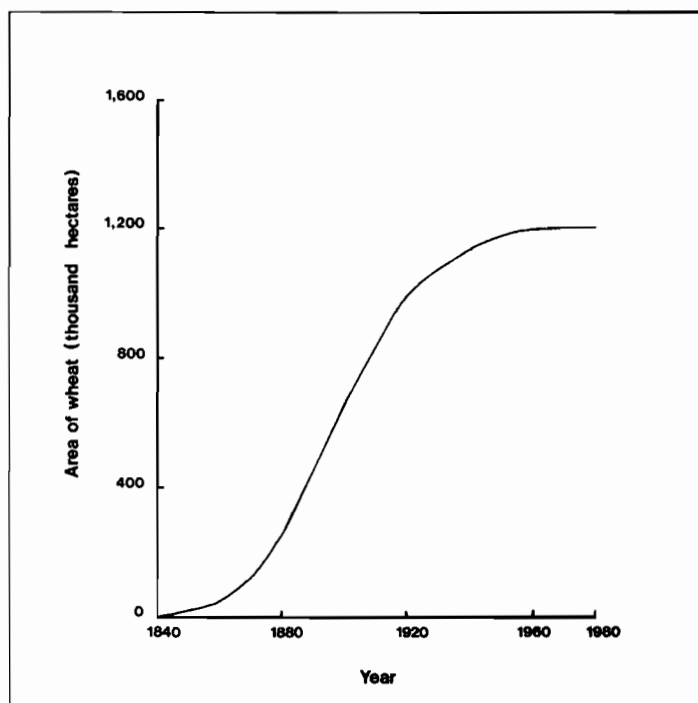


FIGURE 3. Victoria—Area of wheat, 1840 to 1980. (This is a “smoothed” trend line which ignores large changes. The era of increasing area—1860 to 1930—was followed by a period of more stabilised area from 1940 to 1980.)

**VICTORIA—SEED YIELDS OF SELECTED FIELD CROPS BY DECADES,
1870-1879 to 1970-1979
(tonnes per hectare)**

Period	Barley	Oats	Ryecorn	Maize	Millet	Linseed	Sunflowers
1870-1879	1.15	0.86	0.86	1.21	—	—	—
1880-1889	1.03	1.00	0.92	2.83	—	0.28	—
1890-1899	0.96	0.88	0.95	3.27	—	0.31	—
1900-1909	1.17	0.95	0.95	3.72	—	0.38	—
1910-1919	1.17	0.77	0.75	2.78	(a)0.82	0.47	1.05
1920-1929	1.25	0.68	0.84	2.49	0.81	—	1.05
1930-1939	1.01	0.59	0.64	2.08	—	0.37	(a)1.04
1940-1949	0.89	0.59	0.43	2.45	—	0.18	—
1950-1959	1.14	0.79	0.45	3.00	—	(b)0.65	(a)0.64
1960-1969	1.19	1.08	0.44	3.56	1.20	0.82	(a)0.78
1970-1979	1.20	1.21	0.51	3.80	1.38	0.97	0.75

(a) An 8 or 9 year average because of missing data.

(b) Flax production ceased in the early 1950s. The linseed component of flax growing was then supplied by varieties bred especially for seed yield.

Understanding the environment

In the earliest days of permanent settlement in Victoria the attraction of the Port Phillip District was its proximity to Launceston and the expectation of a similar climate in which to raise stock and grow crops. Wheat production was emphasised, the outcome of settlement by predominantly British persons for whom wheaten bread was a dietary staple. Successful wheat production was one measure of prosperity.

Southern Victoria was a fortunate choice for settlement. The higher rainfall and longer cooler spring of coastal districts, although still unsuited to the late maturity wheats upon which the settlers depended, were more favourable than elsewhere in the Colony.

When expansion of wheat growing into the drier inland area was attempted, the inadequacy of the varieties became obvious. By 1857, Victoria was producing only 10 per cent of local flour requirements and wheat imports from Adelaide, San Francisco, or Chile supplied the bulk. A tentative attempt to grow wheat in the Wimmera failed, and it was concluded that the country was too poor for the purpose.

In one of the fortuitous events which re-occur in the history of agriculture, the increasing pressure to feed an expanding population was alleviated by a farmer's selection, in South Australia, of the variety Purple Straw. At this time, little attempt was made by farmers to keep wheat varieties pure. The growth response of mixed plant populations in a harsh environment could offer the observant farmer the chance to select those plants performing better than others. Purple Straw was the first and most important of the wheat selections, establishing a method which was to be repeated for the next 40 years. It was a major advance, as wheat production from Purple Straw was to assist an expansion into the Wimmera, Northern Districts and, later, the Mallee. Even so, some measure of the seasonal hazards and yield failures can be gauged from the fact that Purple Straw wheats ripen about six weeks later than current varieties.

Hugh Pye, the Principal of Dookie Agricultural College and Victoria's pioneer wheat breeder, encouraged farmers to select wheat varieties. Pye wrote in 1897: "It is quite within the power of every farmer to produce a wheat of a high standard by selection; and this is the method I would recommend every farmer to pursue, not only from its simplicity, but from its effectiveness. All he has to do is to keep in view the type he wishes to work to, and select those plants with head and straw approaching nearest to those of the standard type."

Farmers were to benefit from the same process applied to other field crops. A farmer's selection from the English barley variety, Chevalier, became Prior. By 1919, Prior was recommended for the drier areas of Victoria. It remained the major malting variety until the 1960s. Another example is the field pea variety Dun, a selection from English introductions; it has retained its position as the principal variety grown in Victoria since 1880.

The "Age of Optimism" which characterised the 1880s was a time of both solid gains and fuzzy assumptions about the limits to agricultural production. While the geography of the cereal districts assumed the proportions known today, the objective assessment of

Mallee soils and rainfall data was still to be collected. Purposeful crop improvement required a realistic assessment of the environment before consideration could be given to the "blue print" of the variety required to match the environment. In one sense crop selection was the acceptance of plant types revealed by the season, useful as a technique because of the "raw" conditions of farming, but limited by the probabilities of the chance encounter between the farmer and a singular plant type.

As late as 1898, the *Government Handbook of Victoria* in a chapter entitled "The Genial Climate" described winter in Victoria as "... merely the season in which there is more rain or less heat than in summer". Such loftiness could be excused as promotion to attract investment and more settlers to the Colony, but it was no basis for determining a variety "blue print". At this time, Pye was engaged in a wheat variety improvement programme utilising crossbreeding and backcrossing techniques. He was corresponding with William Farrer and testing the progeny of Farrer's experiments in cross breeding. When Farrer released Federation in 1901 the age of scientific wheat breeding was at hand.

Working within the constraints of the environment

By the 1890s, a definition of the environment for crops, expressed in terms of effective rainfall and soil type classification, was still to come, but Pye, Farrer, and the other cereal breeders appointed by State Governments had seen enough of drought, the effects of stem rust, and millers' problems with poor quality flour to identify their objective. The country best suited to extensive crop production had a rainfall pattern constraining the growing season to the months from May to October. A crop plant, whatever other virtues it may have, had to be capable of utilising soil moisture in late spring for filling grain. The ripening and hardening of the grain would then occur as the soils dried out with the onset of summer.

In selecting the parents for the crossbreed which was to become Federation, Farrer attempted to combine the high yield from a Purple Straw selection, the short, strong straw

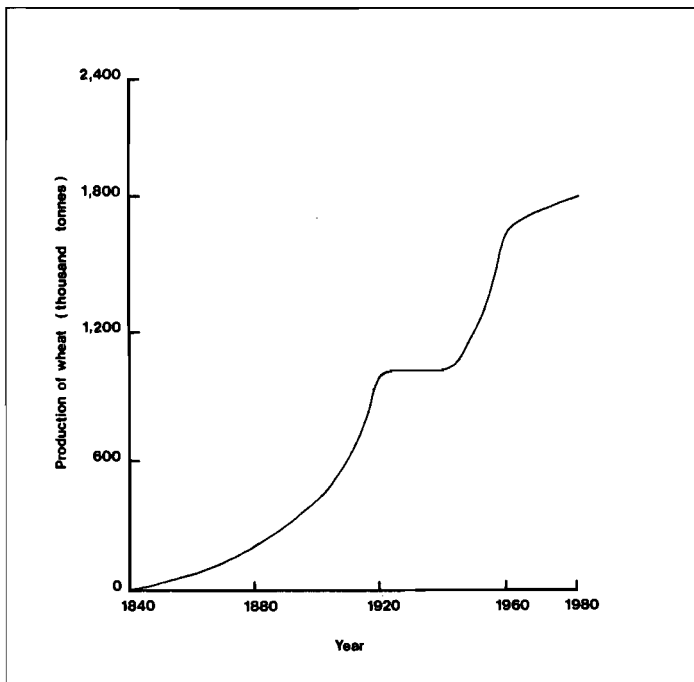


FIGURE 4. Victoria—Production of wheat, 1840 to 1980. (A series of events and problems have prevented the production curve fitting the area curve [Figure 3]. The check to production increase shown for 1920 to 1950 was primarily due to soil erosion and declining fertility, the Depression, the Second World War, rabbits, and the 1943 to 1945 droughts.)

and earliness of an Indian variety, and the flour quality of an American variety. The outcome, while offering no improvement in flour quality or disease resistance was everything that could be wished for in terms of yield and ease of harvesting. The success of Federation was a stimulus to purposeful wheat breeding. With this variety Farrer defined the wheat "blue print" for Australia. The work ahead for plant breeders was to choose other parents, cross them, grow the progeny for a number of generations, and then select plants conforming to the desired type.

The establishment of a Wheat Improvement Committee in 1908 had a lasting influence on the direction and methods adopted for field crop improvement. The Committee consisted of three senior scientists from the Department of Agriculture and Hugh Pye from Dookie Agricultural College. Land was set aside for regional variety testing of the output from the breeding programmes. In 1912, Pye released Currawa which, although overshadowed by the success of Federation, was both an important variety at the time and the forebear of Ghurka, Quadrant, and Insignia. The release of Ghurka in 1924 was the first incorporation of disease resistance (in this case flag smut) in a wheat variety.

The successive broadening and strengthening of wheat improvement remained faithful to the spirit and the goals set by the initial Committee. Pye wrote: "It is possible, in the course of time, to divide the wheat growing areas of Australia into zones, wherein the limits of certain types of wheat could be marked, as a guide to farmers and millers; and should necessity arise, it is possible that the wheatgrowing area may be increased, by knowing that a certain wheat will give a profitable return in a district supposed not to be a wheat-growing one."

"The millers could take advantage of the above mentioned chart in selecting wheats for blending purposes . . .

"It is possible that some favoured districts may grow many types of wheat with profit, whereas other districts may have their choice limited, and it is an advantage to know this."

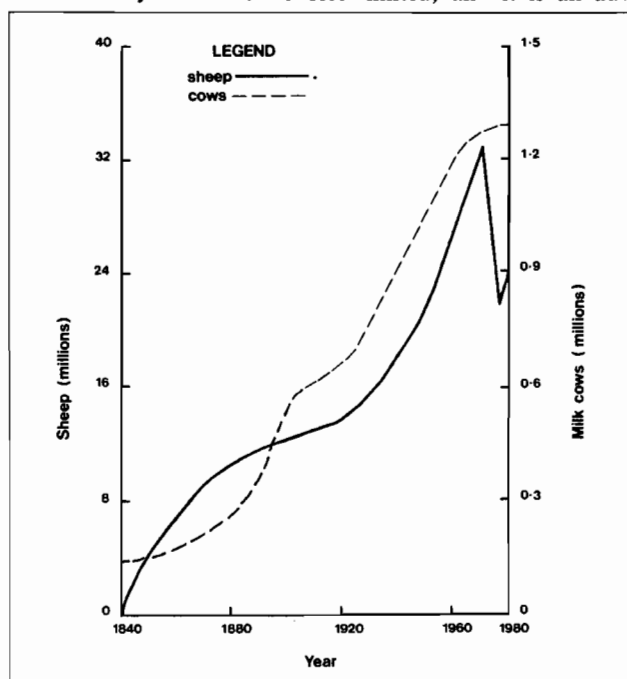


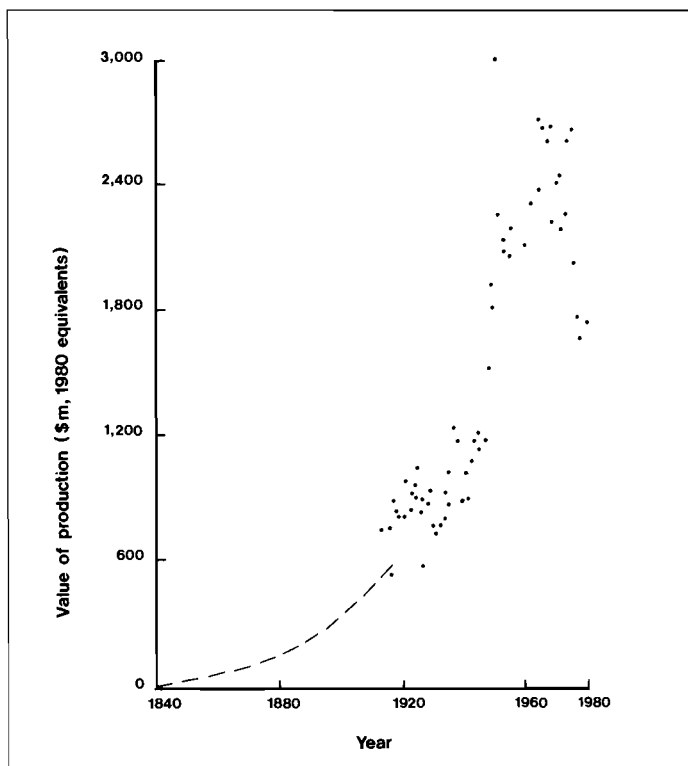
FIGURE 5. Victoria—Number of sheep and milk cows, 1840 to 1980. (These are "smoothed" trend lines which ignore fluctuations occurring year by year due to drought, wet years, and market changes. The sharp decline in sheep numbers after 1970 was partly due to a recession in wool and sheep-meat prices. Recovery commenced in 1978. Data collected March each year. "Milk cows" includes springing heifers.)

This visionary approach was the basis for wheat variety recommendations according to silo groupings across Victoria, but it was to take nearly 60 years before it was implemented.

After the demonstrated effectiveness of crossbreeding techniques, crop selection as a method of yield improvement was seen as a spent force. A diversity of research techniques has ensured that crossbreeding has maintained its impetus to the present day. Until the 1960s the recommended wheat varieties were usually all related to a few common grandparents.

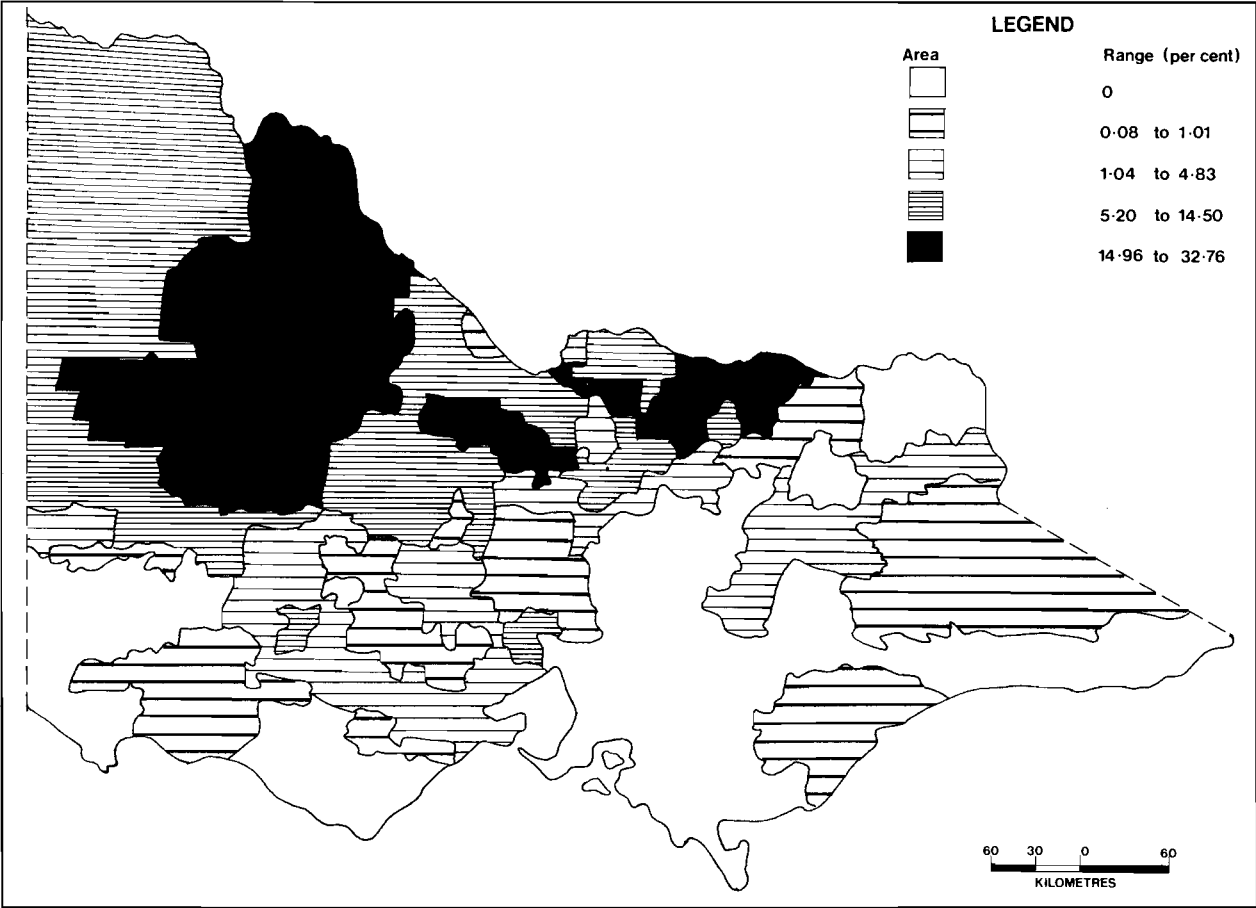
The introduction of "semi-dwarf" crossbreds from the International Maize and Wheat Improvement Centre in Mexico, commonly known as CIMMYT, made new germ plasm available to wheat breeders. The classic Victorian wheats are short by world standards, but tall by comparison with semi-dwarfs. The short growth habit of the introductions is the most recent progression in adapting the wheat plant to give up more of its total growth as economic yield. Semi-dwarf wheats crossed to Australian varieties now constitute 60 per cent of the wheat variety sowings in Victoria.

The scale of the wheat industry is unique amongst the field crops and the exemplary model of crop adaptation. The economic gains and community sense of well being from wheat production warranted perseverance by farmers and later by plant breeders. Their gains spurred further efforts. The other field crops considered important by the early settlers were also the beneficiaries of this effort. The adaptation of barley and oats is a parallel story on a smaller scale.



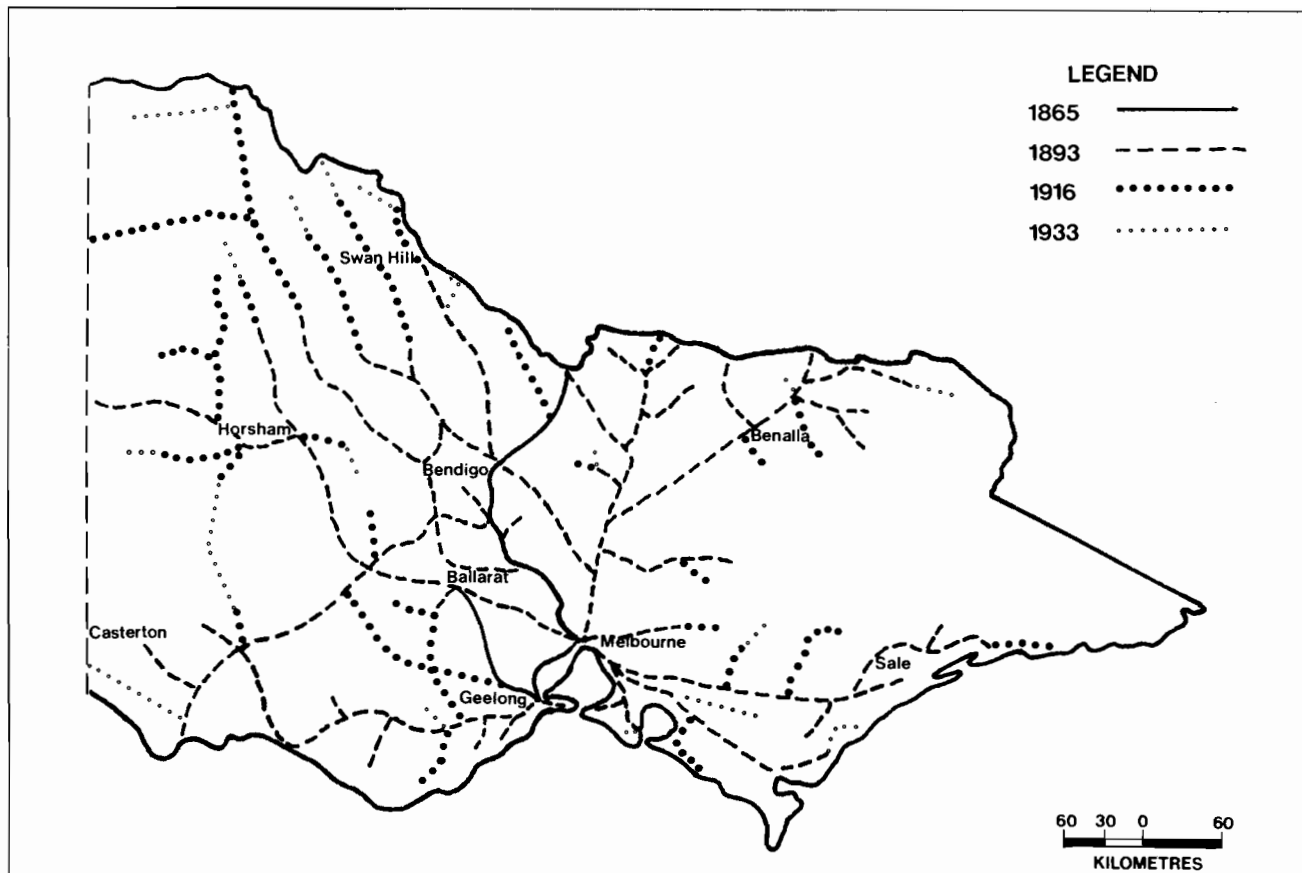
Source: Department of Agriculture

FIGURE 6. Victoria—Value of agricultural production, 1840 to 1980. (The values given are "local values", i.e., gross value on the farm less marketing costs. Many commodity prices have fallen, relative to the general economy, in the past few decades. This was a major factor in the decline in the value of production [1980 dollars] in the mid-1970s. It does not indicate a significant decrease in the *quantity* of production. All values for individual years have been converted to 1980 dollar equivalents.)



Source: Dr J. Massey and J. S. Poliness, University of Melbourne

FIGURE 7. Victoria—Area of wheat for grain as a percentage of total agricultural and pastoral land, 1978.



Source: Victorian Railways

FIGURE 8. Victoria—Development of railway system, 1865 to 1933.

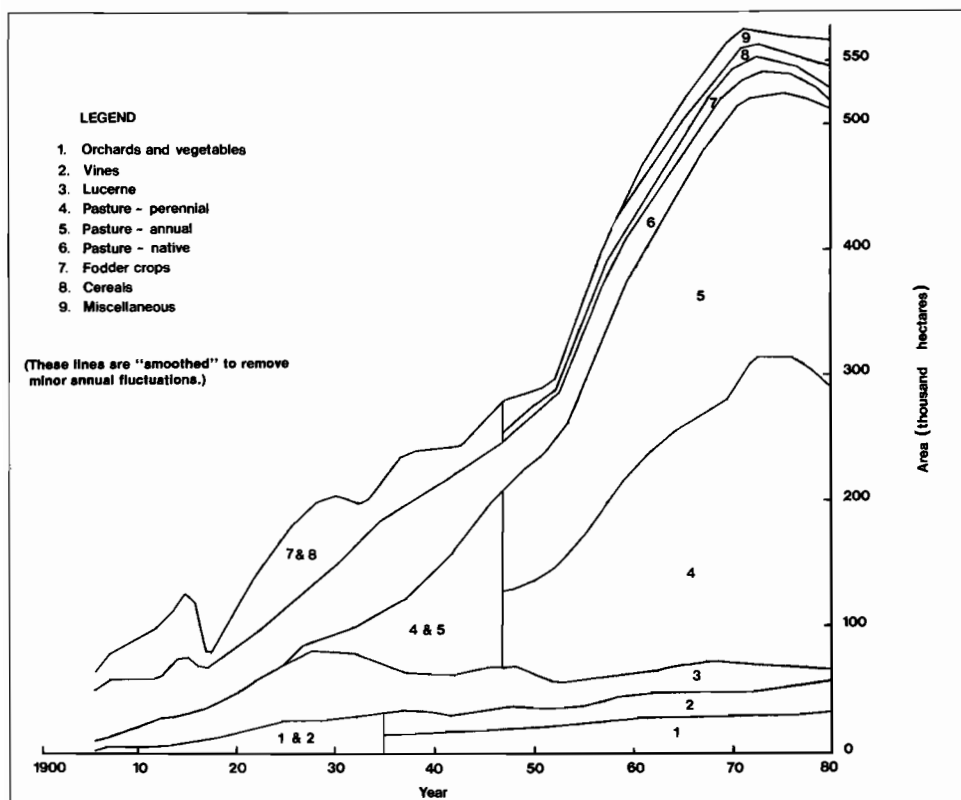
Some crops languished, either because concerted effort was not considered worthwhile, or because the plants proved intractable to improvement either by selection or breeding. Field peas and ryecorn and safflower may be in this category. When little effort has been expended it is not always clear just what has been the impediment to progress.

Renewed interest in maize, sorghum, millet, and sunflowers as irrigated crops in northern Victoria is a recent development. As the table on page 5 suggests, the production of maize in Victoria extends back to the times of earliest settlement but the adaptation of modern maize varieties, and other summer crops, is closely linked to uniform ripening and plant size achieved by the use of hybrid seed. The crossbreeding techniques employed with winter cereals and rapeseed produces seed which breeds true to type, but the basis of hybrid seed gives a once only vigour and requires annual seed purchases. The competition between seed companies each with a range of hybrid summer crops is likely to accelerate progress.

Rapeseed is a new winter oilseed crop in Victoria. A rapeseed breeding programme was initiated in 1973 after introduced varieties from Canada and Europe proved to be only moderately successful. The variety Marnoo was the outcome of the same processes by which Farrer and Pye studied the environment to learn what was required of a crop plant, then chose parents which could give the progeny the best chance of surviving in that environment. In Marnoo, a high yield is matched with an oil quality superior to the standard demanded in world trade.

Modification of the environment

The release of the wheat variety Federation and the impetus to crossbreeding of crop varieties which followed, coincided with the acceptance of a "fallow" period which



Source: State Rivers and Water Supply Commission

FIGURE 9. Victoria—Land under irrigated culture (water supplied by the State Rivers and Water Supply Commission), 1906 to 1980.

conserved winter rainfall for use by a crop the next season, and the application of superphosphate with wheat crops to ensure adequate phosphorus nutrition for the crop.

The significance of these cropping practices was profound. Together they reversed the trend of declining wheat yields evident since 1880, by changing the environment slightly to suit the crop. An extension of the same thinking was the integration of pastures into the cropping system in which several years of pasture then alternate with two or three crops. Annual clover and medic based pastures were utilised for their ability to "fix" atmospheric nitrogen in the soil, in a form available to crops. The legume pastures and the dual role for superphosphate in both pasture and crop nutrition overcame the key nutrient deficiencies of nitrogen and phosphorus. The improvement in plant nutrition is considered to be the most important factor contributing to improved crop yields in the past 50 years. The increases in protein content of grain as measured in wheat deliveries since 1946 are another benefit of the integration of pastures with cropping.

The other important modifications to the environment resulted from changes in the mechanical "hardware" of farming. Timeliness of sowing, weed control, and harvesting can be crucial to achieving high yields. The timeliness factor is related to the scale of farming, the size of implements, and developments in chemical weed control.

Taken overall, the contributions from plant breeding, mechanisation, and soil fertility improvements in raising crop yields are considered to be of equal value. When field crop production is further modified by irrigation, the single most vital limitation to crop growth, available moisture, is brought within the farmer's control. Higher inputs of fertiliser, increased seeding rates, and changes of variety are often required to realise the potential of the new environment. Correctly managed, irrigation farming can triple the dryland yields of wheat, barley, and some other field crops.

Developments

New ideas for the modification of cultivation are bringing changes to crop management which may in turn require further subtle refinements of the Farrer model for an adapted crop. Recent advances in cytogenetics suggest that the horizons for both yield and grain quality improvement in most field crop plants are widening. It is salutary to remember, however, that the origins of the most recent developments now widely accepted, i.e., semi-dwarf wheats as crop parents, and the creation of new species by the crossing of different crop genera, were known to Farrer and Pye, but the initiatives of their day lapsed because the objectives of the time were achieved by simpler means.

The most recent advances in genetic engineering aside, the difference between the efforts at crop adaptation in the last century and this is essentially one of degree. The extent of international co-operation is a good example. The CIMMYT project in Mexico uses a very large area each year for variety testing and new breeding material is then distributed throughout the world to plant breeders.

PASTURES

General

The two major limiting factors for plant growth in the Australian environment are low natural soil fertility (mainly a lack of phosphorus and nitrogen) and low rainfall. Both factors greatly restrict the growth of pasture plants and have profoundly influenced the characteristics of the native pasture plants that developed in Australia.

The pasture plants that the first settlers found in Victoria were well attuned to their environment. After thousands of years of natural selection they were well equipped to survive under the prevailing conditions of low soil fertility, periods of drought, and light grazing by kangaroos and wallabies. These native plants included kangaroo grass (*Themeda australis*), wallaby grasses (*Danthonia* species), and spear grasses (*Stipa* species). There were no pasture legumes (clovers, trefoils, etc.) in Victorian native pastures.

Although well equipped for survival in the conditions that existed before settlement, these native grasses had many limitations from the viewpoint of the newly arrived graziers. The main shortcomings were:

- (1) Low carrying capacity. Even the most productive native pastures could not carry more than about three sheep per hectare.
- (2) They did not persist well under relatively heavy grazing by sheep and cattle.
- (3) They could not produce much extra feed even if provided with fertilisers and/or irrigation.

Pasture improvement

To grow more feed for grazing animals it was necessary to improve the soil fertility and to introduce new pasture plants that could take advantage of this improved environment. Problems associated with this process of pasture improvement have exercised the minds of farmers and agricultural scientists over the last hundred years.

Man can do little to influence rainfall, but he can use what water is available most efficiently by storing surplus for irrigation, and this has been done in Victoria to some extent. However, compared with the rest of the continent, Victoria is well off for rain; its average annual rainfall ranges from about 250 mm in the extreme north-west of the State (cf. Birdsville 120 mm, Oodnadatta 110 mm) to more than 1,000 mm in some of the southern dairying districts.

Soil fertility is more amenable to manipulation than inadequate rainfall. Initially knowledge was gained by "trial and error" on farms, and later the pasture fertiliser needs were determined by pasture and soil research. Appropriate fertilisers supply plant nutrients that are inadequate in the various soil types for optimum pasture growth. Lime may be used to overcome soil acidity which renders some plant nutrients unavailable. The necessary rhizobium bacteria for healthy legume growth can be introduced by inoculating the pasture legume seed (e.g., clover, lucerne, etc.) before sowing. As well as providing feed for animals, growth of pasture also increases the level of soil nitrogen and organic matter and improves the physical condition of the soil.

In an attempt to improve their pastures the pioneers soon began to import seed of the pasture species which had already proved themselves in Britain. Having been grazed by sheep and cattle for hundreds of years, the European species had acquired the ability to withstand heavy grazing by these animals. The introduced species included what were to become some of Victoria's most valuable species—ryegrasses, white clover, cocksfoot, and red clover. The pioneers also introduced grasses such as Yorkshire fog grass, meadow foxtail, and sweet vernal grass, which subsequently proved to be much less desirable, usually being regarded as weeds in their new environment.

These new plants differed very much from the native species because they had developed in the markedly different environment of Northern Europe which has adequate moisture, very cold winters, mild summers, and more fertile soils. These conditions favoured the development of plants which grow well in the spring, summer, and autumn but are dormant in the winter (and so avoid being killed by frost and snow) and are not drought resistant by Victorian standards. Even now, in spite of natural selection in southern Australia for more than a century, they remain basically Northern European plants and their pattern of growth does not fit well into an environment where some winter growth is possible and lack of rain usually restricts growth in the summer.

In spite of these shortcomings the European pasture species are capable of producing much more feed than the native grasses as long as they are growing in a soil of improved fertility, and rainfall is adequate or irrigation is available. Although they grew well in the early years on naturally more fertile river flats and small areas of volcanic soil, none of these species were at first widely useful in Victoria because, even in the adequate rainfall areas, the soils at that time were too infertile to support them for long.

It was not until the beginning of this century that farmers and agricultural scientists began to realise that the key to pasture improvement in most of southern Australia was in fact very different: what was needed was to sow subterranean clover and apply superphosphate to the soil. Subterranean clover is one of many species that were accidentally introduced from the Mediterranean region, where it was not considered to be a pasture species of any note. It is an annual which germinates after the autumn rains and produces high quality feed during the autumn, winter, and spring. In the spring it flowers and sets the seed which will be the basis for its regeneration in the following autumn. Some of the seed is buried by the plant, hence the name "subterranean clover".

Subterranean clover was easy to establish on a variety of soils—the more difficult soils being left until research solved the problem in later years. It survived under heavy grazing and, with good management (which included the regular application of superphosphate), it persisted more or less indefinitely, although there have been various problems requiring research in recent years. The result has been the supply of large amounts of highly nutritious feed for grazing animals. Being a legume, its roots are inhabited by bacteria

(rhizobia) which extract nitrogen from the soil air and convert it into a form which is used immediately by the clover and eventually by the grasses as well. Grasses have no such direct assistance. Thus subterranean clover and other pasture legumes relieve farmers of the expense of regularly applying nitrogenous fertilisers to their pastures. This is a worthwhile saving.

Superphosphate was invented late in the nineteenth century, at about the same time as the virtues of subterranean clover were becoming recognised in Australia, but it was not until the benefits of combining the use of subterranean clover and superphosphate were discovered that pasture improvement began to be applied with any real success in Victoria. This became known as "the sub and super" story. It was the basis of successful pasture improvement over large areas of Victoria and adjoining States. Innovative farmers were improving their farm productivity by this method as early as 1900, but it was not until the 1920s that it became widely adopted. Since the 1930s, other fertilisers have been found to be necessary, in addition to superphosphate, for optimum subterranean clover growth on some soils.

When the clover had sufficiently enriched the soil with nitrogen the second step in pasture improvement became possible. This was the sowing of productive grasses such as ryegrass and cocksfoot (where summer rainfall was adequate) to produce a balanced mixture of clover and grass. Having reached this stage, it became possible for farmers to maintain a more or less stable mixture of these two components (grass and clover) by skilful management of the pasture and the grazing animals. Pasture production is now maintained by regular application of superphosphate, supplemented in some areas with potassium or trace elements (such as molybdenum and copper), depending upon the soil type and its level of fertility.

Thus, by the use of appropriate pasture species and fertilisers, Victorian pastures have been improved greatly in a relatively short time. Large areas of improved pasture were developed between 1920 and 1960. In more recent years the major effort has involved the problem of maintenance of productive pastures and their further development where possible. There is also scope for improvement of the remaining four million hectares of native pasture in the State. Research is now aimed at the solution of soil fertility problems, the development of varieties of pasture plants which are better than those presently available and the establishment of improved varieties in the State's current pastures. Protection of improved pastures from pests and diseases also requires further research. This work is described in more detail on page 25.

Progress to date has permitted large increases in the number of livestock carried, as noted on page 4 and as shown in Figure 5 on page 8.

Pasture species

Subterranean clover, which has already been described, is by far the most important of Victoria's pasture legumes. By selecting an appropriate variety, of which there are now many, subterranean clover can be grown successfully over most of the State. (See Figure 10 on page 16). However, there are two major situations in which other legumes are sown in pastures in preference to subterranean clover.

In the Wimmera and Mallee Districts most of the soils are alkaline and more suited to annual medics (trefoils). The main medic sown is barrel medic, but strand medic and gama medic are also sown to some extent. Like subterranean clover, these species are annuals which regenerate readily from seed in the autumn, if sufficient rain falls. In the higher rainfall districts of Victoria (750 mm or more) or under irrigation, white clover, a perennial, partly or wholly replaces subterranean clover. It is preferred because it can produce high quality feed at most times of the year (soil water supply permitting), including the period from late spring to early autumn when subterranean clover does not grow.

The choice of the grass, or grasses, to sow with the legume depends mainly on the annual rainfall. Figure 11 on page 17 shows the areas in which the more important grasses—perennial ryegrass, annual (Wimmera) ryegrass, phalaris, and Currie cocksfoot—can be grown. By natural selection over many years, useful varieties of perennial ryegrass (Victorian) and white clover (Irrigation) have been developed and made commercial in Victoria.

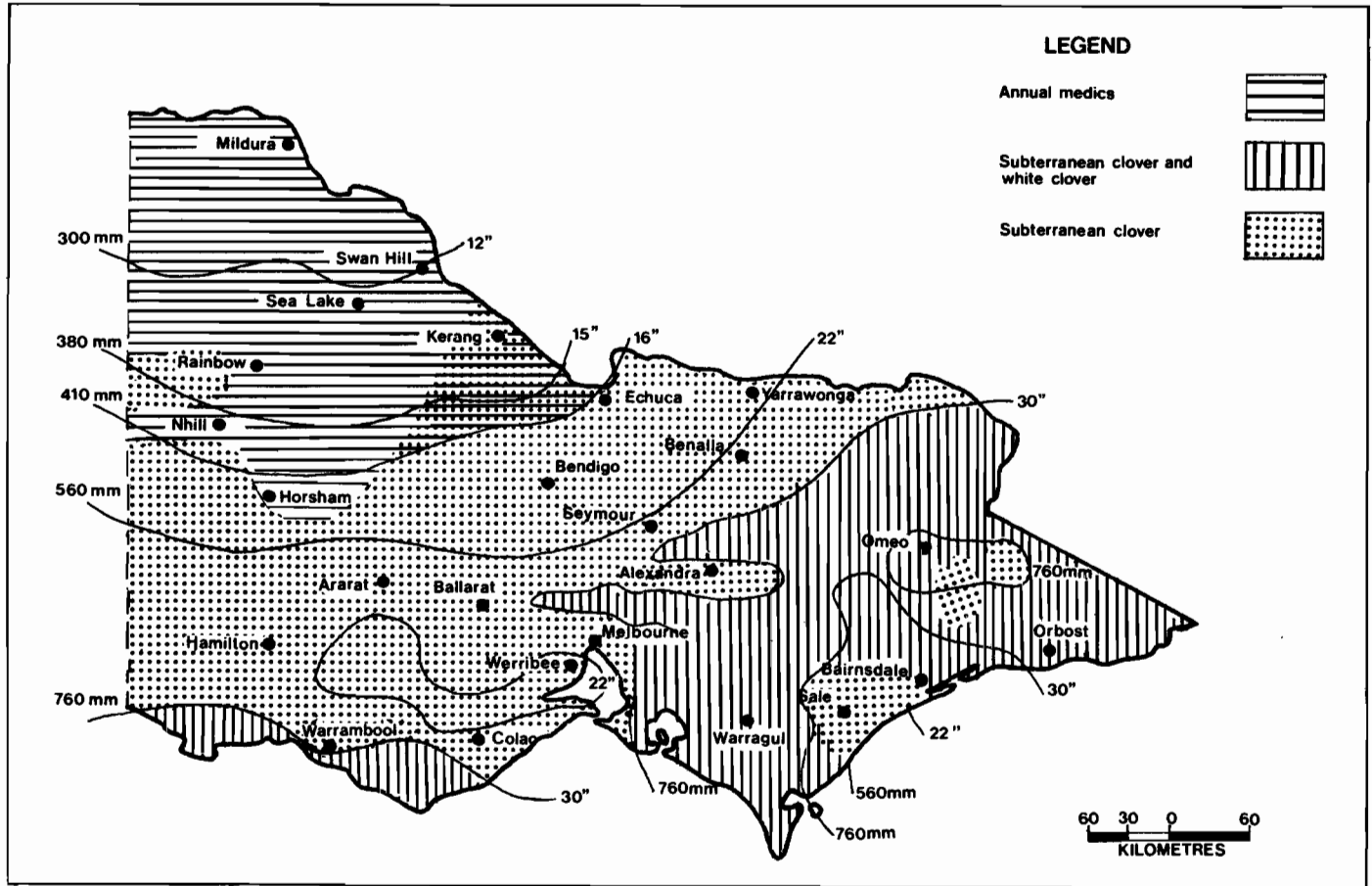


FIGURE 10. Victoria—Pasture legumes for non-irrigated areas, 1980.

Source: Department of Agriculture

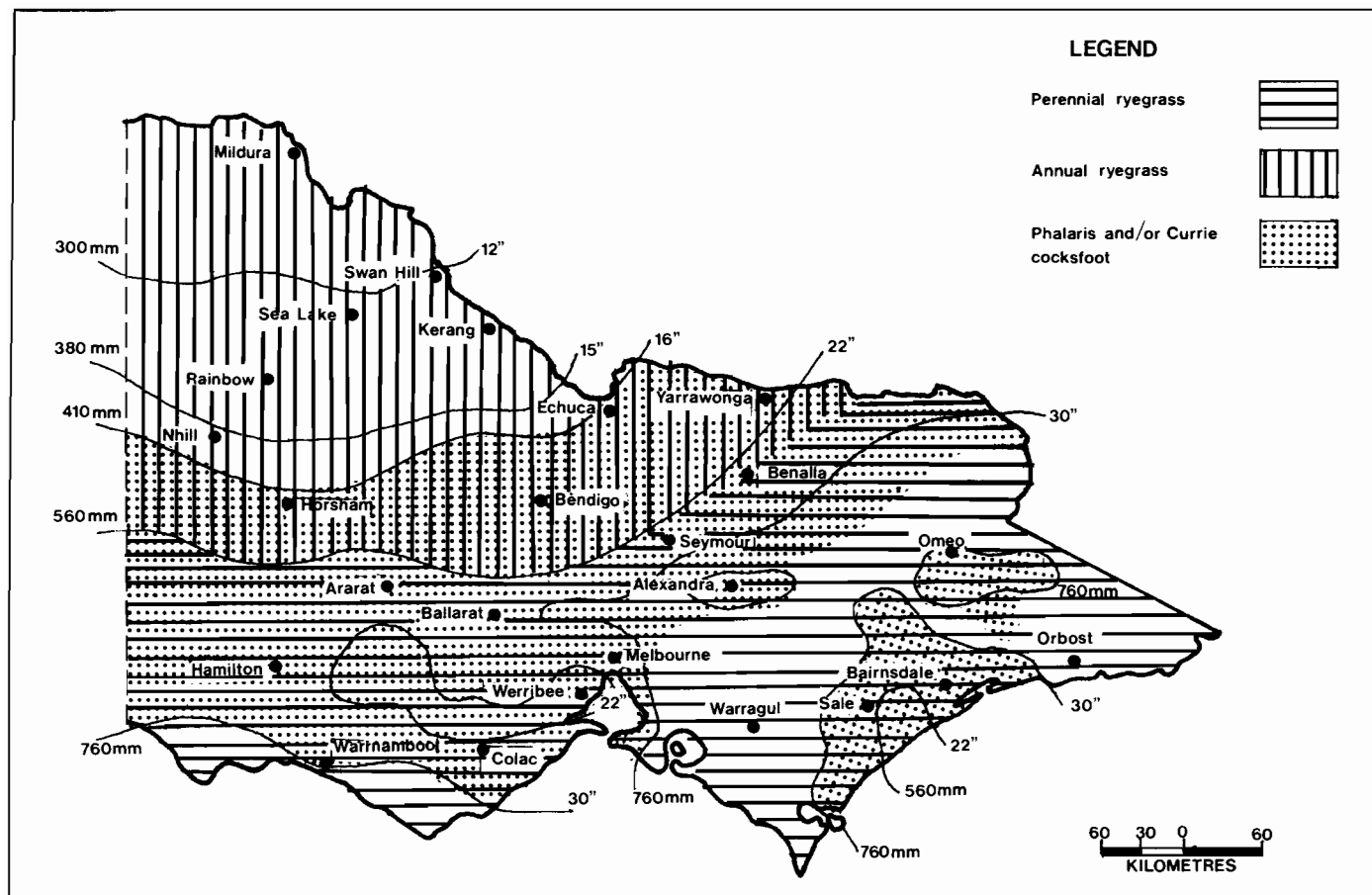


FIGURE 11. Victoria—Pasture grasses for non-irrigated areas, 1980.

Source: Department of Agriculture

Plants from the Mediterranean region have been useful in southern Australia for overcoming some of the limitations of the European pasture species. The Mediterranean climate resembles that of southern Australia in that the rain falls mainly during autumn, winter, and spring; the summer is hot and dry; and the winter is mild enough to allow plants to make some growth. Plants adapted to these conditions have evolved by natural selection. They are drought resistant and can grow fairly well in the winter. They tend to be dormant during the summer, but this is an advantage (except under irrigation) in Victoria's hot, dry summers.

Many varieties of ryegrass, phalaris, white clover, cocksfoot, medic, and subterranean clover have been introduced from the Mediterranean region for selection and plant breeding. In the last decade or so this work has produced superior Australian varieties of phalaris (Siroso, Sirolan) and white clover (Haifa), and great potential exists for further improving Victoria's pastures by using plants of Mediterranean origin. Earlier improvements using Mediterranean plant material include Currie cocksfoot and Demeter fescue.

Establishing and maintaining pastures

The method of establishing pastures described above—sowing subterranean clover seed with superphosphate, and sometimes sowing grass seed later when enough nitrogen has accumulated in the soil—was used widely on the more readily developed land in the early years of pasture development. Similarly, medics were sown for pastures in the Wimmera and Mallee, particularly since the 1940s. However, on strongly acid soils, more complex establishment techniques had to be developed, and often superphosphate, molybdenum and lime, together with legume seed inoculation, were all essential for successful sowings in these situations.

When pastures are re-sown, and in many districts this is not done until after many years, grass and clover seeds are usually sown together as a mixture, as there is then enough nitrogen in the soil to support the grass. Several sowing methods of varying effectiveness are used at present, but the standard and least hazardous is to cultivate the soil to prepare a seedbed and then sow the seed with a drill which buries the seed about 1 centimetre deep. The fertiliser is usually sown with the seed. Alternatively, seed may be sown broadcast on the surface and the land lightly cultivated to cover the seed, but establishment is then more dependent on adequate subsequent rainfall and soil fertility.

Another method of sowing (of which sod-seeding, minimum tillage, and direct drilling are variations) is attracting a good deal of interest at present. This method uses little or no cultivation. Before sowing, the existing vegetation is grazed very short and is usually sprayed with a herbicide to kill it (so that it will not compete with and choke out the emerging seedlings). The seed is then sown with an implement designed for sowing seed into uncultivated ground. This method saves fuel and time, but costs and likely results must be carefully assessed.

Once sown the pasture must be maintained in a productive state in order to feed the livestock from which the farmer earns his living. The main aspects of pasture management include adequate fertiliser treatment, grazing control, pest and weed control, and possibly fodder conservation.

Regular application of superphosphate (often annually) and any other fertiliser that may be appropriate for the soil type, is required to maintain production. Potassium and molybdenum are also widely required for optimum pasture growth to supplement superphosphate, and nitrogen fertilisers are occasionally used. Copper and zinc are of importance for some soils.

Careful grazing management is required. Too little grazing will allow the grasses to grow too tall and so choke out the lower growing clovers on which they depend for nitrogen. Too heavy grazing may kill out both grass and clover and allow a dense growth of weeds to develop. Many other factors also have to be considered and the farmer constantly has to make decisions that involve compromising between the welfare of his pastures and the welfare of the livestock that live on them. To do this successfully requires a good deal of skill on his part.

Farmers attempt to control unproductive weeds and insects and other pests. This may require spraying with a selective weedkiller or an insecticide. However, many so-called "weeds" do in fact provide quite useful feed. Weeds can often be controlled more cheaply

and for a longer time by using an ecological approach rather than spraying. For example, most annual weeds can be prevented by maintaining pasture density so that the pasture plants smother weed seedlings in their infancy. The more troublesome weeds found in Victorian pastures include many thistles, rushes, heliotrope, storksbill, dock, sorrel, ragwort, bracken, and bent grass.

Insect pests of Victorian pasture include cockchafer grubs, red-legged earth mites, lucerne fleas, field crickets, and grass eating caterpillars. Two new pests of lucerne and annual medics, the spotted alfalfa aphid and the blue-green aphid, were first discovered in Victoria in 1977 and have since spread over the whole of eastern Australia.

As two-thirds of the year's growth of pasture can occur in the spring, many Victorian farmers exclude stock from some pastures during spring and then make the growth into hay at the end of spring. A few farmers cut the saved pasture a few weeks earlier and make it into silage. The conserved hay or silage is then fed to the animals when the paddock feed supply is limited. In some cases the conserved feed is stored mainly to support stock during the inevitable periodic droughts; in other cases it is largely fed out in periods of feed shortage during the following year.

Irrigation

In some parts of Victoria it is possible to improve the environment for pasture growth greatly by adding water as well as fertiliser to the soil. There are about 500,000 hectares of irrigated pasture in Victoria. Most of this area is in the Murray and Goulburn Valleys upstream from Swan Hill. There are smaller irrigation areas in other parts of the State, notably at Maffra and Werribee.

The ability to irrigate makes farmers virtually independent of the rainfall and enables them to grow feed for their livestock at most times of the year. Thus, because of irrigation, intensive types of farming such as dairying and prime lamb raising can be practised with a sense of security in parts of northern Victoria which would otherwise be used primarily for cereal cropping.

There is often not enough water available to irrigate the whole of an irrigation farm and so there are usually two kinds of irrigated pasture on farms in the northern irrigation areas. Some of the paddocks are sown with subterranean clover and annual ryegrass or drought resistant perennials such as phalaris and Currie cocksfoot. Irrigation water is used on this pasture to extend the growing season in both autumn and spring, beyond the five months or so normally possible in that area with natural rainfall alone. Generally the pastures are irrigated once or twice during March–April and once or twice during September–October.

The second and more important type of irrigated pasture consists of perennial species which are irrigated regularly throughout the warmer half of the year. These pastures consist of species which can produce large amounts of high quality feed during this period as long as they are given enough water. The main species in such pastures are white clover, perennial ryegrass, and Paspalum.

Problems and research

One of the most obvious problems facing graziers in the early 1980s is connected with superphosphate. The price has risen dramatically in recent years and, from the long-term view, the high grade phosphate rock, from which superphosphate is made, is, like petroleum, a diminishing resource. Research being conducted into this problem is aimed at more efficient use of phosphatic fertiliser and of the phosphorus already in the soil. The efficient use of potassium and other trace elements are other pasture problems requiring further research.

Further aspects of soil fertility which need watching if pasture production is to be maintained and improved, is the widespread nitrogen deficiency observed in pastures, despite the presence of some (but possibly not enough) clover. Similarly, the increasing evidence of salinity in both irrigated and non-irrigated pastures is of concern, and the gradual acidification of pasture soils and evidence of the detrimental effect of soil compaction also require research.

In recent years, subterranean clover has not been growing as well as it did in the earlier decades of this century. The deterioration of subterranean clover-based pastures is probably due to several factors which, either alone or in combination, are causing the

clover to die out. Possible causes include plant diseases, deterioration of soil structure, and increased soil acidity. The Victorian Department of Agriculture has a research programme aimed at defining the causes of these soil fertility problems and developing technology to overcome them.

Although the pasture plants sown at present are a substantial improvement on the original native species, and an acceptable pasture can be obtained anywhere in Victoria, nevertheless there is room for improvement of the present species and varieties. Most have one or more quite serious limitations, including low production in winter, poor drought resistance, seasonal content of substances which are harmful to livestock (e.g., which cause staggers, or reduce their reproductive capacity), poor persistence under normal grazing practices, and susceptibility to pests or diseases.

The range of pasture plants in the State can be improved by developing varieties which are better suited to specific soil and climatic environments in Victoria and are resistant to the attacks of plant diseases and insects. Research is continuing into this area and into the various insect pests and diseases which attack Victorian pastures.

These pasture problems will need to be solved in order to help farmers maintain and improve their pastures, so providing an adequate pasture base for Victoria's grazing industries in the future.

FRUIT CROPS

Industry significance

There are about 2,000 orchards and 2,200 vineyards in Victoria, each group occupying about 20,000 hectares. The gross value of production on these units was over \$220m in 1979-80. Relative to the total area under crop, the area under fruit was approximately 1.5 per cent, but the gross value of fruit crops was about 20 per cent of the gross value of all the agricultural crops produced. Fruit and vine crops are grown for the local market in the first instance. However, fresh and processed fruit is regularly exported and in some instances (fresh and canned pears, dried vine fruit) the volume exported exceeds local market requirements.

While the gross value of the fruit and vine crops is relatively high, these crops have high requirements regarding capital investment (soil, building and equipment, irrigation and drainage) and operating costs (power, fertilisers, pest control materials, and labour). Also, because of the perennial nature of the crop, it will take some years before the plantation will start to bear and with orchards and vineyards production patterns cannot be changed at short notice, irrespective of changes in market trends.

The production and processing of fruit and vine crops provide job opportunities in country centres and assist decentralisation. Besides their contribution to the gross national product, these crops have an important dietary role as sources of vitamins, minerals, carbohydrates and fibre.

Historical development

Fruitgrowing in Victoria started with the first settlers and according to early records, members of the Henty family were the first to plant apples in Victoria, soon after their arrival at Portland in 1834. One of the earliest orchards in Victoria was planted by T. C. Cole, on the banks of the Yarra River, at Hawthorn, in 1845.

As a result of the gold rush in the early 1850s, there was a rapid increase in population near the goldfields and in Melbourne, which had quickly become the administrative and commercial centre of the new colony. To satisfy the needs of the population many of the newcomers settled on sites suitable for the growing of fruit. During the second half of the last century numerous small blocks were developed in a big semi-circle around Melbourne, from the north to the south-east, about 20 to 50 kilometres from the centre of the settlement (at Diamond Creek, Templestowe, Doncaster, Burwood, Croydon). Here migrants from England and continental Europe established a wide variety of horticultural crops: pome and stone fruit, berry fruits, and vineyards. These small orchards and vineyards and similar small farms on the Bellarine Peninsula had a very significant role in satisfying the daily needs of the settlement.

In addition to these small diverse orchards, some farmers in the more distant districts (Bacchus Marsh, Mornington Peninsula, Pakenham, Bendigo—Harcourt, Stanley—Bright, Horsham—Pomonal, and Portland) developed apple blocks to supply export markets in

Europe. This development followed the successful shipment of apples to England under refrigeration in 1885.

By the turn of the century the area increased almost five times to 16,476 hectares from 3,018 hectares in 1880. With vineyards, the development was even more spectacular: from 1,734 hectares in 1880 to 11,149 hectares in 1900. This increase is even more significant when one considers that it was during this period that vineyards in the Geelong, Bendigo, and Rutherglen areas had to be eradicated because of the outbreak of phylloxera that threatened Victoria's viticultural industry. This great expansion of vineyards was partly due to the establishment of the Mildura irrigation settlement by the Chaffey brothers, who came as pioneer irrigators from California in 1887.

The fruit industries grew strongly after the First World War, when reticulated irrigation water was made available in the Goulburn Valley and along the Murray River at Swan Hill for soldier settlers. In the Goulburn Valley growers concentrated on the production of canning fruit (peach, pear, apricot, and plum) and at Swan Hill on dried vine fruit and citrus. These developments, together with a gradual expansion in the traditional fruitgrowing districts led to the area under fruit (excluding grapevines) reaching a peak of 35,191 hectares in 1921-22.

During the next 20 years the area was reduced to about 28,000 hectares with considerable losses in the more distant areas which depended on exports. Because of increasing pressure on fruitgrowers to give way to urban development and adverse economic conditions in the 1970s further reduction took place and by 1981 the area under fruit (excluding grapevines) was 19,352 hectares.

During this period the area of vineyards increased gradually from 11,105 hectares in 1920 to over 20,000 hectares in 1970. There have been no significant changes in the area of vineyards since then.

Traditional fruitgrowing

During the last century and early this century, most fruitgrowers had 4 to 10 hectare orchards planted with many kinds and varieties of fruit. This diversity ensured that some produce was available for sale during the greater part of the year. This situation did not change significantly until the end of the Second World War.

Being engaged in fruitgrowing on small properties meant constant hard work for the grower and his family, who performed most tasks in the orchards and vineyards, although permanent or casual hands were employed on the larger establishments. Land preparation and cultivation was carried out by horse drawn implements, and tree and vine planting, occasional watering of the young plants, and weed control had to be done by hand.

During the winter months much time had to be spent with detailed hand pruning and the gathering and burning of the prunings. During the growing season, in addition to cultivation, the orchardists' main tasks were pest and disease control, and hand thinning to increase fruit size, particularly in the years with heavy crops ("on years").

Outside the irrigation districts, only a few farmers had a dam or bore for supplementary irrigation. In the irrigation districts, water was provided on a roster basis and at the beginning of the season growers had to prepare bays for flood irrigation (in the Goulburn Valley), or furrows (in Mildura and Swan Hill) for the distribution of water.

Pest and disease control was based on the few available chemicals, such as copper (mainly applied in combination with lime, as "Bordeaux mixture"), lime sulphur and sulphur dust against diseases, and arsenate of lead, nicotine sulphate, lime sulphur, and mineral oils for the control of insects and mites. The diluted spray was made up in large casks or wooden vats placed on a horse drawn cart and applied by a hand spray gun—a time consuming and tiresome operation.

Pome and stone fruit growers and berry growers usually harvested and packed the fruit themselves with the help of their family and some casual labour. From orchards in the Melbourne metropolitan area, many growers took their fruit regularly to the Queen Victoria Market in Melbourne. From the outlying districts, the fruit was sent to agents at the market by rail. Citrus and dried vine fruit was usually cleaned and packed in co-operative packing houses. With the gradual development of cool storage techniques, increasing amounts of apples and pears were stored in district co-operative coolstores and sent from there to Melbourne or to overseas markets in the United Kingdom and Europe.

Technological advances during the first half of the century included the gradual replacement of man and horse powered equipment by tractor drawn implements for cultivation and pest and disease control, and improvements in fruit storage, grading, and packaging practices. These developments had a temporary setback during the Second World War when fruit export had to be discontinued because of lack of shipping space. However, the situation and outlook changed dramatically once the war was over. By 1950, there was a strong demand for fruit and growers were eager to make use of the new technology to upgrade their orchards and vineyards which had been neglected during the war years.

Modern orchards

Research investigations had intensified after the Second World War and resulted in new technology on most aspects of fruit and vine growing. As a result, orchard and vineyard management changed more drastically in the last 20 years than in the previous 50 years. Many of the new practices involved increased inputs and higher costs (supplementary irrigation, more fertilisers, a wide range of more specific pesticides, growth regulators, private cool stores, appealing packages). As the increase in costs of these inputs and labour were not matched by similar increases in prices received, many growers realised that the traditional orchard with a wide range of fruit kinds and varieties must be at a disadvantage. In response, growers consolidated their plantings to concentrate on a restricted number of the most popular varieties and developed specialised skills to increase production and thus retain economic viability.

Many of the modern deciduous tree fruit orchards tend to be somewhat larger than orchards in the past (now 10 to 20 hectares). Apple and pear growers tend to concentrate on only five to six varieties, but stone fruit growers tend to select a wider range of varieties that ripen in sequence. In general, when choosing varieties, growers will consider market preference and the selection of lines for high production potential, high fruit quality, and freedom of diseases.

In the past, planting density and tree training and management practices in orchards favoured the establishment of large trees which generally took four to eight years to settle down to commercial production. In modern orchards, trees are being planted closer and with suitable training and management can be induced to bear earlier. Greater numbers of trees per unit area increase yields and income and the financial outlay of the investment will be repaid sooner. One of the high density planting systems, the Tatura Trellis, was developed at the Irrigation Research Institute of the Department of Agriculture.

In order to keep labour costs down, operations have had to be made more efficient, and practices which have proven not to be essential have been eliminated. Many tree fruit growers have chosen lighter pruning methods, the replacement of frequent regular cultivations by permanent grass, and increased use of chemical thinning sprays instead of hand thinning.

Outside the constituted irrigation districts, orchardists and vinegrowers have seen the importance of supplementary irrigation in achieving higher yields. Many of these growers, as well as some in the irrigation districts, have installed low volume irrigation systems for greater efficiency and economy.

In the immediate post-war years the insecticide DDT gained general acceptance for the control of a wide range of insect pests. However, because of the development of resistant strains of pests and concern about chemical residues in the 1960s, this material was gradually replaced with more specific organic pesticides. Parallel with the development of newer insecticides was that of several synthetic fungicides. More recently, reliance on pesticides for control of all pests has been modified and growers have adopted integrated control methods wherein the selection and timing of pest control sprays is influenced by the presence of beneficial insects in the orchards. This "biological pest control" is particularly significant in citrus groves where the majority of citrus growers now rely largely on the activities of parasitic wasps to control scale insects.

The great potential for the reduction of labour costs in fruitgrowing is in the harvesting and post-harvest handling operation. The use of bulk bins, fork lifts, and improved fruit graders has made the work considerably faster and easier, but the major achievement has been the use of mechanical harvesters in orchards and vineyards. At present, this machinery is not suitable for harvesting fruit or grapes for the fresh market, but with fruit

AGRICULTURAL PLANTS IN THE VICTORIAN ENVIRONMENT

A field of golden wheat. Wheat is Victoria's largest crop and about 1.4 million hectares, or approximately 65 per cent, of the State's total area under crop is sown to wheat.

Australian Wheat Board





Laboratory analyses and examinations are essential parts of research projects and diagnostic services.

Department of Agriculture

Harvesting the multi-million dollar wheat crop.

Department of Agriculture





Increasing fuel and labour costs have encouraged the development of crop production systems requiring fewer traverses of the fields. Modified tillage techniques such as stubble mulching require special machinery for sowing.

Department of Agriculture

The beginning of mechanical harvesting of fruit—shake a tree! More sophisticated methods today incorporate mobile catching and collection frames.

Department of Agriculture





Recent experiments aimed at developing a new variety of subterranean clover resistant to a fungus disease.

Department of Agriculture



Measured water flows onto irrigated perennial pasture in an irrigation frequency experiment at Swan Hill.

Department of Agriculture



Lettuce variety comparisons at the Department of Agriculture's Vegetable Research Station, Frankston.

Department of Agriculture



Harvesting tomatoes for yield measurements in a "plant density by nutrient" experiment.

Department of Agriculture



Harvesting celery. This is one of Victoria's most valuable vegetable crops.

Department of Agriculture

Merino wethers in an experiment on irrigated perennial pasture at Kerang.

Department of Agriculture





Chinese gooseberries, a new fruit crop which has won many markets.

Department of Agriculture

Jersey calves at pasture. Improved pastures provide nearly all the feed for Victoria's dairy herds which produce about half of Australia's dairy products.

Department of Agriculture





Cereal cyst nematode has caused the stunting and yellowing of this Mallee wheat crop.

Department of Agriculture

Parasites have been gathered, multiplied, and released to attack the aphid pests of lucerne.

Department of Agriculture



and grapes for processing it has proved to be most economic and prevented costly delays that are often inevitable when hand harvesting large blocks. Mechanical harvesting also has a great role in re-establishing the once viable raspberry and brambleberry industry that declined because of very high harvesting costs.

Great improvement in storage techniques and introduction of the concept of controlled atmosphere (with reduced O₂ and high CO₂ content) storage has made it possible for pome fruit growers to release fruit gradually from their own store practically throughout the year. Improved storage techniques have also helped to provide a better environment for fruit exported in containers and to extend the market season for stone fruit, grapes, and berries.

All these technological improvements have resulted in significant increases in productivity and fruit quality. In the case of apples, for example, the average yield in 1920 was 3.5 tonnes per hectare; by 1980 it had increased to 14.5 tonnes per hectare.

Current trends

More recently there has been an increasing involvement by professional people and commercial firms in developing both large and small orchards and vineyards. Thus, while there has been a trend towards the establishment of large fruit producing corporations, there has also been one towards growing fruit on a small scale or on a part-time basis. Among both groups of growers there has been great interest in fruits and nuts not grown commercially here in the past. Many people appreciate the opportunity to spend some of their leisure time on the land, and some orchards and berry farms open their properties to urban families for "pick your own" sales.

Increasing energy costs and environmental factors stress the need for the more efficient application of pesticides and more reliance on integrated pest control.

Changes in production trends and loss of preferential treatment for Victorian fruit on British markets make it necessary to develop new markets in Asian countries where, because of Australia's geographic advantage, high quality fruit and grapes could gain new markets.

VEGETABLES

History

Melbourne's earliest market gardens were established along the Yarra River and its tributaries in areas which are now inner suburbs. Further afield market gardens developed around the major centres of population and especially close to the goldfields at Bendigo and Ballarat.

As Melbourne expanded, the gardeners were forced further out, the main development was south of the city in Brighton on the sandy soils close to the coast. With the help of manure from Melbourne stables the growers learned to master the relatively infertile soils. The temperate climate and good drainage enabled crops to be produced throughout the year. With the return of the diggers from the goldfields in the late 1850s the city began to expand and the gardeners moved to Bentleigh, Moorabbin, and Cheltenham to find suitable land. By 1865, there were 1,000 growers from all districts in Melbourne's Eastern Market. As development continued the gardeners moved on to Mordialloc, Heatherton, Clayton, Dingley, Keysborough, Dandenong, and Cranbourne.

To the east of the city on the heavier clay soils market gardens developed at Ashburton, Burwood, and Doncaster. These soils were ideal for tomatoes, Brussels sprouts, and cauliflower. By 1920, production areas extended to Scoresby, Wheelers Hill, Ferntree Gully, and Lysterfield. The deep well drained soils of the Dandenongs were ideal for the production of berry fruit and vegetables. In the early days growers used the narrow gauge railway to ship their potatoes and carrots to market.

Vegetable growing commenced at Werribee South in 1923 with water from the new State Rivers and Water Supply Commission scheme. In the 1930s immigrants from Italy and Greece settled in the area and developed market gardens.

The new settlement in the Hallam Valley at Narre Warren after the First World War had a shaky start because of low prices and difficult growing conditions. Italian migrants later took up the land and further developed the area. The Narre Warren-Cranbourne area is now a major growing area with approximately 1,000 hectares of market gardens; it is also the principal celery growing district in Australia.

The development of northern production areas was limited until the Second World War. Tomatoes for processing were grown near Bendigo in the 1930s and winter lettuce was first grown at Nangiloc and Colignan near Mildura in 1937.

The Second World War transformed the vegetable industry with production expanding to meet the requirements of the Armed Forces. Crops were produced for processing in the Goulburn and Murray Valleys, East Gippsland, and Kooweerup as well as the Melbourne metropolitan market gardens. The tomato processing industry developed at Shepparton and Bendigo. Further afield, bean and bean seed growing was established on the river flats at Orbost and Bairnsdale and onions at Colac.

After the Second World War, extensive areas of vegetable production were developed in the Murray and Goulburn Valleys by migrant farmers. The main crop was tomatoes for processing. During the 1950s, the frozen vegetable processing industry developed particularly after the introduction of mobile pea viners and green bean harvesters.

Potato production developed in the higher rainfall areas of the State, particularly on the better soils at higher elevations. The largest potato growing district is still the Central Highlands. Earlier crops were grown in the market gardens and at Kooweerup and Koroit.

Cultural methods

Vegetables are grown on market gardens or as field crops in conjunction with other cropping or livestock enterprises. There is very limited greenhouse production.

Market gardening is an extremely specialised and intensive form of agriculture and is highly developed in a number of locations within 50 to 60 kilometres of Melbourne. Two and sometimes three crops are produced on the same piece of land each year. Well drained sandy soils, such as those south-east of Melbourne, are ideal for successive cropping but they require large inputs of manure and fertiliser.

Less intensive cropping with only one or two crops a year is normal in vegetable growing areas more remote from Melbourne. More vegetables are now being grown on larger holdings for the fresh market as well as processing. Potatoes, Victoria's principal vegetable crop, are produced by specialist growers and mixed farmers.

Potatoes, onions, asparagus, sweet corn, and processing peas, beans, and tomatoes are all produced as broad area crops. Most vegetable crops are irrigated, generally by permanent-set sprinklers in market gardens, while on broad area farms portable sprinklers or travelling irrigators are used. Processing tomatoes are mainly irrigated by the furrow method.

Seeding and transplanting equipment reduces establishment costs; herbicides eliminate much weeding. Mechanical handling and harvesting methods, pre-cooling, and new packaging systems have generally lowered costs and improved product quality.

Vegetable improvement

All vegetables produced in Victoria have been introduced but a considerable amount of local selection has moulded these species to local requirements. Almost all the early varietal development work was done by farmers who selected seed from outstanding plants within their own crops. The Australian Brown onion was selected from a heavy skinned Spanish type, and was particularly suited to harsh growing conditions and long distances from market. Local selections of bean, cabbage, carrot, celery, cauliflower, potato, and tomato found their way into the seedsmen's catalogues. Burwood Wonder was widely grown as a fresh market and processing tomato in the 1930s and 1940s, and was later replaced by an improved selection, KY1. Exton potato is a local selection from a seedling of the variety Katahadin.

In recent years, the development of new varieties has become a specialised task and local seedsmen continually import and evaluate new varieties many of which are now F₁ Hybrids. Nevertheless, many growers still maintain and jealously guard old varieties.

Prior to the development of a specialised seed industry, a number of certification or registration schemes were established by the Victorian Government to ensure that seed of a number of crops was true to type. Potato seed certification is the only major scheme now operating in Victoria although a limited amount of certified onion seed is still grown.

Standards control

Fruit and vegetables offered for sale in Victoria must meet the standards prescribed in the Fruit and Vegetables Act which sets general standards for all fruit and vegetables and

specific requirements for major commodities such as potatoes, onions, and tomatoes. The Act also prohibits deceptive packaging practices such as "topping". Inspectors check produce at the Melbourne Wholesale Fruit and Vegetable Market, in warehouses, and retail outlets. The *Plant Diseases Act* 1982 provides for the control of diseases in crops or the spread of disease by infested planting material or produce. The quality of vegetable seeds is regulated by the *Seeds Act* 1981.

The standards of quality of processed vegetables are under the control of the manufacturer, although the provisions of the *Tomato Processing Industry Act* 1976 set grades for tomatoes for processing.

Research

Since the establishment of the Department of Agriculture in 1875, the main objective of vegetable research programmes has been the control of pests and disease. The importance of the potato industry in the State is reflected in the concentration on problems of potato disease control. The development of the pathogen tested potato scheme to free potatoes of important tuber borne pathogens has been most significant.

In addition to research on vegetable pest and disease control at the Plant Research Institute at Burnley, vegetable research is conducted at the Vegetable Research Station at Frankston, which was established in 1964 and the Potato Research Station at Healesville established in 1951. Major contributions have been the development of new weed control and fertiliser practices together with the breeding of new tomato and bean varieties for processing and the fresh market.

In addition to projects at research establishments, extensive district work is conducted in conjunction with local extension officers.

Markets

Vegetables are primarily grown for home consumption and there is only a small export trade. Victoria produces one-third of the nation's vegetables with considerable quantities being exported to northern States during the summer months. Broccoli, Brussels sprouts, celery, cauliflower, lettuce, and potatoes are the main crops supplied to interstate markets. Processed beans, sweet corn, broccoli, cauliflower, tomatoes, and potatoes are also distributed to markets throughout the country. Victoria produces 80 per cent of Australia's processed tomato products.

Fresh vegetables are sold to retailers at the Melbourne Wholesale Fruit and Vegetable Market directly by growers or through agents or merchants. Country buyers purchase produce in the market from growers, merchants, or agents for distribution throughout the State. While Melbourne has the largest growers' market in Australia, increased quantities of fresh vegetables are sold direct to supermarkets and chain stores. Produce is sold in this market by private treaty between the grower and the buyer, the price being determined by the prevailing supply and demand situation. The Department of Agriculture Market Reporting Service publishes the wholesale prices of fruit and vegetables sold on the Melbourne Wholesale Fruit and Vegetable Market each day.

Processors generally forward purchase their requirements under contract arrangements between buyer and grower. Victorian Government legislation was enacted in 1964 to control the terms and conditions for the sale of tomatoes for processing and price is determined each year by a statutory committee.

Onions and potatoes are exported to markets in south-east Asia and the south-west Pacific. Exports of onions to Japan and the European Economic Community have increased in recent years as have exports of perishable vegetables such as broccoli, celery, and cauliflower which are air freighted to south-east Asia, mainly Singapore.

Pest and disease control

Most vegetable pests and diseases have been introduced to Australia, but Australia's relative isolation still keeps the country free of many problems which confront growers in the northern hemisphere.

As intensive crop culture favours the cumulation of pests and disease, careful attention needs to be paid to crop rotation and crop hygiene and intensive spray programmes are often necessary to prevent crop losses. Persistent chlorinated hydrocarbon insecticides such as DDT now have limited use in vegetable culture and have given way to newer materials

which, although less hazardous to the environment, require extreme user care. Biological control methods have been used to control a number of vegetable pests and diseases, and certification schemes have reduced the level of seed borne disease in potatoes and beans.

Varieties resistant to various diseases have become available since the 1950s. These provide a cheap and extremely efficient means of disease control; examples include carrots and beans resistant to virus diseases, tomatoes and melons resistant to soil borne wilt disease, and canteloupes and cucumbers resistant to powdery mildew. Department of Agriculture plant breeders have produced disease resistant tomato and bean varieties for the local industry.

ENVIRONMENTAL DEVELOPMENTS

The contributions of agricultural plants to meeting most of Victoria's food and clothing needs as well as achieving considerable export earnings have been outlined above.

As the world's population and its demand for food continue to grow, there will be a need to produce and export increasing quantities of agricultural products. At the same time agriculture must co-exist with many other facets of man's environment and other sources of man's needs, such as forests, water supply systems, recreational areas, and wildlife reserves. Securing a satisfactory co-existence between agriculture and the total environment will mean avoiding certain mistakes of the past, e.g., the use of some pesticides which, while effective in subduing a specific pest, proved hazardous in terms of accumulation in the environment and potential toxicity to other desirable species (including man). Thus, scientists continue to develop effective, safe methods of pest control including new, low toxicity pesticides and biological control methods.

Streams are often the collectors of pollutants including those generated by agriculture. Environmental protection policies have been prepared, or are now proposed, for the waters of all rivers and tributaries in Victoria. These policy statements set limits for the quantities of pollutants tolerable in streams, relative to identified beneficial uses for the water. The limits set for the various water quality criteria reflect on the forms of land-use and the agricultural practices that may be tolerated in the catchment or parts of the catchment of each stream. Conflicts between agricultural land-use and the environment need to be resolved.

To this end, a study was commenced in 1981 by an Environment Protection Authority/Agriculture Research Working Group. The terms of reference of this group reflect the current discussion on agricultural plants—and subsequent utilisation methods—in the Victorian environment. They are:

- (1) To identify existing and potential conflicts between agricultural land-use and environmental protection;
- (2) to identify land management practices or land-use controls which may require change to reduce the environmental impact of agriculture; and
- (3) to recommend a priority based programme of research and data collection to develop and evaluate, in economic terms, management practices consistent with the aims of environment protection and the viability of primary production.

The preliminary report of the Group on (2) above, included reference to the use of buffer zones between agricultural land and water bodies, fertiliser practices in relation to nutrients in run-off and ground waters, cultivation practices, grazing intensities, pest control methods, use of farm drainage water, retention of indigenous flora, and disposal of waste.

Research work on these problems will seek to resolve conflicts and achieve agricultural progress consistent with environmental protection.

Further references: *History of Victoria*, *Victorian Year Book* 1961, pp. 1-28; *Land flora*, 1962, pp. 1-36; *Mammals*, 1963, pp. 1-24; *Soils*, 1964, pp. 1-9; *Palaeontology*, 1965, pp. 1-24; *Birds*, 1966, pp. 1-28; *Fish*, 1967, pp. 1-27; *Molluscs*, 1968, pp. 1-21; *Insects*, 1969, pp. 1-26; *Minerals*, 1970, pp. 1-29; *Amphibians and reptiles*, 1971, pp. 1-36; *Forests*, 1972, pp. 1-29; *Meteorology*, 1974, pp. 1-29; *National Parks*, 1975, pp. 1-35; *Victoria at the time of settlement*, 1976, pp. 1-45; *The Victorian environment*, 1977, pp. 1-46; *Victoria's forests and man*, 1978, pp. 1-35; *Transport in the Victorian environment*, 1979, pp. 1-25; *Great Dividing Range in Victoria*, 1980, pp. 1-33; *Grazing in the Victorian environment*, 1981, pp. 1-23; *Water and Victoria's environment*, 1982, pp. 1-19