

Improving Agricultural Practices

Science and the Australian Sugarcane Grower,
1864–1915

PETER GRIGGS

Sugarcane emerged by 1884 as the most favored crop cultivated in the coastal lands of Eastern Australia between Cairns and Grafton. Initially, Australian canegrowers invested as little labor and capital as possible. Contemporary commentators, however, were very critical of the agricultural practices adopted by the country's first canegrowers, noting a lack of careful cultivation and plowing, fertilizer use, drainage, and paddock design. Various reasons for the use of these "inadequate techniques" are discussed in this essay, with the conclusion being offered that the most important factor was a lack of scientific knowledge about farming under Australian conditions. By 1891 cane-growing techniques were reported to be "on the upgrade," with improved cane and sugar yields. Such a transformation had commenced due to the introduction of some mechanization and the dissemination of research findings and technical information about scientific cultivation methods under Australian conditions. This detail had been assembled during the 1890s and 1900s mainly by the Colonial Sugar Refining Company and the Queensland government Sugar Experiment Stations, which had been established following pressure from canegrowers who increasingly sought advice on the correct farming methods.

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EUROPEANS occupied the tropical and subtropical regions of northern New South Wales and Queensland from the 1820s onward. There they encountered environments not suited to the cultivation of wheat, barley, oats, and other temperate crops (e.g., apples, pears, hops). Farmers tried crops such as cotton, tobacco, coffee, and bananas that preferred warm, humid climates. Of these crops, sugarcane emerged by 1884 as the most favored in the coastal districts between Cairns in northern Queensland and Grafton in northern New South Wales (Figure 1). During the early years of Australian cane growing, farmers necessarily used as little labor and capital as possible. However, by the 1910s some mechanization, improved cultivation practices, and new cane varieties, promoted by the sugar mills and government experiment stations, increased both cane and sugar yields.

An analysis of farming methods adopted by the country's first cane-growers is absent in broad surveys of Australian agricultural practices, although early commentators criticized the European methods employed. Walter S. Campbell, a politician who toured New South Wales in the mid-1880s and reported on the state of agriculture in the colony, suggested that cane farming in the Richmond River district was "wretched and primitive in the extreme" and the chief product was "weeds and these grow to perfection." A similar report from the Special Correspondent for the *Sydney Morning Herald* in 1884 claimed that Richmond River district cane farmers engaged in a "careless profligate system of farming." As late as 1900 Dr. Walter Maxwell, director of the Sugar Experiment Station of the Hawaiian Sugar Planters' Association and an agricultural scientist with an international reputation, prepared a report on the Queensland sugar industry. He concluded that handling of the land by Queensland cane-growers was "crude and superficial." Subsequent studies focusing on Queensland or New South Wales offer limited insights into the late nineteenth-century agricultural practices of canegrowers. The historical geographer Jack Camm provides no detail about Queensland farming methods but, in a discussion of rural technology, concluded that "the northern sugar farms were more highly capitalised than those of the south-east." In his book on the historical geography of New South Wales, Denis Jeans discussed agricultural practices employed on cane farms in Northern South Wales but provides no clues to the suitability of the practices or their effectiveness.¹

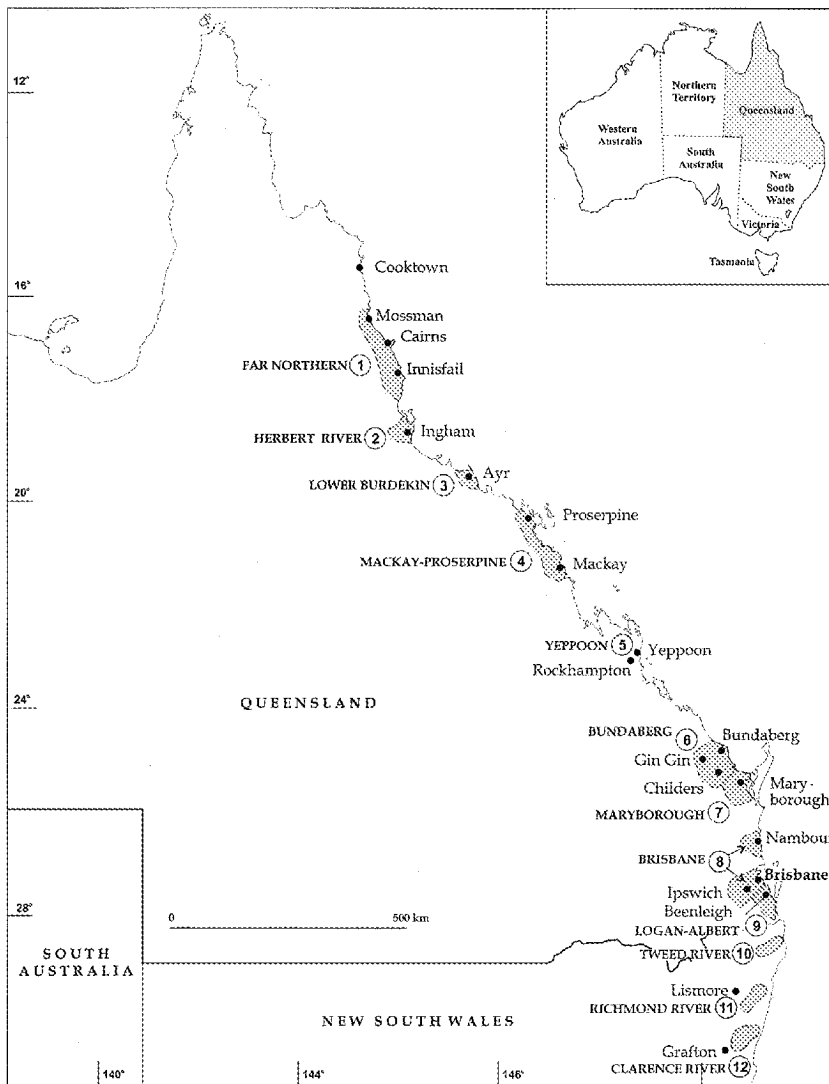


Figure 1. Sugarcane Growing Districts in Eastern Australia, 1915. Information compiled by author and drawn by Adella Edwards.

The historiography on Australia’s sugar industry also reveals little about agricultural practices adopted by early canegrowers. Neither the historian Kay Saunders nor the economic historian Ralph Shlomowitz considered farming methods in their now-classic studies on how small

farmers supplying central mills replaced sugar plantations in Queensland during the 1890s. Harry Easterby, in his 1933 book on the history of the Queensland sugar industry, devoted a chapter to field machinery and the development of mechanical cane harvesters. Ralph Shlomowitz, Geoff Burrows, Bill Kerr, and Ken Blyth also studied these endeavors. Kenneth Manning and Frank Rolleston examined the topic of machinery and implements on cane farms in their histories of Farleigh and North Eton Mills but provide few details about farming practices. Malcolm K. Wegener completely ignored the pre-1930 period in an article about the contribution of science to the Australian sugar industry. Only Adrian Graves provides brief details about cane farming methods before 1900, in his study of the Queensland sugar plantations and the immigrant laborers who worked on them. He concluded that the techniques of cane cultivation employed during the plantation period were inadequate. Planters did not routinely attend to deep plowing, proper drainage, crop rotation, or adequate fertilizing. Graves argued that such neglect was a function of the high wages commanded by experienced European plowmen and the focus by planters upon clearing new land and extending acreages, rather than making existing cane acreage more productive.²

Analysis of contemporary newspapers, industry publications, government reports, and the correspondence of some early sugar producers allows reconstruction of the agricultural practices adopted by Australia's first canegrowers between 1864 and 1915 and their attempts after 1880 to adopt more scientific methods. Such reconstruction fills gaps in the historiography of the Australian sugar industry and broadens the literature on Australia's agricultural history that has focused overwhelmingly upon southern Australia.

The first reflections on Australia's sugarcane industry by contemporary commentators criticized the various crude agricultural practices of the country's first canegrowers. Field creation was one activity that often drew criticism, and numerous reports exist of cane fields still containing tree stumps. Late nineteenth-century photographs of sugar plantations confirm these observations (see Figures 2 and 3). Many early canegrowers simply cut down the vegetation on their blocks of land, allowed it to dry, and then burned the material. Bigger tree stumps survived this initial firing and, in most instances, just rotted away, usually in three to five years but sometimes longer. Stones and boulders littered other paddocks. At



Figure 2. Sugarcane Paddocks at Hambledon Plantation Near Cairns c. 1895. Though founded in the early 1880s, paddocks still contained trees and stumps. Lyne Brown Album, PXD 543, Picture No. 11, Mitchell Library, State Library of New South Wales, Sydney.

Cedars plantation near Mackay, a visitor in 1882 noticed that field laborers moved the stones in the fields to one side, creating spaces for cane planting. Walter H. Clarke, a reporter for the *Tweed Herald and Brunswick Chronicle*, described one paddock near Altonsville in 1900 as “two great undulating slopes being covered with boulders varying from the size of one’s fist to about a foot square.” The cane grew amongst the boulders.³

Preparation of the soil for cane planting varied enormously. Initially, on many properties where stumps and/or boulders filled the paddocks, canegrowers were unable to use the plow and relied on hoes to break up the ground. These farmers made troughs or oblong holes for the reception of setts—stem cuttings of cane with two or three buds. The canegrower could break up the soil further after clearing away stumps, stones, and boulders. By the 1870s a few Queensland sugar planters utilized teams of horses or bullocks to pull plows. Steam plows undertook deep plowing of the soil at Ormiston plantation near Brisbane, but this approach was

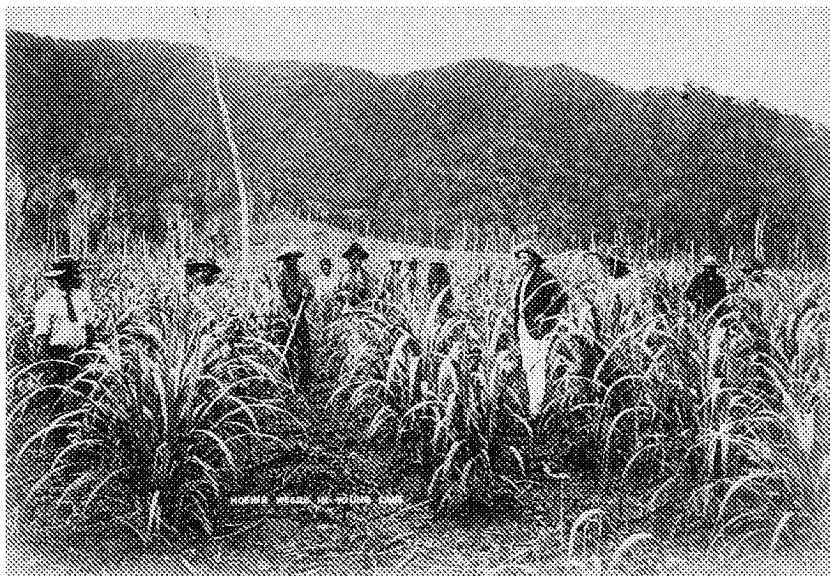


Figure 3. Melanesians on Hambledon Plantation c. 1890 Using Hoes to Keep Paddocks of Young Sugarcane Free of Weeds. John Oxley Library, Brisbane.

exceptional due to the expense associated with the purchase of such machinery. In New South Wales, a survey in 1869–1870 found that two-thirds of the sugarcane growers had plowed and/or harrowed their paddocks in preparation for planting (see Table 1). Yet, only one grower engaged in deep plowing using a subsoiler. Almost twenty years later Campbell complained that there was still not a subsoil plow in the Richmond River district, while along the Clarence River “very shallow ploughing is the rule; the land merely skimmed over.” Generally, deep plowing did not occur; the reputed motto of the country’s first sugarcane growers was “tickle the soil with a hoe and it will laugh a harvest.”⁴

Uncertainty prevailed over the correct method to plant sugarcane. Some growers adopted a system known as “planting in squares.” They dug holes about eighteen inches square and about eight inches deep in a regular pattern, as far as stumps and boulders would permit. Growers then placed setts in the holes and covered them with soil. They tried almost every conceivable distance between the holes. Archibald Liversidge, Professor of Chemistry at Sydney University and author of a report on

Table 1. Agricultural Practices by New South Wales Sugarcane Growers, 1869–1870

	<i>Number Responding</i>
Preparing fields by plowing only	28
Preparing fields by plowing & harrowing	54
Preparing fields by hoeing	8
Use of subsoiler	1
Planting in holes	22
Planting in trenches/furrows	17
Use of surface drainage	8
Use of subsoil drainage	2
Adoption of manuring	5

Survey of 105 growers from *Sydney Morning Herald*, July 13, 1870. Each question was not answered by every grower.

agricultural practices in the Maryborough district in 1875, strongly condemned this practice claiming excess water would pool and stagnate in the holes, thereby damaging the root system of the plants. Moreover, canegrowers using this technique often planted as much cane as possible, irrespective of quality. This practice of over-planting in New South Wales resulted in as many as 2,500 stools of cane—i.e., the clusters of cane stalks arising from the germination of setts—per acre, whereas 1,400–2,000 stools provided ample coverage. On other properties, workers placed setts in furrows and covered them with soil (see Figure 4). Canegrowers experimented with various distances between furrows, as they had no idea if one particular distance led to better yields.⁵

Some canegrowers carefully cultivated the paddocks as the young cane grew, trying to reduce the growth of weeds. At Malungavel plantation near Beenleigh in 1869, growers kept the fields in a “remarkably clean state by means of stalwart ploughmen, who use ploughs, horse hoes and grubbers.” At Noyea plantation near Beenleigh in 1874, a combination of plowing with horse-drawn cultivators and hand hoeing kept down the weeds. In most instances, however, growers neglected cultivation of the paddocks as the sugarcane matured. A journalist from the *Queenslander* described the cane fields around Maryborough in 1874 as “a compact mass

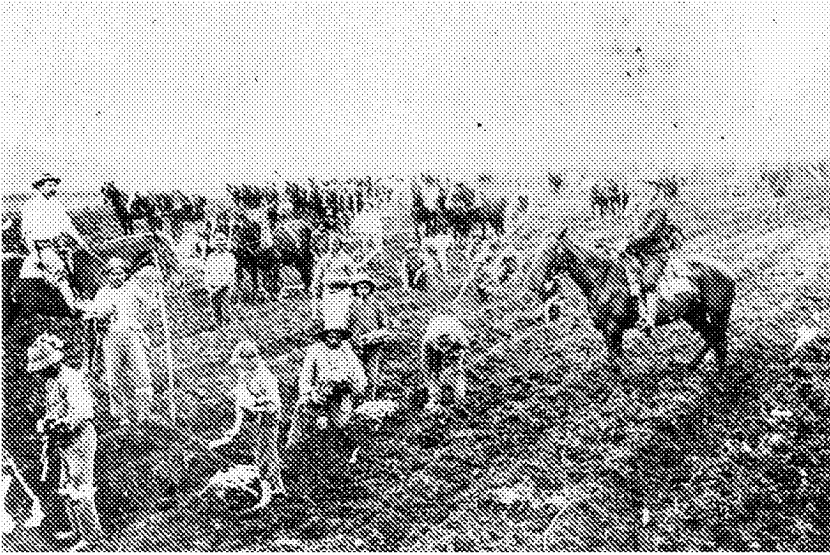


Figure 4. Melanesians Hand Planting Cane Setts in the Mackay District c. 1870.
John Oxley Library, Brisbane.

of weeds and grass, with a few stunted canes here and there. All attempts at ploughing or anything but scratching are ignored.” A reporter from the *Brisbane Courier* visited the Marburg district near Ipswich in 1883 and found the cane “in some places overrun with weeds,” with no attempt made to “trash or otherwise attend to the cane since it had been planted.” After an inspection of the Union Bank’s Mourilyan plantation near Innisfail in 1891, the bank’s inspector wrote that “on some fields the edges have been kept clean, while in the interior the cane has been well nigh choked by the trash and weeds which have been allowed to accumulate around it.” He also reported two fields in which he was “really unable to decide which predominated—cane or jungle.” Reports from the Brunswick River district of New South Wales in 1900 described cane paddocks as being full of the weed, “stinking roger,” standing as “thick as a crop of wheat feet higher than the cane.” The practice of over-planting in New South Wales meant farmers could not use horse-drawn cultivators to keep down weeds and had to rely on the hoe. Farmers frequently neglected such expensive and laborious work, which led to paddocks being full of weeds.⁶

Considerable debate existed about proper care for growing cane plants. Some canegrowers advocated trashing or stripping the cane of dead leaves during the hotter growing months. This activity removed dead leaves and exposed the matured part of the stalk to more sunlight, thereby enhancing the production of more extractable sugar. Other growers near Beenleigh, such as Fryar and Strachan from Loganholme plantation and Samuel Grimes from Rockholme plantation, opposed the practice on the grounds it made no difference to sugar yields. Small farmers in New South Wales, especially those contracted to the Colonial Sugar Refining Company (CSR)—Australia’s largest and most influential sugar milling and refining firm—generally trashed their cane once, because CSR paid a higher price per ton for trashed cane. Often growers performed the task solely to satisfy CSR, without any thought given to its purpose, and even removed green leaves at the wrong time. Writing for the *Queensland Review*, George Craig concluded that the Queensland canegrowers who trashed “guessed at random” the proper time for completing the task. Moreover, to trash sugarcane paddocks twice in New South Wales where cane took two years to mature, added considerable expense. Double-trashing cost £4 per acre, and growers had difficulty finding workers to undertake the unpleasant task. Some small farmers in New South Wales attempted to avoid trashing by burning their fields before harvesting, thereby saving on labor costs, but CSR refused to accept burnt cane. Other New South Wales canegrowers stopped supplying CSR in preference to small millers who generally accepted untrashed cane.⁷

Growers and other agricultural experts assessed soil fertility by the thickness of vegetation, with jungle-covered alluvial soils close to rivers believed to be the most fertile. Soil analysis to determine fertility was unheard of in Australia’s cane-growing regions before 1880, except on Beenleigh plantation, where the owners had their soils scientifically tested in 1876 to determine its deficiencies. The results guided them in the correct selection and application of fertilizers. A few other planters also fertilized. W. Canny, owner of Iveragh plantation near Maryborough, used guano and lime; Congoon plantation applied meatworks manure—a fertilizer made from meat processing by-products; the Fisherfield, Koorooroo, and Clydesdale estates added megass—sugarcane fiber after the harvested stalks have been crushed. Ferney plantation practiced cattle penning and mixed cattle manure with megass before adding it to the

fields. Generally, however, Australian canegrowers neglected care of the soil, as proven by the widespread absence of fertilizing and fallowing. They cropped the land until it showed signs of decline before taking any action to restore fertility.⁸

Some canegrowers failed to fertilize, no doubt, believing the various reports about the inexhaustibility of the country's soil. Richard Daintree, agent-general for Queensland from 1871 to 1876, wrote that the alluvial soils of coastal Queensland covered with dense jungle was of "robust description, and capable of repeated cropping with exhausting crops without manure." Maurice Hume Black, special immigration agent to the Queensland government in the 1890s, made similar claims in 1894, when he reported that land at Mackay still gave "good yields after being cropped for twenty years, without any artificial aid." Other Australian canegrowers just appeared to be lazy when it came to this most basic of all agricultural practices. In 1884 the special correspondent for the *Sydney Mail* reported some New South Wales mill owners suggested that their farmers should carry a load of megass back to the farms in the otherwise empty drays after delivering the harvested cane. The canegrowers, however, were too indifferent to even take away free material that could fertilize their farms.⁹

In addition to lack of interest in maintaining soil fertility, little thought entered into the design of the paddocks. The owners of Helensvale and Noyea plantations left square belts of timber around the fields to protect cane from damaging, icy winds. Their approach was exceptional. To reduce flooding of paddocks, the owners of Pimpama, Fisherfield, Morayfields, Burpengary, and Benowa plantations established surface drains on their properties by the mid-1870s. Louis Hope at Ormiston estate even created elaborate diamond-shaped drains of hardwood to depths of between thirty inches and six feet filled with coral rubble. Yet, these planters were the minority. Liversidge observed in 1875 that most Mary River planters had no artificial drainage system on their lands. The *Sydney Morning Herald's* survey of one hundred and five canegrowers in New South Wales in 1870 found the majority had no drainage, with ten having surface drains, and only two having underground drainage (see Table 1). In the Tweed River district in the late 1870s, CSR's cane inspector noted that many of the company's contractors planted cane in the hollows or on parts of their farms where the land was wet from want of drainage. They

did not attempt to establish drains to rid their properties of excess water. Gustav Kottman, CSR's inspecting chemist in the 1880s and 1890s, claimed to have observed on travels around the cane-growing districts of New South Wales "fields of cane which for weeks had been literally swamped; little had been done towards draining the low parts of the farms."¹⁰

As with paddock design and drainage, growers commonly relied on cane stools left in the ground after harvesting—ratooning—for subsequent crops to reduce expenditures of capital and labor. Generally, they took the heaviest crop at the initial harvest. From the cane roots left behind, canegrowers anticipated up to six or eight ratoon crops. As the land did not have to be prepared for planting very often, they believed this practice saved on cultivation costs even though yields per acre declined with each successive ratoon crop. Moreover, this practice led to the undisturbed furrows becoming a breeding ground for pests and diseases that were harmful to the crop.¹¹

Despite these apparently poor agricultural practices, the criticism from early commentators was harsh, especially in the context of virgin soil cultivation. Initial limited clearing of the fields can be explained by the need of planters to get a crop into the ground quickly in order to obtain some return on the large amount of capital being expended upon the formation of the sugar estate. Clearing paddocks of all the stumps cost between £15 and £20 per acre if done immediately after clearing the vegetation compared to £5–£7 per acre after three or four years. In addition, canegrowers faced labor shortages by the early 1880s, so it was not easy to secure workers to undertake the task. Even CSR with its huge financial backing did not immediately remove all the stumps from paddocks during the formation phase of its Goondi plantation near Innisfail because of the cost associated with removing so much timber. Another large expense in the 1880s—farm drainage—cost around £5–£10 per acre if growers installed pipes. Such expense was beyond the means of most small farmers, and there was the added difficulty of the absence of main outlet drains to natural watercourses to which farmers could connect surface drains. Additionally, the canegrowers planted the first crops in virgin soil, which responded well to little or no cultivation.¹²

The canegrowers' techniques, moreover, were consistent with the approaches adopted by farmers in other parts of the continent. According to historian Lionel Frost, "Australian farmers like their counterparts in North

America, developed simple techniques of ‘extensive’ cultivation.” With abundant land, farmers cropped continuously, exhausting the soil rather than using more expensive labor and capital (often in short supply) to increase the productivity of existing land. After they exhausted the fertility of a field, they simply moved to other virgin lands on their estates. Such strategies sought to maximize output instead of raising the productivity per acre.¹³

The prevalence of poor agricultural practices among Australia’s earliest canegrowers may also be attributed to the fact that few had farming backgrounds. Robert Muir of Benowa plantation and the MacDonald brothers of Inverness plantation had sugarcane-growing experience in the West Indies. John Davey and Francis Gooding of Beenleigh plantation came from farming backgrounds in Devon. Many of the pioneer canegrowers, however, had no or only limited previous experience of farming. James M. Knox, CSR’s inspector of mills, observed in 1887 that most CSR contractors were “never brought up as farmers,” while Henry Roth claimed the majority of Queensland’s pioneer canegrowers were not “agriculturalists.” Maxwell on his visit to Queensland in 1899–1900 concluded that the colony’s canegrowers, who were farmers in other countries, had no preparation for cultivating sugarcane, while for others “land work with them is a very recent thing.” He believed there was “not one farmer in their number who even pretends to know anything of the special principles of the science and practice upon which the continuous and economic production of cane must depend.”¹⁴

Some scientific knowledge that could have improved agricultural practices for growing sugarcane existed by the 1860s. In the West Indies, farmers applied chemical and natural fertilizers to the land to replenish fertility, although sometimes indiscriminately due to the absence of proper soil analysis. Agricultural experts preferred placing setts horizontally rather than vertically in the soil. Scientists advocated the use of animal-drawn implements—plows, harrows, and horse hoes—for breaking up the soil thoroughly and keeping the paddocks free of weeds. Such information was available to Australian canegrowers and was printed regularly in contemporary newspapers and specialist journals such as the *Australian Sugar Planter* (Maryborough) and the *Sugar Journal and Tropical Cultivator* (Mackay). Publications on practical sugarcane cultivation by Thomas de Keating, John Hincliffe, Angus Mackay, Melmoth Hall, and Frederick Bell were also available.¹⁵

Determining how many canegrowers accessed this information, however, is difficult. In New South Wales, the *Sydney Morning Herald* tried to survey canegrowers in 1869 and 1870 to determine their cultivation practices, but concluded, “many of them were illiterate.” Hence, the growers probably did not widely read the published material. However, meetings of the Wide Bay Farmers and Planters Association in 1868 and 1870 contained discussions about cane growing, while the Agricultural Society of Southern Queensland organized a conference about sugarcane cultivation in 1875. Therefore, some canegrowers had exposure to details about scientific cultivation methods. Nevertheless, promotion of this literature did not occur via government agricultural extension programs, as the Departments of Agriculture in Queensland and New South Wales did not exist until 1887 and 1890, respectively. In addition, formal training for prospective farmers did not commence in Queensland until the establishment of the Gatton Agricultural College in 1896.¹⁶

The impact of a non-scientific approach to cane cultivation became apparent in some sugar-producing districts by 1885. In the Clarence River district in the mid-1880s, CSR management began commenting that continuous cropping, shallow plowing, and limited fertilizing created a great diminution in soil fertility, which often produced half the mid-1870s yields. Farm land purchased for £30–£35 per acre in the past now cost only £15 per acre. In the Mary River district, a reporter for the *Queenslander* concluded in 1885 that under the present system of cultivation, exhaustion of the soil occurred rapidly, and sugar yields of 4,000 to 6,000 pounds per acre had fallen to only 500 pounds. Poor cultivation methods lowered the potential yield and markedly increased the vulnerability of sugarcane to attack by disease, fungi, and parasites. Inappropriate agricultural practices adopted by the country’s canegrowers contributed to the rust and gumming disease outbreaks of the 1870s and 1890s, respectively.¹⁷

The Colonial Sugar Refining Company, the first organization to actively promote the need for more scientific cultivation methods, decided in 1870 to encourage its Macleay River contractors to improve their land and cultivation methods. Edward Knox, Sr., CSR’s chairman of directors, offered two prizes of £50 each for the best ten or more acres of sugarcane and two prizes of £25 each for the best five to ten acres of sugarcane supplied to Darkwater Mill in the 1871 season. Three years later CSR announced it would distribute £1,000 worth of prizes, in sums varying from

£5 to £50 each, among its Clarence River contractors who supplied the firm's mills with sugarcane that had been carefully cultivated. The Colonial Sugar Refining Company required particular attention to fertilization, drainage, thrashing, and keeping the growing crop free of weeds. Farmers had to keep continuous records of these aspects, so CSR could identify the best farmers at the end of the crushing season. Such incentives, however, did little to raise the overall level of cultivation among the bulk of CSR's New South Wales contractors. Edward W. Knox, Jr. observed in 1876 that "our efforts to obtain better cultivation of the cane are not meeting with much success; farmers are still not ploughing." Nevertheless, CSR kept trying to improve the cultivation methods of its New South Wales contractors, lending money without interest to farmers who purchased pipes to drain their properties and encouraging the use of animal charcoal and superphosphate fertilizers by supplying them at reasonable rates.¹⁸

When CSR commenced growing cane for its own mills in the 1880s, the firm practiced the scientific methods that it promoted to contractors. Edward W. Knox, CSR's general manager between 1800 and 1920, allowed no discrepancy between what CSR practiced and what it advised its tenants and contractors. He counseled the mill manager at Condong Mill that "if we set a bad example we can hardly expect our tenants who have not the same facilities for hiring men as we have to keep their crops in proper order." Therefore, steam plows at Victoria and Homebush plantations ensured properly prepared paddocks for cultivation. Horse-drawn implements under the control of European plowmen undertook the annual tillage on each estate. Drains at Victoria and Condong estates removed excess water from the fields. After the dry seasons of 1885 and 1888, irrigation facilities at Victoria and Homebush plantations ensured crop survival during drought. Victoria and Homebush also used ash from the mill furnaces, megass, or molasses as fertilizer. Colonial Sugar Refining Company plantations practiced trashing but discovered, like its contractors, that labor shortages meant the task could not always be done once, let alone twice.¹⁹

To improve their own agricultural practices and those of their contractors, CSR's management realized the organization needed to keep up-to-date with the best overseas agricultural practices in sugarcane cultivation. In late 1887 Dr. Gustav Kottman, the inspecting chemist for CSR, traveled

to Java to report upon Dutch cultivation practices. Kottman concluded that CSR cultivation methods were “much behind our Java competitors and though we cannot hope with our dear labour to bestow the same amount of care on cane fields, there is no doubt that closer attention to the fields will improve our cane supply.” As a result of this report, CSR began scientific investigations into growing cane under Australian conditions. On five to ten acres set aside at each estate, CSR tested the effectiveness of green manuring and fallowing on restoring soil fertility and subsequent cane yields. They delivered different types of chemical fertilizers, including fertilizer manufactured at the firm’s Pyrmont Refinery since 1886, to all the plantations with instructions to test them on different cane varieties to see how much should be applied and which varieties responded best to chemical fertilizers. A. C. Barry, manager at Harwood Mill in 1889, selected forty of the best farmers in different parts of the Clarence River district and provided them with fertilizers to test their effectiveness. Trashing experiments commenced in 1887. They conclusively showed the practice did not improve sucrose content or cane yield from a paddock, resulting in CSR from then on deeming it unnecessary.²⁰

Kottman acted as a clearinghouse for new information. As he received results from the plantation trials, he compiled agricultural circulars and sent them to the estates with advice on best practices. Because of these trials, green manuring using Mauritius beans, cowpea, and lupine seeds began at Homebush and Victoria plantations in 1891. These crops covered the land during the wet season, thereby reducing soil erosion and when plowed back into the fields returned essential nitrogen to the soil. By the turn of the century, a quarter of the land cultivated by CSR at its Victoria plantation each year was under green manure or else fallowed. Subsoiling experiments at all plantations in 1893 improved yields following the procedure at Condong plantation. Further experiments in drainage, planting in squares versus furrows, fertilization, and plowing occurred at Keith Hall estate, a run-down property in the Richmond River district purchased by CSR in 1889 and converted to an experimental farm. Knox hoped CSR’s methods at Keith Hall would “show to farmers that clean and careful cultivation paid.” A booklet issued to its New South Wales contractors in 1895 summarized conclusions from the trials at Keith Hall. The company encouraged farmers to abandon planting in squares in favor of planting in rows as the latter method gave better

yields. It asked farmers to cease plowing between plant cane in favor of using shallow cultivation that reduced damage to the roots of young cane and to adopt drainage, subsoiling, green manuring, and crop rotation. The Colonial Sugar Refining Company issued another booklet outlining the latest cultivation methods to Queensland contractors in 1914.²¹

As CSR began settling farmers on its plantation lands, management realized that many of its tenants had little experience in tropical agriculture. Moreover, the organization's future depended upon the mills receiving expanded cane supplies from these tenants. Hence, CSR tried to improve farming techniques based upon the results from its own investigations. After 1895 CSR decided to forego rent on land under green manure at its Homebush and Victoria plantations to encourage rotation and resting of the soil. In 1901 and 1902 CSR offered tenants at Homebush plantation a bonus of ten shillings per acre if they practiced green manuring, installed surface drains, and appropriately plowed the paddocks of cultivated cane. The Colonial Sugar Refining Company's inspector of mills, Walter A. Farquhar, remarked in 1903 that this strategy at Homebush led to better drained fields and cowpea crops becoming "the rule rather than the exception now." The company purchased fertilizers in bulk and allowed its tenant farmers to procure them at cost, free of interest, with payment for the company to come from the proceeds of the fertilized crop. To encourage drainage at Victoria plantation, CSR from 1897 onwards, either supplied the pipes to the tenants who installed them, or the firm drained the fields and added the cost to the rental or purchase price of the farm. After 1909 CSR even advanced up to £3 per acre free of interest to farmers in the Tweed River district to assist in clearing stones so they could plow the land. During the 1900s CSR began welcoming Italians as contractors for its North Queensland mills. The Italians were favored because the Macknade Mill cane inspector observed: "There is no doubt that these Italians will grow more cane than the Britishers and succeed where the latter failed, for they live more cheaply, are exceedingly hard workers, keep the young cane thoroughly clean by both horse cultivation and hand weeding (which the British do not), are strong believers in artificial and green manures and procure more labour as they are usually three to four to a company."²²

Other companies operating sugar plantations in the 1880s also demonstrated more scientific cultivation techniques (see Table 2). With their large financial resources, they removed the stumps from their estates and

Table 2. Agricultural Practices by Selected Queensland Sugar Companies Between 1880 and 1892

<i>Plantation</i>	<i>Owner</i>	<i>Plowing</i>	<i>Fertilizing</i>	<i>Irrigation</i>	<i>Drainage</i>	<i>Thrashing</i>
Hambleton	Swallow & Ariell			Y		Y
Mourilyan	Mourilyan Sugar Co.			N	Y	Y
Innishowen	Qld. Sugar Co.				Y	Y
Ripple Creek	Wood Bros. & R. Boyd	Y	Y			
Hamleigh	Hamleigh Sugar Co.	Y	Y	Y	Y	
Kalamia	C. & J. Young	Y	Y	Y		
Pioneer	Drysdale Bros.	Y	Y	Y		
Seaforth	J. Mackenzie	N		Y		
The Palms	Melbourne-Mackay Sugar Co.	Y				
Pleystowe	Pleystowe Sugar Co.			Y	Y	
Victoria	Mackay Sugar Co.	Y			Y	
Meadowlands	W. Hyne & Co.		Y	Y		
Farleigh	Sir J. Lawes			Y		
Fairymead	A. H. & E. Young	Y	Y			Y
Bingera	Gibson & Howes	Y	Y	Y	Y	
Island	Cran Bros.		Y		Y	

SOURCES: *Queensland Votes & Proceedings* 4 (1889): 129–32, 177–79, 185–87, 211–13, 217–19, 235–36, 240–44, 286, 404; *Queenslander*, June 21, 1884, December 31, 1887, January 23, 1888; *Mackay Mercury*, September 23, 1882; *Townsville Herald*, November 5, December 31, 1887; Aeneas Munro, *Sugar Fields of Mackay* (Mackay: Hodges and Chataway, 1895), 58; *Capricornian* (Rockhampton, Queensland), July 28, 1888; *Mackay Standard*, June 12, 1895; John Kerr, *Southern Sugar Saga: A History of the Sugar Industry in the Bundaberg District* (Bundaberg: Bundaberg Sugar Company Limited, 1983), 62 and *Maryborough Chronicle*, April 27, 1885; *Sugar Journal and Tropical Cultivator* (January 15, 1893): 262.

Y = practice observed; N = practice not observed.

employed steam plows to thoroughly break up the soil in the paddocks. On many of these estates, European plowmen using horse-drawn implements plowed the paddocks and kept the growing cane free of weeds. On other properties, gangs of Melanesians used hoes to remove weeds from the paddocks (see Figure 3). These organizations adopted fertilization,

consisting mainly of megass or other mill refuse, on several of the properties. However, they did not universally practice trashing cane. The Lower Burdekin planters claimed not to have the labor to spare on trashing, so they fired their cane to clear the trash before harvesting. They undertook drainage on some properties, with the most elaborate system of channels in North Queensland reputedly existing on the Victoria plantation (Mackay). The planters spent an estimated £15,000 to connect fifty miles of small surface channels to larger surface drains constructed around the property's boundaries. Irrigation was essential on the Lower Burdekin where a highly variable annual rainfall averaged forty inches. By 1888 the Lower Burdekin boasted the largest irrigation system in Australia. Pumping stations on each of the main plantations delivered water into forty miles of canals that spread throughout the district's cane paddocks. After the dry seasons of 1885 and 1888, another half-dozen sugar-producing properties began irrigating, mostly in the Mackay and Bundaberg districts, but not on the scale found on the Lower Burdekin sugar plantations.²³

Some of the larger sugar-producing firms that survived into the 1890s adopted the system of scientific agriculture introduced by CSR. Meatworks manure replenished the soil at Nindaroo and Pioneer plantations, while the Farleigh plantation owners imported six hundred tons of fertilizer direct from Chile in 1892. By the turn of the century, the proprietors of Fairymead plantation practiced crop rotation with about three-fifths of the property being under cane each year, leaving the remainder in cowpeas or fallow. They also experimented with sheep on the cowpeas to see if animal manure benefited the soil. In the mid-1890s the owners of Bingera plantation carried out underground drainage of low-lying lands extensively, making their own pipes at the pottery on the estate. The mill chemist tested different composts and artificial fertilizers to see which benefited the soil the most and analyzed the soil to determine deficiencies and ensure correct fertilizer applications. In 1897 the plantation owners used steam plows to "purge the ground of roots and stumps," and by 1900 they added lime and treated the soils with superphosphates made on the property and used green manuring from cowpeas. Goodwood plantation owners restored soil fertility through the adoption of green manuring and the application of meatworks manure and refuse from the property's piggery.²⁴

The above advances, however, virtually ignored irrigation except on the Lower Burdekin where approximately 75 percent of Queensland's

irrigation was concentrated in the 1890s. Pioneer and Kalamia plantation owners substantially expanded their irrigation facilities throughout the 1890s. Tenants on these estates took advantage of the landlords' irrigation facilities to irrigate their own crops. A series of dry seasons at the turn of the century also forced other sugar-producing companies to devise ways to irrigate their properties. The Australian Estates and Mortgage Company erected a pumping station on the banks of Pioneer River in order to provide water for its Palms plantation, while Fairymead and Qunaba plantations used bores and spears to tap underground water supplies. In contrast, the Millaquin and Yengarie Sugar Company irrigated with refuse water from the Millaquin Refinery. Gibson and Howes, who already irrigated on Bingera plantation, spent £30,000 on expanding their facilities. Owing to the prevalence of floods in the Burnett River, their plant had to be above flood reach. Consequently, the water passed through a tunnel in the riverbank to the main shaft. Pumps then forced the water through 1,500 feet of thirty-inch steel pipe into a reservoir, two hundred feet above the river level. Coal, delivered by rail to coal hoppers, fueled boilers for four pumping station engines that lifted water to the reservoir. Small canegrowers could not afford such large capital outlays. Moreover, the planters estimated the annual operational cost of irrigation facilities at £3–£5 per acre, so throughout the 1900s and 1910s irrigation remained out of reach for most Australian canegrowers, except on the Lower Burdekin where millers provided assistance.²⁵

As some planters ceased growing cane and became proprietary central mill owners, they assisted their tenant farmers and other suppliers in the improvement of cultivation methods. The Drysdale Bros. on the Lower Burdekin supplied fertilizer to their farmers in 1897 and allowed them to use the firm's fertilizer spreaders free of charge. The farmers paid for the fertilizer after harvest. The proprietors of Bingera plantation rented their steam plow on reasonable terms to their tenants to ensure the land was thoroughly broken up on the rented farms. Farmer co-operatives, formed in the late 1890s after groups of small canegrowers secured Queensland government funds to build central mills, also encouraged their suppliers to adopt more scientific cultivation practices. Management at Mulgrave, Nerang, and Moreton Central Mills arranged for their contractors to have abundant supplies of lime, artificial fertilizers, and mill products to encourage fertilizing. Payment was not required until the mills crushed the

crop from the fertilized area. During the mid-1900s Mt. Bauple Central Mill offered farmers use of the factory's horses in the non-crushing season to facilitate plowing of the fields. Farmers could even rent up-to-date implements such as disc plows from the mill. A similar scheme operated at Mossman Central Mill in 1911, but the directors were more modern in their approach, providing a gasoline-powered tractor and up-to-date implements for rental. In 1910 the Moreton Central Sugar Milling Company tried to stimulate good cultivation practices by offering five prizes of £100 to the farmers producing the best-cultivated crops of cane.²⁶

By 1900 CSR and other milling companies showed that scientific principles improved cultivation methods. Governments in New South Wales and Queensland, however, were slower to become involved in promoting these investigations. The New South Wales government established the Wollongbar Experimental Farm near Lismore in 1893. There the main investigations during the 1890s concentrated on determining the suitability of different sugarcane varieties to the frost-prone environment of northern New South Wales, while leaving research in cultivation methods to CSR. In the late 1880s the Queensland Department of Agriculture established State Nurseries at Mackay and Kamerunga near Cairns. These nurseries propagated nearly one hundred cane varieties mainly from British New Guinea in hope of finding new, sucrose-rich varieties for Queensland canegrowers. The investigations, although appreciated by the colony's growers, did not fully satisfy their needs. Growers continued to complain that the State Nurseries did not address the sugar industry's requirements for scientific investigations into soil types, fertilization, and irrigation. The growers pressured the Queensland government to establish sugar experiment stations and laboratories similar to those established in Java in 1887, Louisiana in 1885, and Hawaii in 1895.²⁷

This pressure succeeded. A laboratory addition to the Mackay State Nursery in 1898 initiated experiments to determine the effect of various artificial fertilizers and green manuring on the growth of cane. This development, however, only temporarily appeased the Queensland canegrowers' demands for sugar experiment stations. Because of continued pressure, in 1899 the Queensland Minister for Agriculture announced the conversion of the Mackay State Nursery into a Sugar Experiment Station. At the same time, the Bundaberg Planters and Farmers Association persuaded

the government to invite Dr. Walter Maxwell to investigate the state of Queensland's sugar industry.²⁸

Maxwell's report in January 1900 analyzed the condition of the soils in the colony's sugar-producing districts, causes of declining yields, irrigation, and cultivation methods. He determined that continuous cropping and indifferent cultivation greatly diminished soil fertility. He concluded that the canegrowers needed advice and assistance in maintaining and restoring soil fertility and in the cultivation of cane. Maxwell's main recommendations included the establishment of three additional sugar experiment stations: one in the neighborhood of Mulgrave Mill near Cairns, one at Mackay, and another at Bundaberg. A director aided by a staff of analytical chemists and assistant directors, would have overall responsibility for a program of scientific research and farmer education carried out at the stations.²⁹

Maxwell's work spurred further government research in the sugarcane industry, but this was not unopposed. Based upon his report, the Queensland government passed the Sugar Experiment Act of 1900 and offered Maxwell the position of director of the Queensland Bureau of Sugar Experiment Stations (BSES). Maxwell accepted and returned to Queensland in November 1900. He took over the existing laboratory at Mackay and arranged for the erection of another chemical laboratory at Bundaberg, which became his headquarters. He established substations for experimental trials on a wide range of subjects under varying soil and climatic conditions, on properties throughout the sugar-producing districts. Financing of the BSES came from a levy, not exceeding one penny per ton of cane delivered to the state sugar mills, paid by the mill owners and canegrowers in equal proportions. The CSR, outraged when asked to fund the BSES, complained that improvements made at its mills and plantations resulted from their own extensive and expensive research program. Knox predicted that the proposed investigations by the BSES would be of little benefit to his company, yet they were required to contribute to the funding of these investigations. In what appears a deliberate retaliatory action, Knox banned Maxwell from gaining access to any figures relating to the operation of CSR mills and plantations, although the firm generally did not allow outsiders to view the results of its operations.³⁰

Despite this opposition, BSES staff at the substations and canegrowers began experiments into cultivation methods and ways to restore soil

fertility. Tests to determine the value of subsoiling carried out in 1902 and 1905–1907 showed conclusively that first ratoons grown on subsoiled ground produced one-third higher yields than ratoons grown on land plowed to eight inches deep only. Irrigation experiments at the Mackay Station from 1905–1907 proved that sugarcane from irrigated and fertilized plots produced 15 percent more weight than cane from non-irrigated and non-fertilized plots. Investigations during 1905 and 1906 into planting at different inter- and intra-distances suggested that the distance between rows had a definite bearing upon overall crop results. In addition, BSES analyzed 8,140 soil samples from different cane-growing districts by 1908, thus creating the first comprehensive assessment of soil fertility in Queensland.³¹

Along with experimentation, Maxwell and his staff worked hard disseminating their findings to growers. They traveled to Queensland's different sugar-producing districts, addressing meetings of canegrowers on their results. In September 1902 Maxwell advised canegrowers at Mossman to use more lime, as soil analyses indicated the district's soils were deficient in this nutrient. In 1903 he suggested to farmers at Proserpine that their soils needed more nitrogen. Farmers could easily obtain this element by burying their trash; the common practice of burning off the trash led to release of nitrogen into the air. During a visit to the Lower Burdekin in 1903, Maxwell also assessed irrigation practices throughout the district. He found damage to some fields on the Pioneer plantation caused by the application of vast quantities of water. Maxwell advised Drysdale Bros. not to irrigate with so much water or as often.³²

Farmers criticized Maxwell's emphasis on soil analyses. John D. Campbell, a local parliamentarian for the Moreton electorate, during a speech in the Queensland Parliament said, "the practical farmers who use the central mills scorn his advice. They tell me they can do better without him." George Muntz, chairman of the board of directors of the Mossman Central Mill Company, claimed to have observed Maxwell's methods and listened to his teaching but thought that he did not "add to the knowledge of the cane growing community one iota." Maxwell grew tired of the complaints, the heavy workload of running the BSES, and overseeing the operation of the state's central sugar mills, a task he assumed in 1904. He eventually left Queensland in 1909. His successors at BSES decided that greater interaction with the canegrowers would lead to better appreciation of their

problems. They appointed field instructors in 1912 to constantly move from farm to farm giving advice to canegrowers on cultivation methods. Despite this change, the general thrust of Maxwell's program—soil analysis, improving soil fertility, liming, and green manuring—continued into the 1910s.³³

Major changes in the farm implements used to cultivate sugarcane did not accompany the improvements in field preparation and soil fertility that occurred after 1880. The plow replaced the hoe on many cane-growing properties, but most canegrowers did not seriously entertain mechanized cultivation and harvesting before 1915. Two main reasons explain this lack of progress in substituting machinery for labor. First, most canegrowers had access to cheap, indentured workers until the deportation of Melanesian workers in 1906, limiting incentive to seek out mechanical replacements. Second, replacing the hoe with animal-drawn implements was easier and cheaper than mechanizing the cultivation and harvesting processes. Nevertheless, some Australian growers attempted to do so in the latter part of the nineteenth century, but not always successfully.³⁴

Harvesting was the most laborious and bothersome feature of cane growing during the nineteenth century. Inventors found designing a practical harvester that could cut cane to replace cane cutters a difficult task. In March 1887 Thomas Tomlinson approached CSR with details about an apparatus that could mechanically harvest cane. The Colonial Sugar Refining Company advanced Tomlinson money so he could complete the machine. After negotiations, however, CSR decided against the project because as Edward W. Knox concluded, "Mr. Tomlinson could not adequately explain how the cane stalks were to be cut off close to the ground or how the cane was to be topped." The company never again sought to trial mechanical harvesters, despite numerous opportunities throughout the 1890s and 1900s when at least another twenty inventors took out patents on designs for cane harvesting machines. In 1915 most of these early machines were too bulky and unwieldy, keeping Australia's canegrowers another fifty years away from replacing cane cutters with mechanical harvesters.³⁵

Australian inventors achieved more success in devising mechanical cane planters to replace the usual method of hand planting, where dozens of workers walked behind the plow, filling the furrows with setts (see Figure 4). In January 1898 they tested a machine in Bundaberg known as

Crowe's cane planter. The main principle of this apparatus consisted of the hand feeding of pieces of cane cut into suitable lengths through a hopper that delivered them into a furrow made by an attached plow. The arrangement of the moldboards forced a sufficient quantity of soil to fall back into the furrow where it covered the setts. Pryce Trevor, an inventor of a similar mechanical planter in 1900, claimed the machines saved up to ten shillings per acre, reducing the numbers of workers needed considerably. The Colonial Sugar Refining Company began systematic tests of Crowe's planting machine in 1898. By 1904 CSR concluded that two men with a mechanical planter could plant three to four acres per day, whereas under the traditional system of hand planting, two men could plant only two acres per day. Improved versions of the cane-planting machine during the 1900s and early 1910s enabled larger capacity and better delivery of the setts. Even where hand planting continued, the BSES observed in 1914 that the use of a cultivator, with its teeth removed, replaced the old method of covering up the plants by hand. A horse pulled this apparatus along either side of the drill, causing sufficient amounts of dirt to cover the setts.³⁶

Before 1910, despite some mechanization and improved planting practices, workers performed field preparation and weed control in Australian sugarcane paddocks with hoes or animal-drawn implements. Steam plows had never been widely used in Australia's sugar-producing regions due to their cost of purchase and lack of maneuverability. By 1910, however, overseas inventors developed internal combustion-powered tractors that proved much easier to employ in cultivation tasks. Moreover, the tractors replaced both men and horses in the field. During the early 1910s farmers tested a few of these early model tractors throughout Queensland sugar-producing districts. Australian investigations found that plowing fields with tractors cost 10–11 shillings per acre as opposed to £1 per acre when plowed by teams of horses. Unfortunately, the tractors cost almost £600, which put them beyond the reach of most Australian canegrowers.³⁷

Regardless of the high cost of tractors, Australian canegrowers did adopt the expanding body of scientific knowledge, which resulted in improved cultivation methods by 1915. A considerable increase in liming and green manuring took place, while crop rotation and the application of artificial and organic fertilizers rapidly gained fashion amongst the small canegrowers. They abandoned trashing as a cultivation method due to

labor shortages, the unwillingness of white workers to undertake such a task, and CSR investigations that found trashing to be unnecessary. In districts where CSR mills operated, cane inspectors noted a tendency amongst canegrowers to put more effort into cultivating the plant crop—i.e., first crop of planted setts—while allowing the later ratoons to take their chances. Nevertheless, contractors aimed to produce more tons per acre, rather than poorly cultivate large areas, thus pleasing CSR. Improved types of implements found wide use. Cane planters gained favor, harrows saved labor in some northern cane-growing districts, and gasoline-powered tractors appeared in the paddocks. Modified cane planters spread lime and distributed fertilizer.³⁸

Beginning in the 1890s many Australian canegrowers—both small-scale farmers and more prominent, bigger operators—readily adopted scientific cultivation methods. Part of the reason for this related to the payment system used at most Australian sugar mills until the mid-1900s: payment was based on tonnage delivered. More fertilizing, weed reduction, and better drainage resulted in more tonnage. Additionally, increasing numbers of small canegrowers in the 1890s actively adopted these practices. They probably did so to satisfy their landlords—the milling companies—who would only lease or sell them the land with the certainty of securing an abundant cane supply for their mills.³⁹

Adoption of scientific approaches by Australian canegrowers had more positive benefits than just making the fields look cleaner and tidier. Statistical evidence suggests that yields improved during the 1900s and 1910s (see Tables 3 and 4), although the adoption of the new, sucrose-rich cane varieties such as Badila, Goru, and M1900 also reduced the average tonnage needed to produce a ton of sugar. A lack of surviving detailed financial records for small canegrowers from this period, however, makes it impossible to assess if they benefited by improved incomes. Seventy-five years ago, it is doubtful if many small canegrowers could say that adopting the scientific cultivation methods had improved their profits. One small canegrower, representative of many of his colleagues, advised the 1912 Royal Commission into the Australian Sugar Industry: “I am not able to state the profit I make on cane-growing, but I am satisfied I am making a profit; there is no thorough system of bookkeeping.”⁴⁰

Thus, the economic historian Adrian Graves appropriately concluded that the techniques of sugarcane cultivation in Queensland, and most

Table 3. Average Tonnage Per Acre of Sugarcane Harvested in Queensland and New South Wales, 1897–1914

<i>Period</i>	<i>Queensland</i>	<i>New South Wales</i>
1897–1899*	15.2	19.4
1900–1904	13.4	20.1
1905–1909	15.9	22.0
1910–1914	17.1	25.9

SOURCES: *Statistics of Queensland* and *Statistical Registers of New South Wales*.

* Figures for 1897 include only Queensland.

likely New South Wales, were inadequate for much of the late nineteenth century. Farmers during the early stages of frontier farming in Australia used their limited resources of labor and capital as little as possible. Australia's first canegrowers simply engaged in rational behavior when confronted with abundant land, but limited supplies of capital and labor. High wages for experienced plowmen does not fully explain why such poor agricultural practices existed. In addition, many of Australia's earliest canegrowers had no or limited previous farming experience, and some were illiterate, they could not even read the published material on scientific cultivation methods. Lack of scientific knowledge about cane growing under Australian conditions, particularly information on correct planting methods (i.e., planting in squares versus furrows), the advisability of trashing, the effectiveness of deep plowing, and the application of appropriate fertilizers, thwarted success.

Table 4. Average Tonnage of Sugarcane to Produce a Ton of Raw Sugar in Queensland and New South Wales, 1897–1914

<i>Period</i>	<i>Queensland</i>	<i>New South Wales</i>
1897–1899*	9.0	10.2
1900–1904	8.9	9.6
1905–1909	9.0	9.4
1910–1914	8.6	8.4

SOURCES: *Statistics of Queensland* and *Statistical Registers of New South Wales*.

* Figures for 1897 include only Queensland.

Investigations after 1888 by the Colonial Sugar Refining Company, and later by the Queensland Bureau of Sugar Experiment Stations, supplanted the dearth of information on cane farming under Australian conditions. Both organizations actively promoted the results from these investigations and the use of scientific cultivation methods, in general, amongst Australian canegrowers. New strategies met with some success, leading to increased amounts of cane harvested per acre and a reduced amount of cane needed to make a ton of sugar. As a result, Ernst Scriven, director of the BSES, concluded that farming methods used by Australian canegrowers in 1914 were generally on the “upgrade.”⁴¹

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25. In the Australian context a bore is a deep hole of small diameter that goes to an underground aquifer. Sometimes a metal pipe is placed in the hole and used to extract the water. A spear or Abyssinian tube well was an English invention of the late 1870s. This spear method consisted of sinking perforated tubes, twenty to twenty-five feet into the ground to tap underground water. The invention was modified in Australia by the addition of gauze over the end of the spear to keep out fine gravels.

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