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The untold history of banana bunchy top disease

Andrew D. W. Geering[A,*]

For full list of author affiliations and declarations see end of paper

***Correspondence to:**
Andrew D. W. Geering
Queensland Alliance for Agriculture and Food Innovation, The University of Queensland, St Lucia, Qld 4072, Australia
Email: a.geering@uq.edu.au

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ABSTRACT

Of all the plant diseases that occur in Australia, banana bunchy top disease would rank high on any list of those that have had the greatest impact on society. Bunchy top first became a major problem in Australia during World War 1 in the Tweed Valley in New South Wales, close to the border of Queensland. The Soldier Settlement Scheme was initiated to provide a livelihood for returned soldiers, and the Northern Rivers region of New South Wales was chosen as the site for a new subtropical fruit industry. Physically and psychologically damaged men were encouraged to settle on the land to grow bananas, only to be left in ruins within two years because bunchy top had destroyed their plantations. Bunchy top did not discriminate, and many other well-established growers also 'went broke'. The cries for assistance from the banana growers made it to the federal Parliament in Melbourne, and a Bunchy Top Investigation Committee was formed in 1924 with funding equally contributed by the New South Wales, Queensland, and Australian Governments. Charles Magee was the full-time plant pathologist appointed to the investigation, and he did most of the research. Most histories of the bunchy top research program follow the written accounts of Magee, but he only provided a narrow perspective. Several of the major hypotheses about the epidemiology of bunchy top disease, such as that it was spread in the plant's suckers and was vectored by the banana aphid *Pentalonia nigronervosa*, were established by growers such as William John (aka Jack) Burton Marks well before the Bunchy Top Investigation Committee began. This paper describes the beginnings of the subtropical banana industry, the introduction of bunchy top disease, and efforts by the scientific and farming communities to find a preventative treatment or cure for the disease.

Keywords: *Babuvirus*, banana bunchy top virus, Charles Magee, disease control, Elvin Stakman, Ernest Goddard, George Darnell-Smith, Henry Tryon, John Marks, lantana seed-fly, *Pentalonia nigronervosa*, Sam Farrant, Soldier Settlement Scheme.

Introduction

Banana bunchy top virus (BBTV, genus *Babuvirus*, family *Nanoviridae*) is by far the most damaging viral pathogen of bananas and plantains (*Musa acuminata* and *M. acuminata* × *M. balbisiana* hybrids), and related species in the Musaceae such as abacá (*Musa textilis*).[1] Plants, if they are infected at a young age, fail to produce fruit (Fig. 1). The virus is efficiently transmitted by aphids (*Pentalonia nigronervosa* and *P. caladii*), which are highly mobile and spread the virus rapidly (Fig. 1). Bunchy top is poorly managed in many parts of the world, but Australia is a notable exception. This was not always the case, as the subtropical banana industry in northern New South Wales and southern Queensland was nearly destroyed by the disease during the 1920s.

In 1922, the problem of bunchy top in the Northern Rivers region of New South Wales (Fig. 2) had become so severe that it was elevated to the House of Representatives of the federal Parliament in Melbourne for discussion. The Minister for Trade and Customs promised to refer the matter to the Commonwealth Institute of Science and Industry

[1]For a recent literature review on banana bunchy top virus, see Thomas (2021).

Fig. 1. Banana bunchy top disease and its aphid vector. Photograph (*a*), 'Cavendish' banana infected with banana bunchy top virus in Hawai'i; photograph (*b*), cigar leaf of banana plant infested with banana aphids (*Pentalonia nigronervosa*). Photographs by Scot C. Nelson, University of Hawai'i.

(a predecessor of the Council for Scientific and Industrial Research—CSIR—and the Commonwealth Scientific and Industrial Research Organisation—CSIRO), and to commit £1500 in funding for the 1923–4 financial year on the condition that the governments of New South Wales and Queensland each matched this funding for the first year of a joint investigation.[2] This offer was accepted by all parties, but a deadlock arose as to who should control the investigation, and how and where it would be carried out.[3] To overcome these difficulties, an advisory committee containing representatives from the two states and the Commonwealth was formed to make recommendations as to the procedure and administration of the joint fund. This committee comprised Professor Robert Dickie Watt (1881–1965) from the University of Sydney, Professor Ernest James Goddard (1883–1948) from the University of Queensland (Fig. 3), and Professor Theodore George Bentley Osborn (1887–1973) from the University of Adelaide, who represented the Commonwealth Institute of Science and Industry.[4]

The Bunchy Top Advisory Committee prepared a report for presentation to each of the contracting governments in early 1923. In this report it was concluded that the disease epidemic had begun in the Tweed Valley, and that the disease had spread from the first affected farm to others in the district by the transfer of young plants and corms. Several recommendations were made, including sending a horticulturist to Fiji to study the disease there and to bring back potentially resistant varieties of banana.[5] However, the most important recommendation was to appoint a scientific team of 'high standing' to research the cause of the disease, and for this team to be headquartered at Tweed Heads or Coolangatta, close to the banana-growing districts. A 'Bunchy Top Investigation Committee' was created in May 1924, comprising Professor Goddard as supervisor, Charles Joseph Patrick Magee (1901–89) as assistant plant pathologist (Fig. 4), and Henry J. Collard as horticulturist. Tweed Heads was selected as the location for a laboratory, and land was leased at Cobaki

[2]Knibbs (1924).
[3]Anonymous (1924*e*).
[4]Goddard and others (1926). The School of Biological Sciences building in the Great Court of The University of Queensland is named after Ernest Goddard.
[5]Anonymous (1924*d*).

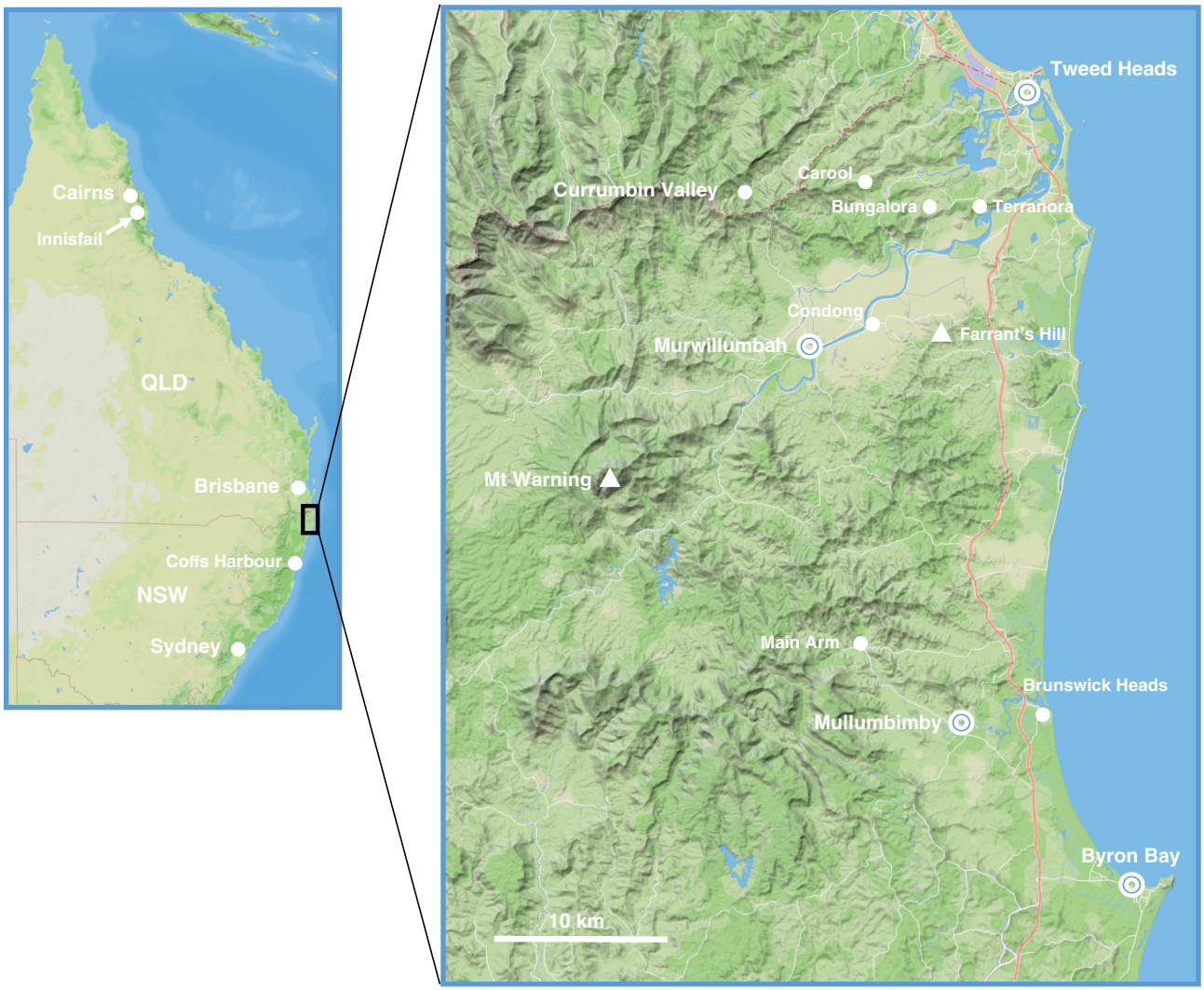

Fig. 2. Map of the east coast of Australia showing the location of the Northern Rivers region (enlarged inset). Map created using Mapbox Studio.

from Messrs. T. Pilgrim and McAlister for the field trials.[6] This investigation was managed by a 'Bunchy Top Control Board', comprising the director of the Commonwealth Institute of Science and Industry, and the under secretaries of the New South Wales Department of Agriculture and the Queensland Department of Agriculture and Stock.

The investigation ran for two years, and a final report was submitted on 30 March 1926;[7] the majority of this report was published the following year as a CSIR bulletin by Magee.[8] The most important results from the investigation were that the bunchy top pathogen was transmitted by the banana aphid *P. nigronervosa*, and that the host ranges of both the pathogen and its aphid vector were confined to *Musa* species. Furthermore, it was shown that the pathogen systemically infected the plant, including all the suckers, and propagation using the suckers spread the disease. Several options to control bunchy top were considered, but only prevention, eradication, and exclusion were regarded as viable. The Bunchy Top Investigation Committee recommended the establishment of domestic quarantine zones, the eradication of all diseased plants and abandoned plantations, and the creation of rules to ensure only healthy suckers were used to establish new crops. It insisted that any plant health regulations should be rigidly enforced by government legislation. The recommendations of the Bunchy Top Investigation Committee were adopted by the banana industry, and bunchy top was eventually controlled. The development of a bunchy

[6] Goddard and others (1926).
[7] Goddard and others (1926).
[8] Magee (1927).

Fig. 3. Professor Ernest James Goddard, Supervisor of the Bunchy Top Investigation Committee. Photographer unknown. Photograph from the University of Queensland Archives s177 p. 1437.

top control program was a strong outcome of the research, but the success of the control program relied upon the full cooperation of the farming community, and the strong legislative support provided by the state governments.

Magee left a detailed account of the research he undertook on bunchy top,[9] but much less is known about the period before the creation of the Bunchy Top Investigation Committee in 1924, when theories abounded as to the cause of disease, and financial rewards were offered for anyone who could provide a cure. This article examines the early years of the Australian banana industry, and highlights some of the research done by the state departments of agriculture and by growers such as John (Jack) Marks, who responded to the desperate calls of the farming community to find a way to halt the progress of bunchy top disease, which was crippling the economy of the Northern Rivers region of New South Wales. Fortunately for historians, bunchy top disease was a major topic of discussion in the local newspapers, and these newspapers represent a rich resource to piece together this untold history.[10]

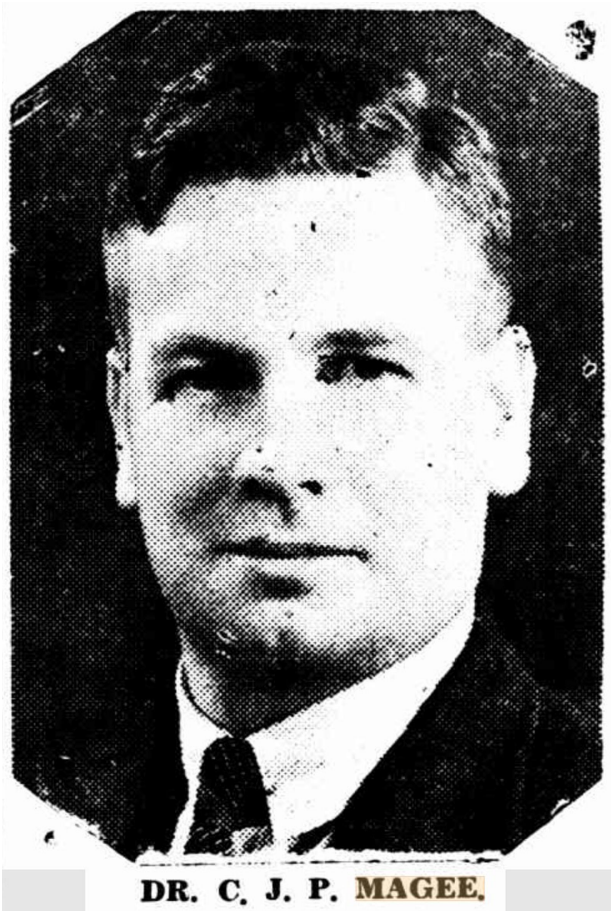

Fig. 4. Charles Joseph Patrick Magee, Assistant Plant Pathologist with the Bunchy Top Investigation Committee. Photograph from the *Tweed Daily* newspaper, 16 May 1939, p. 4. Magee is pictured about the time he was awarded the degree of Doctor of Science in Agriculture by the University of Sydney.

The history of the subtropical banana industry in Australia

Although edible bananas have been grown in Australia since early colonial times,[11] they were only cultivated in small quantities until an industry was established around Cairns and Innisfail (known as Geraldton prior to 1909) in far north Queensland in the 1880s (Fig. 2).[12] This industry was created by Chinese immigrants who initially were attracted to the area in 1873 by the promise of making a quick fortune at the Palmer River Goldfield on Cape York Peninsula. The reality turned out to be overcrowding and fierce competition for resources, leading to poverty and crime and a mass exodus of the Chinese from the goldfield from 1877

[9] Magee (1927, 1939, 1940, 1948, 1953).
[10] 13,446 newspaper articles are stored in Trove (https://trove.nla.gov.au/) that match a search using the keywords 'banana bunchy top'.
[11] Ryley and Drenth (in press).
[12] Much of the information on the Chinese banana industry in north Queensland is sourced from May (1984) and Yong (1964).

onwards. These workers gravitated to Cairns, and some turned their hands to market gardening, including the cultivation of bananas.

Through the enterprise and hard work of the Chinese, the banana industry rapidly expanded through the 1880s, and in 1886 interstate fruit exports began. However, problems slowly accumulated that eventually became insurmountable for the Chinese growers. The *Chinese Immigration Restriction Bill 1889* (Queensland) and the *Immigration Restriction Act 1901* (Commonwealth) prevented workforce rejuvenation by drastically curtailing Chinese immigration, and the *Leases to Aliens Restriction Act 1912* (Queensland) limited the area of land a Chinese grower could lease to five acres (two hectares). The journey to Melbourne by steamer took approximately twelve days with several trans-shipments, and frequently less than 50% of the fruit arrived in a saleable condition due to rough handling and overripening. The southern governments introduced regulations to prevent the introduction of Queensland fruit fly (*Bactrocera tryoni*), resulting in entire consignments of fruit being destroyed if a single fruit fly was detected by fruit inspectors at either end of the journey.[13] In 1908–9, the Victorian Government introduced even more draconian regulations relating to fruit fly, including the costly and burdensome requirement that bunches of fruit had to be encased in a stockinette two months before harvest. To reduce the risk of fruit fly infestation and other damage that happened during transit, the Chinese growers tended to pick the fruit too green, resulting in the produce acquiring a poor reputation for quality in the Sydney and Melbourne markets. Finally, severe cyclones hit the banana-growing districts of north Queensland in 1906, 1911 and 1918, causing major destruction of the crops. The Chinese became disheartened with the banana industry and moved into more profitable crops such as maize.

European farmers saw opportunities to enter the banana industry once the Chinese had left, but there was one last obstacle, and that was importation of cheap bananas from Fiji.[14] Bananas were first brought into Australia from Fiji in 1877, commencing with 3,100 bunches, and reaching a record of 1,715,760 bunches in 1914.[15] Melbourne fruit merchants were especially attracted to the Fijian bananas, as they were free of fruit fly, and they were considered of better quality than the north Queensland product.[16] In response to political lobbying by European farmers from Queensland, the Australian Government increased the duty on Fijian bananas from 1 to 1s/6d per cental in 1911.[17]

Fig. 5. Samuel Farrant pictured driving his buggy on his Condong Range property in the 1920s. Photographer unknown. Photograph provided by the Murwillumbah Historical Society Inc.

By the end of the first decade of the twentieth century, all social and economic factors were favourable for the creation of a subtropical banana industry in Australia that was closer to the major population centres along the east coast of Australia. Sam Farrant (1858–1937, Fig. 5) is credited with starting the commercial banana industry in the Tweed Valley in the Northern Rivers region of New South Wales. In 1894, Farrant purchased a 640-acre (250 ha) property in the Condong Range at a place that now bears his name, Farrant's Hill (Fig. 2), and in the same year he planted his first bananas, a half-acre plot of Cavendish, Pear, Lady's Finger, Sugar, and Plantain varieties.[18] These bananas were left for the possums and fruit bats, as there was no local market for the fruit. Farrant predominantly grew sugarcane until the Australian Government introduced excise and bounty schemes over 1902–3 to induce the sugarcane farmers to employ white labour.[19] These schemes reduced the profits of the sugarcane farmers in the Northern Rivers region, as any additional income received from the government bounty on 'white-grown sugar' was offset by more expensive labour costs, and the cost of the excise applied to all sugar produced by the Colonial Sugar Refining Company was transferred by the mills to the farmers through a deduction in the price paid for the cane.[20] The bounty scheme also had the unintended consequence of prompting an exodus of white canecutters from the Northern Rivers region to north Queensland, where wages were higher.[21] Farrant abandoned sugarcane and began to focus on bananas. 'He estimated that if one acre, planted

[13] Anonymous (1919*a*).
[14] Anonymous (1911*a*).
[15] Anonymous (1916*e*).
[16] Couchman (1995).
[17] Anonymous (1909). Yong (1964).
[18] Anonymous (1910*d*, 1937).
[19] Moore (1999).
[20] Anonymous (1904, 1911*c*, 1937, 1946*b*).
[21] Anonymous (1907).

10 feet by 10 feet, yield one bunch per stool and these were marketed at 1s/ per bunch, the return per acre would be £21/15/, which was much better, and entailed less work, than sugar cane'.[22]

Farrant started planting bananas as fast as he could from 1908 onwards, only limited by the speed by which he could procure planting material. He soon reached twenty acres of production and sold his fruit to a Chinese fruit merchant in Murwillumbah, Chow Kum and Coy, who paid 1s per bunch on the farm, later raised to 1s/6d.[23] In 1910, Farrant severed his business relationship with Chow Kum and Coy as he was dissatisfied with the price he was receiving for his produce and sought markets further afield. On 13 June 1910, he sent his first consignment of twenty bunches of bananas to Sydney on the *Friendship*,[24] a steamer owned by the Corrigan Bros that docked at the Tweed River once every two or three weeks. 'The bananas as they appeared on arrival in Sydney were big, well-developed bunches, equal to average Fijian fruit, and distinctly better than Queensland; they sold from 6 to 10s per bunch, while those from the northern State were worth 5s to 7s 6d'.[25]

Fortuitously for Farrant, his first export of bananas to Sydney coincided with a severe cyclone that hit Fiji on 25 March 1910, which resulted in high prices for Australian-grown fruit until the Fijian banana industry recovered. By November 1910, banana bunches from the Tweed Valley were worth 12s/2d when delivered on the local wharf.[26] Farrant further promoted the Tweed Valley banana industry by exhibiting at the 1913 Royal Agricultural Show in Sydney, where he was awarded first prize for his 'Cavendish' and 'Gros Michel' bananas. 'The bunch of Cavendish weighed 84 lbs., and many people were interested. (He) then increased his area under bananas to 40 acres'.[27]

The second person to enter the banana industry on a commercial scale in the Tweed Valley was Timothy J. O'Keefe (?–1945), whose property was located at Duranbah, approximately five kilometres east of Farrant's Hill. O'Keefe was a graduate of Hawkesbury Agricultural College and was initially a dairy farmer.[28] He started with six acres of bananas in 1910, and rapidly expanded to 46 acres by the end of 1912.[29] O'Keefe and his mother opened the banana trade to Newcastle.[30] Other early players in the banana industry were Elijah Caleb Marks (1864–1946) at Bungalora, Numa Ferdinand (Fred) Joubert (~1874–1935) at Terranora, and Oswald Edward (Ted) Boyd (?–1943) at Dungay.[31] Marks and Joubert were foundation president and vice-president, respectively, of the Tweed Fruitgrowers' Association when it began in 1915.[32]

Farrant's success gave the impetus for the banana farming boom in the Northern Rivers region between 1914 and 1920.[33] In 1913, the value of the crop raised on the Tweed, Brunswick, and Richmond Valleys was £3730, and this increased to £120,080 by 1918.[34] In 1916, uncleared land in the Tweed Valley was procurable for £12–13 per acre, but a banana plantation on good country with three-year-old plants was worth £100 per acre; the cost of clearing was £3–5 per acre and 100 banana suckers could be purchased for 35–50s, to be planted at a density of 400 plants per acre.[35] A ten-acre plantation at Bilambil returned a gross profit of £2300 in 1915 for a first ratoon crop. Such were the profits to be made from banana farming that the *Sydney Morning Herald* newspaper felt it necessary to warn 'peoples of sedentary occupations and others without practical experience on the land' of the dangers of 'unscrupulous persons with many and varied sugar-coated baits watching for victims. The unwary will be sold land that is not banana land, or told a south-west aspect is a north-easterly one, unless he go(es) armed with a pocket compass'.[36]

The final stimulus for the subtropical banana industry was the Soldier Settlement Scheme, a repatriation program for soldiers returning from World War 1 that was implemented by each of the state governments.[37] The Soldier Settlement Scheme was viewed as a way of gainfully employing a large, disbanded army, while at the same time, rehabilitating physically and psychologically damaged men by exposing them to the supposed virtues of life on the land. The war hero was to be transformed into the mythical Australian bushman, but many were ill-equipped for this new lifestyle. The soldier settlement schemes varied in each state, and in New South Wales, the scheme was

[22] Anonymous (1937).
[23] Anonymous (1931*b*).
[24] The SS *Friendship* was wrecked at the mouth of the Tweed River on 2 June 1912.
[25] Anonymous (1910*c*).
[26] Anonymous (1910*a*).
[27] Anonymous (1937).
[28] Anonymous (1912).
[29] Anonymous (1913).
[30] Anonymous (1917*d*).
[31] Anonymous (1912, 1935, 1943).
[32] Anonymous (1915).
[33] Anonymous (1916*d*).
[34] Anonymous (1923*a*).
[35] Anonymous (1916*c*).
[36] Anonymous (1917*a*).
[37] Scates and Oppenheimer (2016).

administered according to the rules prescribed by the *Returned Soldiers Settlement Act (1916)*. Land was not donated but an interest-bearing loan was provided by the state government to enable the discharged soldiers to purchase or lease land.[38] Advances of money were also provided to pay for land improvements, and for the purchase of equipment, plants, stock, and seeds.

In February 1917, Mr Bryant, Director of Soldiers' Settlement, was despatched to the Northern Rivers region to inspect the lands.[39] On his return to Sydney, he recommended two parcels of land for banana growing, one at Mullumbimby and the second in the Tweed Valley. In March 1918, the state government acquired 386 acres of land from Thomas H. King at Main Arm, approximately 4 ½ miles (7.0 km) northwest of Mullumbimby (Fig. 2).[40] King only received £11/6 per acre, the amount estimated by the commonwealth valuer, which was considered a giveaway by the local growers and an injustice by King.[41] Charles Rose, the manager of the settlement, was appointed on 1 May 1918 and twenty returned soldier-settlers employed to clear the land, construct a road and begin planting.[42] The land was subdivided into fourteen blocks, comprising twelve 20-acre blocks that were suitable for banana growing, while the remaining area was divided in two and allocated to dairy farming.[43] By March 1919, five acres of land in each block had been cleared and planted with bananas, and wooden cottages were in the process of being erected.[44] Optimism was initially sky high, as reflected in a report by the *Tweed Daily* newspaper: 'there can be no gainsaying the fact that areas under crop comprise excellent banana land, so that the returned soldiers who have been fortunate enough to acquire them are afforded a unique opportunity to "make good". And the soldier-farmers (the majority new to this work) are shouldering their responsibilities with the same indominable spirit which made for them a glorious name in the Western battlefields'.[45]

The Bilambil Soldier Settlement (Fig. 6) in the Tweed Valley offered a stark contrast to Mullumbimby as it was beset with problems from the start. The state government resumed two adjoining properties (886 acres in total) owned by Patrick Birmingham and Thomas Vidler at the headwaters of Cobaki Creek (present-day Carool, Fig. 2). Clearing operations were completed by August 1920, the land divided into 45 blocks, and a ballot for the land held the following month.[46] In an astonishing display of bureaucratic intransigence, the land was occupied by the soldier-settlers even before the land purchase had been settled due to a failure by the state government to reach agreement with Birmingham and Vidler on the value of the land.[47] Land ownership remained contested for at least a year, and Vidler still ran his cattle on the blocks while the soldier-settlers were trying to establish their crops, causing them a great deal of anxiety.[48]

Upon arrival at Bilambil, the soldier-settlers and their families had to live in tents for at least fifteen months, and they received a miserly allowance from the government until their plantations came into bearing.[49] Ironically, timber was in short supply as most of it was sent offsite and there was not enough even to build sheds to store produce.[50] A village was eventually built in 1922 using timber that was cut using a second-hand sawmill that had been purchased by the government, but no accommodation was provided on the blocks as this was considered a waste of arable land.[51] The newly planted bananas came into bearing at the beginning of 1922, but there were no internal roads in the settlement to take the fruit away, and thus it was often left on the ground to rot.[52] One letter writer to the *Tweed Daily* newspaper expressed his disgust with the situation by stating that the soldier-settlers 'trudge daily forth, up bullock tracks and wallaby paths to their holdings … What the men require are roads, not herding together like a lot of Bedouins'.[53] It is no wonder that the Bilambil Soldier Settlers' Progress Association carried a motion of no-confidence in the manager of the soldier settlement in 1921.[54] Unfortunately, even more misfortune was to unfold over the next couple of years.

[38] Anonymous (1931*a*).
[39] Anonymous (1917*b*).
[40] Anonymous (1920*d*). The road to the site is now called Settlement Road.
[41] Anonymous (1917*c*). Rose (1919). King (1919).
[42] Anonymous (1918*e*, 1919*e*).
[43] Anonymous (1919*h*).
[44] Anonymous (1919*e*).
[45] Anonymous (1919*d*).
[46] Anonymous (1920*b*).
[47] Anonymous (1919*i*, 1921*g*). Birmingham died in 1923, and Vidler moved to Gympie. It is unknown whether either man was ever compensated for the land resumed by the State government.
[48] Anonymous (1921*a*, 1921*b*, 1921*g*).
[49] Anonymous (1921*h*, 1921*i*). The allowance was given as a loan.
[50] Anonymous (1920*e*, 1921*h*). Knight (1921).
[51] Anonymous (1921*c*, 1921*g*).
[52] Perdriau (1922).
[53] Anonymous (1921*f*).

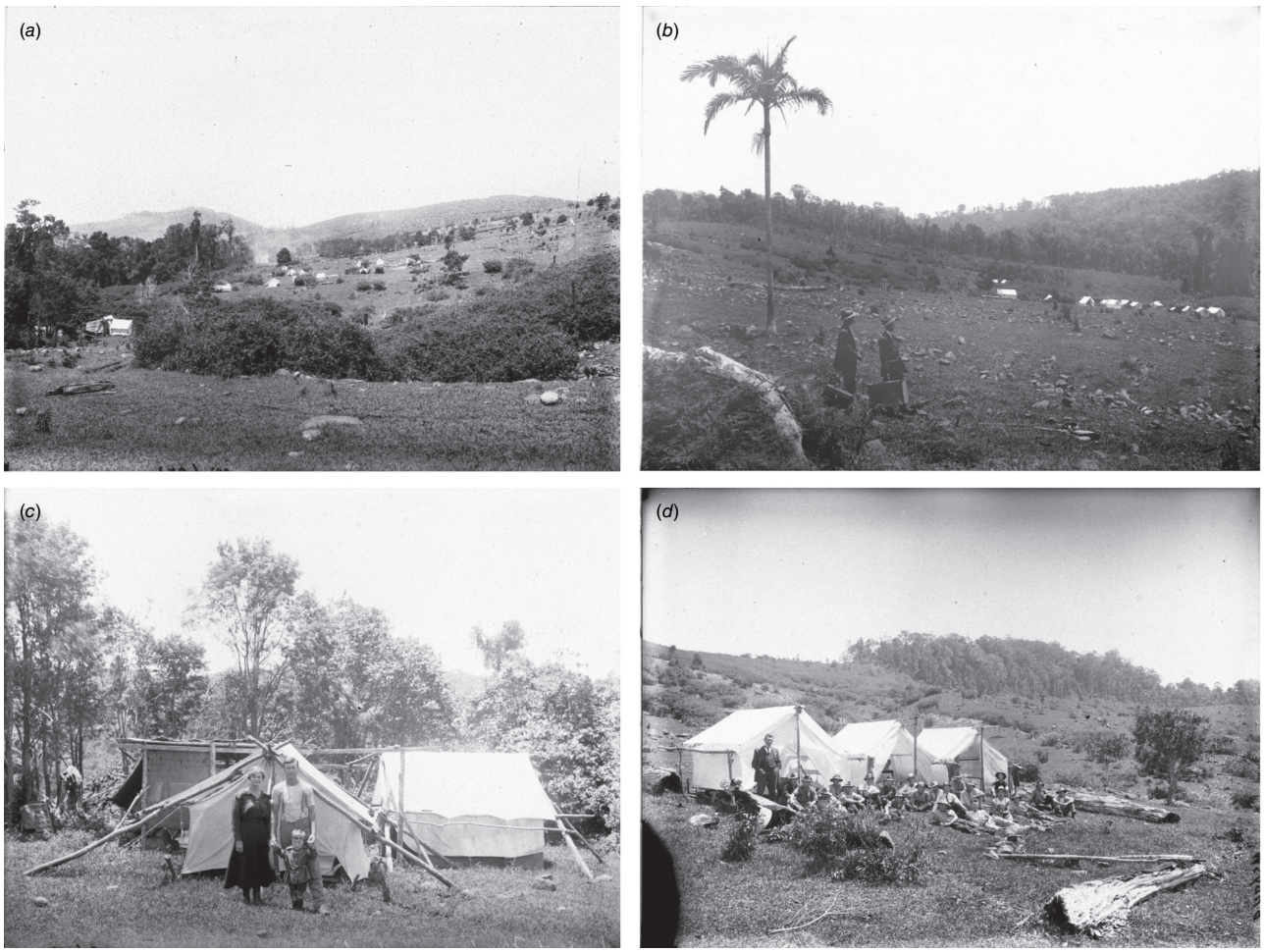

Fig. 6. The Bilambil Soldiers' Settlement. Photograph (*a*), character of the country; photograph (*b*), newly arrived settlers; photograph (*c*), first family; photograph (*d*), settlers listening to manager's advice. Photographs provided by the Museums of History NSW (files d1_37292, d1_37298, d1_37295 and d1_37296, respectively).

Banana bunchy top virus is introduced into Australia

The Bunchy Top Investigation Committee concluded that bunchy top first occurred in Australia on a farm in the Tweed Valley in 1913, and it was introduced in banana stock that had been imported from Fiji, where the disease had been present since about 1885.[55] In 1916, the *Tweed Daily* newspaper reported that 'most of the cases of the disease reported are in the suckers obtained from one plantation, and that one of the first planted in the district'.[56] From several independent accounts, the disease epidemic in the Tweed Valley began in the Condong Range,[57] which would immediately place suspicion on Farrant as the grower who inadvertently introduced the disease. Farrant was known to have experimented with at least a dozen different banana varieties before settling on Cavendish as the best-suited variety.[58] He is also reported to have imported some banana stock from Fiji.[59]

In December 1925, Goddard presented a public lecture at Tweed Heads, where he stated that the origin of the disease and the means of its dissemination had been identified with certainty.[60] Farrant felt that Goddard had accused him by innuendo of spreading bunchy top, leading him to pen an angry letter to the editor of the *Daily Mail* (Brisbane) newspaper, in which he emphatically denied any wrongdoing.

[54] Anonymous (1921*h*).
[55] Goddard and others (1926). Magee (1927).
[56] Anonymous (1916*a*).
[57] Anonymous (1922*f*, 1928*b*).
[58] Anonymous (1910*b*).
[59] Anonymous (1926*e*).
[60] Anonymous (1925).

> I have been a grower of bananas for 31 years on the Tweed, and was the first to discover 'Bunchy Top'. About the early part of 1914 I saw one stool in each of two plantations infected over a mile apart, and later a third, between these two. Then I heard of one or two others. All of them had obtained their suckers of plants from the same plantation, and cannot, in any way, be connected with any consignment from Fiji.
>
> In due course, my place became infected. When in Sydney, in March and April, 1916, I interviewed the Entomologist and Assist. Biologist. On June 16, 1916, I sent six badly infected bunchy top plants, and received a curt reply from the Under-Secretary that there was nothing wrong with them. In September 1917, the department quarantined my place on account of having banana beetles (Cosmopolitus Sordidus [sic]), which are fliers. I asked why I was singled out.
>
> In 1912 I sold 400 or 500 to go to Mt Cotton, and another lot to Terranora. After I knew mine was diseased, I refused dozens of purchasers.[61]

Throughout the course of his public lectures, Goddard revealed many facts about Farrant without explicitly mentioning his name, allowing him to be identified with confidence as the person who allegedly introduced BBTV into Australia. In Innisfail, Goddard is reported to have said he could take anyone 'to the few acres of ground where bunchy top first made its appearance in Australia', and 'the owner of that ground saw that something was happening to the banana plants and sent a sample to the Department of Agriculture in Sydney'.[62] In Mooloolah, 'the speaker (Goddard), through following on the same lines as delivered elsewhere, traced the history of bunchy top from the importation of banana suckers from Fiji Islands in 1887 to Condong (Tweed River, N.S.W.) … Eventually the man who had received the imported suckers distributed them to his friends, and the disease was allowed to go unchecked'.[63] Farrant was publicly defended by at least one fellow farmer after Goddard had rehashed his lecture in Gympie in July 1926.[64] 'ANOTHER GROWER' wrote to the *Daily Mail* (Brisbane) accusing Goddard of only presenting 'half the story, the other half being omitted to suit his scheme of eradication without compensation'.[65] A slightly different version of events was described in this letter, as it was stated when Farrant received official assurance from the Department of Agriculture in Sydney that nothing was wrong with his banana plants, he 'sold the suckers without hesitation, thereby being the innocent agent of one of the causes that spread bunchy'.

In the final report of the Bunchy Top Investigation Committee, it was stated that some growers thought the disease occurred much earlier in Australia, referring to 'a banana trouble in the Clarence River area (and) some malady affecting Sugar Cane in that region'.[66] These anecdotal reports from the growers were dismissed as being unreliable, but there was much more substance to the reports than the committee was either aware of or was willing to acknowledge.

In June 1914, Ewen MacKinnon was commissioned by the Lower Clarence Agricultural Society to investigate a new disease of bananas that was locally called 'cabbage top' or 'bunch top'.[67] MacKinnon, who grew up in Ballina on the Richmond River, was an assistant biologist in the Biology Branch of the New South Wales Department of Agriculture.[68] The disease was reported to have first appeared on the property of John Bale, who owned Wolbin Island in the North Arm of the Clarence River Estuary. The disease was most prominent in a plantain variety called Pear (syn. Dacca),[69] and had spread from Wolbin Island to Palmer's Island and other contiguous places.

English-born John Bale (~1847–1921) was an entrepreneurial farmer. He pioneered the sugarcane industry in the Clarence district, planting his first crop in 1867, which he crushed using his own hand-made appliances and a mill that he constructed himself.[70] In 1872, a new disease struck the sugarcane ('a kind of rust'), leading to a failure of the crops over two years.[71] This led Bale to dispose of the mill and to later plant fourteen acres of 'green bananas', presumably a reference to plantains.[72] He turned Wolbin Island into an experimental farm, growing ginger, arrowroot, tumeric, rice, cotton, tea, olive, tobacco and coffee. He was also the largest banana grower in the district. 'He supplied plants and seeds … in response to inquiries from many distant

[61] Farrant (1926).
[62] Anonymous (1926*a*).
[63] Anonymous (1928*b*).
[64] Anonymous (1926*c*).
[65] Anonymous (1926*e*). I suspect the unnamed correspondent was Jack Marks, who was living in Gympie in 1926.
[66] Goddard and others (1926). Magee (1927).
[67] Anonymous (1914*c*).
[68] Anonymous (1919*g*).
[69] Anonymous (1875).
[70] Anonymous (1921*e*).
[71] Anonymous (1903).
[72] Anonymous (1898).

parts'.[73] Bale probably sourced some of his banana stock from Henry August Volckers (~1835–1911), who owned a plant nursery in Grafton, and was responsible for importing 'a number of' banana plants from Fiji in 1892 for distribution to the farmers and gardeners of the Clarence River Valley.[74] These bananas were imported at the height of the bunchy top disease epidemic in Fiji. Volckers was a highly regarded horticulturalist and won awards for his exhibits of bananas at the autumn flower and fruit show of the Horticultural Society of New South Wales in 1890.[75]

After visiting the Clarence River Estuary, MacKinnon formed the opinion that 'bunch top' was unlike anything known in the state, and that the cause of the disease was a 'lack of proper cultivation, the age of the stools, and the fact that the young suckers have no depth of root'.[76] The results of the investigation were published in the September 1914 issue of the *Agricultural Gazette of New South Wales*.[77] A fungus or bacterium could not be detected,[78] leading to the conclusion that the disease was of physiological origin, possibly due to soil exhaustion. This conclusion was based on the observations that (1) the disease only occurred in old plantations, (2) young suckers from elsewhere planted in the soil of these plantations developed the disease, and (3) sugarcane on similar soils also developed 'bunchy-top' symptoms. The remedies that were recommended were (1) the thinning out of the plants, (2) manure, and (3) rotation with another crop to avoid cultivation of bananas on the same soil over many years. In the paper it was stated that the disease had only been present in the district since 1911, although this claim may not have been entirely accurate. In 1901, it was reported in the *Clarence River Advocate* that a new disease was destroying the once flourishing banana industry in the Clarence, to which Bale is quoted as saying: 'Nothing of the sort … only one variety, the plantain, suffered'.[79] It is unlikely that Fusarium wilt was being referenced, as this was a well-known disease by 1901.[80]

The reports of bunchy top disease in the Clarence River are credible and it is surprising that MacKinnon's paper was not cited in the final report of the Bunchy Top Investigation Committee. This omission is even more unusual as MacKinnon was the first New South Wales Government officer to visit the Tweed Valley in 1917 to investigate bunchy top, and when he did see the disease, he was in no doubt that it was the same as observed in the Clarence River Valley in 1914, even calling it by the same name.[81] MacKinnon became a science instructor for the Commonwealth Institute of Science and Industry in 1919,[82] and perhaps Magee and MacKinnon never interacted.

There were at least two more reports of bunchy top disease in the late nineteenth century. Elija Marks recalled seeing the disease at Terranora on the northern side of the Tweed River (Fig. 2) in the 1890s,[83] but no details were provided to assess the accuracy of these records. However, there are quite accurate descriptions of bunchy top disease from Korora, a northern suburb of Coff's Harbour, from about 1892, but the disease was quickly eradicated due to the quick-thinking actions of Herman Rieck, a pioneering farmer of the district.[84]

> Rieck got 100 banana plants from Fiji, because he seemed to think that those in Queensland were about played out. The plants from Fiji were about three months old on the trip and were withered on arrival. Mr Rieck picked about half a dozen of them to plant and threw the others behind a sand bank at Coff's beach. Nearly all the Fiji plants grew, but they were miserable-looking. Later Mr Rieck discovered they were diseased and Mr Jordan helped him dig them out (and subsequently burn them). They grew little and appeared to be choked at the throat, the leaves all came out together, and instead of spreading out seemed to turn back upwards and come together similar to a tied-up cauliflower. They were not pointed like ordinary banana leaves, but rounded off at the tips, and the edges of the leaves were crinkled and serrated. Mr Rieck called it 'Fiji disease'.[85]

In conclusion, it seems likely that BBTV was present in Australia prior to 1900 and was introduced from Fiji into Australia on several independent occasions. Prior to 1910, there would not have been the population size, nor density of banana plants in the Northern Rivers region to sustain large disease epidemics or create a significant economic impact. Even though Farrant was a man of 'strong opinions and convictions (and) not always liked', he was 'honoured

[73] Anonymous (1901, 1921*e*).
[74] Anonymous (1893, 1911*b*, 1951).
[75] Anonymous (1890).
[76] Anonymous (1914*b*).
[77] Anonymous (1914*a*).
[78] The methods used for diagnoses were not described.
[79] Anonymous (1901).
[80] Ryley and Drenth (in press).
[81] Anonymous (1918*a*, 1918*d*).
[82] Anonymous (1919*g*)
[83] Marks (1937).
[84] Anonymous (1922*h*).
[85] Anonymous (1942).

and respected',[86] and may have been unfairly singled out by the Bunchy Top Investigation Committee as the person that introduced and spread BBTV. The Clarence Valley farmers can claim credit for naming a plant disease (and subsequently a virus) that has now swept the banana world. Even though MacKinnon did not put his name to the 1914 article in the *Agricultural Gazette* (no one did), it was likely authored by him and therefore he would be the first person to have published a scientific paper on bunchy top.

Bunchy top, a plant disease that impacted a whole community

For many years the subtropical banana industry experienced uninterrupted growth due to the opening of new lands for farming, but bunchy top always followed close behind as the land was planted with bananas. By 1916, bunchy top could be found in virtually every plantation in the Tweed Valley and had crossed the state border into the Currumbin Valley in Queensland.[87] The advance of the virus was inexorable, facilitated by the exchange of planting material between the districts. By December 1925, the distribution of the virus extended north to the Caboolture River on the Sunshine Coast of Queensland, and south to the Clarence River in New South Wales. However, BBTV never established in Coffs Harbour, perhaps reflecting the geographical isolation of this district, the early lessons learnt by Rieck, and a dose of good luck.

The bunchy top disease epidemic peaked during the 1920s, causing a dramatic slump in banana production. In the Northern Rivers region of New South Wales, production declined from 400,000 cases during 1922–3 to 60,000 cases in 1925, and the area under banana cultivation contracted from 5500 to 1500 acres.[88] A similar trend was observed in the Currumbin Valley in southern Queensland, with exports to Melbourne declining from 102,000 cases in 1922 to 2500 cases in 1925, and employment associated with the industry reducing from approximately 200 to five men.[89] Many growers just walked away from their plantations, as the steep and stony land where bananas had once grown was unsuitable for any other crop, especially one that gave similar returns to bananas. The diseased plants that remained in the abandoned plantations just fuelled the epidemic. Land that had been bought at £150 per acre prior to the disease epidemic was now selling for £20–25 per acre.[90]

The soldier-settlers were among the worst affected by the bunchy top disease epidemic, as they were new to the industry, and were still carrying substantial debt. Many of these men were left in ruins by the disease epidemic. For example, Arthur Campbell Robinson settled on a block of poor quality on a clay ridge at the Mullumbimby Soldier Settlement on 24 February 1921.[91] Bunchy top disease quickly overcame the bananas, causing him to vacate the block on 10 July 1923, penniless and unemployed. He returned into the care of his parents in Nambour, still suffering ongoing health issues from an explosive bullet that had penetrated his helmet on the Western Front.

Arthur Robinson had his debt of £230 written off by the government, but many were less fortunate. Jack Cedric Price was a decorated war veteran, who grew bananas with his brother on a twenty-acre block at Mullumbimby.[92] To supplement his income, he worked part-time for the Brunswick Fruit Growers' Association and later the *Tweed Daily* newspaper. Like all around him, his bananas were devastated by bunchy top. In 1924 he defaulted in his repayments and his block was forfeited to the state government, but the Department of Lands pursued him for the balance of the debt (£393) that remained after all assets had been sold. The Returned Solders' Settlement Branch believed he could repay the outstanding amount because of his employment with the *Tweed Daily newspaper*. Price protested: 'This is not repatriation … Why should I be hounded for this money by the Department when the average returned soldier in my place would never be in a position to get off the bread line, and so could never pay?' Eventually the Returned Soldiers Settlement Act was amended in 1935, and his debt was waived.

The soldier-settlers at Bilambil fared no better than those at Mullumbimby. 'Hardly a plantation remained by 1924 and the holdings one by one were abandoned. Drab cottages, uninhabited, alone remained, amid the lantana and tobacco weed, to tell of the prosperity and life that had once been there—the forlorn remnants of a thriving settlement. Eventually the blocks were consolidated, and the area consolidated into seven or eight dairy farms, while most of the cottages were dismantled and sold'.[93]

The search for a cure for bunchy top disease

Members of the Tweed Valley Fruitgrowers' Association first discussed the problem of bunchy top in May 1916. 'Mr.

[86] Anonymous (1937).
[87] Anonymous (1924*b*).
[88] Magee (1936).
[89] Magee (1927).
[90] Anonymous (1923*h*).
[91] Information about Robinson is sourced from Scates and others (2011*a*).
[92] Information about Price is sourced from Scates and others (2011*b*).
[93] Anonymous (1931*a*).

Higgins brought to the meeting one of the plants affected with the cabbage disease, which had made its appearance of late. Eventually it was decided to write (to) the Queensland Minister of Agriculture and the Fiji Authorities for information regarding the pest'.[94] In response to this callout for assistance, Henry Tryon (1856–1943), the Queensland Government Entomologist and Vegetable Pathologist, toured affected farms in the Tweed Valley a month later, and expressed the opinion that there was nothing to be worried about, and 'if he were a younger man he would rather embark in the banana than any other rural industry'.[95] Tryon echoed the conclusions of MacKinnon that the disease was due to soil impoverishment.

Not surprisingly the problem of bunchy top did not dissipate, and in July 1919, Frederick William Stuart, the first secretary of the Tweed Fruitgrowers' Association (and later Country Party member for Byron),[96] wired the New South Wales Department of Agriculture to ask for experts to visit the region. In response, Government Biologist George Percy Darnell-Smith (1868–1942) and Government Entomologist Walter Wilson Froggatt (1858–1937), were sent to inspect the affected plantations.[97]

Darnell-Smith promptly published the results of his investigations in the November 1919 issue of the *Agricultural Gazette of New South Wales*.[98] Microscopic examinations of diseased tissue sections failed to reveal bacterial or fungal pathogens, and although two species of nematode were observed on the roots, they were not considered abundant enough to cause significant damage to the plant, nor were they exclusively confined to the diseased plants. Darnell-Smith concluded that bunchy top was non-contagious, and it was caused by retardation or decay of the roots, which in turn was caused by the physical or chemical condition of the soil, adverse weather patterns such as drought or flood, or simply a 'running out' of the banana stock through continual vegetative propagation of the same clone. Froggatt concurred with Darnell-Smith that bunchy top was a physiological condition, as he was unable to find any major insect pests on the bananas other than the banana weevil borer (*Cosmopolites sordidus*), and this insect was confined to the Condong Range, whereas bunchy top was widespread throughout the Tweed Valley.[99]

Early scientific investigations on bunchy top in Queensland were much more restricted than those in New South Wales. An experimental site was identified in the Lower Currumbin district in early 1921, but the grower eradicated all diseased plants before any work could begin. Tryon excused his inability to conduct a proper investigation because the disease principally occurred south of the border, which was beyond the scope of the official work of a Queensland officer.[100] It took a formal request from the Queensland Minister Agriculture and Stock to his counterpart in New South Wales before Darnell-Smith and Tryon met in Brisbane in December 1922 to confer over the disease and then travel to the banana growing districts for a joint investigation, ensuring that an equal amount of time, two days, was spent inspecting plantations on either side of the state border.[101]

A joint report by Darnell-Smith and Tyron was published in the January 1923 issue of the *Queensland Agricultural Gazette*, but again a cause of the malady could not be identified.[102] It was recommended that scientists in the two affected states collaborate in a research program, and to facilitate this collaboration, northern New South Wales and southern Queensland would be considered a single area.[103] However, the commencement of this research program was delayed by six months due to bickering between the governments over cost-sharing.[104] The New South Wales Government claimed that it should be retrospectively paid a portion of the costs of the research it had already done on bunchy top. The Queensland Government countered by arguing that it should pay less than New South Wales, as they already had borne the cost of investigations into other pests that affected both states, and bunchy top had started in New South Wales, and its citizens had failed to arrest its spread! The New South Wales Government also objected to any Queensland Government officials other than Tryon inspecting banana plantations in the Tweed Valley.[105] The interstate rivalry (and perhaps formalities) was so strong that the Queensland Minister for Agriculture and Stock refused to cross the state border to have a meeting with his counterpart from New South Wales in Tweed Heads, instead delegating negotiations to his under secretary.[106]

[94] Anonymous (1916*f*).
[95] Anonymous (1916*b*).
[96] Anonymous (1954*b*).
[97] Anonymous (1919*b*, 1919*f*).
[98] Darnell-Smith (1919).
[99] Anonymous (1919*c*).
[100] Anonymous (1921*d*).
[101] Anonymous (1922*e*).
[102] Darnell-Smith and Tryon (1923).
[103] Anonymous (1923*f*, 1923*g*).
[104] Anonymous (1923*d*, 1923*g*).
[105] Anonymous (1923*i*).
[106] Anonymous (1923*i*).

The proposed meeting at Tweed Heads never happened, but in July 1923, the two governments finally reached agreement over arrangements for the research program: the costs of research would be shared from the 1st of January gone by; Darnell-Smith and Tryon would be given entire responsibility for carrying out the investigations, including freedom to make their own arrangements; and a joint report was to be prepared by the end of 1923.[107] Just when it seemed as if little more could go wrong, Tryon was brutally assaulted while walking down a laneway at night between the grounds of Brisbane Boys and Girls Grammar Schools in December 1923, landing him in hospital in a serious condition and unable to contribute in any further way to the bunchy top investigation.[108] Darnell-Smith carried on alone,[109] publishing his final report on the disease in the March 1924 issue of the *Queensland Agricultural Gazette*.[110] In this report, the possibility of an insect transmitting the disease was canvassed for the first time, but transmission experiments using banana aphids (*Pentalonia nigronervosa*) were unsuccessful, although only three healthy plants were inoculated. This report marked the end of research by the 'old guard' of plant pathologists, with the younger generation represented by the Bunchy Top Investigation Committee taking over in May 1924.

The banana growers take matters into their own hands

The Tweed Fruitgrowers' Association were frustrated at the pace of research being done by the government officials and engaged with growers who thought they had found a cure for the disease. In May 1918, a Mr C. Hutchings, of Rewa, Fiji, visited the Tweed, and offered advice to the association that the disease was a 'result of poverty of plant and not of soil … and some people had recommended the exploding of half a plug of gelignite near the roots as a cure'.[111] Members of the association showed good sense and 'decided to write to the Federal Bureau of Science and Investigation asking that an investigation be made … and to recommend to the Association the offering of a reward for a cure for bunchy top'.[112] Both Darnell-Smith and Tryon were critical of the reward concept, as they saw little prospect of the growers making meaningful discoveries, and much time would be wasted pursuing spurious claims.[113]

Frank Wilson was one of the first growers to announce he had found a cure for bunchy top, which he was willing to divulge on the condition that the Tweed Fruitgrowers' Association paid a £300 reward in instalments over two years and they restricted knowledge of the secret to only two men (the logic being that other growers might try and test the treatment in an inexpert fashion, causing detriment to their plants). 'Mr. Stuart said that there were great hopes of the success of Mr. Wilson's treatment, which offered more encouragement than the Department could do'. The growers did not share the same optimism as Stuart and only endorsed the agreement at a meeting in December 1919 on the proviso that only £30 in remuneration would be paid if the experiments were unsuccessful. Little is known about the nature of the proclaimed cure, but it required operations to be done on the plants and did not involve the use of chemicals.[114] The experiments failed!

Other growers such as Messrs. J. Duffy and R. Walton, 'two practical men' from Bungalora and Terranora, respectively, were much more willing to publicly share their knowledge. They confidently declared that bunchy top was due to cutting immature bunches of fruit from stools, 'which causes immature suckers or peepers in the same way as if a mother was taken from a baby, and the baby made to look after itself'.[115]

At a conference involving the Tweed, Brunswick and Currumbin Fruitgrowers' Associations, and the Tweed Fruitgrowers' Co-operative Company Ltd in August 1920, the reward for a cure for bunchy top disease was raised to £3000.[116] This lucrative incentive had the effect of bringing many growers forward to offer their solutions to the problem, but most offers were immediately rejected. One person who did receive serious consideration was William John (Jack) Burton Marks (1897–1970, Fig. 7), eldest child of Elija Marks.

On 4 July 1922, the *Tweed Daily* newspaper boldly announced: 'Cure for Bunchy Top Claimed'.[117] As reported in the article, Jack Marks from 'Bungalora' on Terranora Road, Tumbulgum, had written a letter to the Brunswick Fruitgrowers' Association, to the Tweed Fruit Growers' Cooperative Company Limited (the Cooperative), and to the departments of agriculture in Queensland and New

[107] Anonymous (1923*e*).
[108] Anonymous (1923*b*).
[109] Anonymous (1924*c*).
[110] Darnell-Smith (1924).
[111] Anonymous (1918*b*).
[112] Anonymous (1918*c*).
[113] Anonymous (1923*f*, 1923*j*). Anonymous (1920*f*).
[114] Anonymous (1919*j*).
[115] Duffy and Walton (1919).
[116] Anonymous (1920*a*, 1920*c*).
[117] Anonymous (1922*g*).

Fig. 7. Jack Marks (back row, far left hand side) pictured as part of the Cudgen football team in the 1920s. Photograph provided by the Murwillumbah Historical Society Inc.

South Wales, stating he had 'the good fortune to discover in the course of numerous experiments, the cause of the disease and he had found a simple and effective way of combatting the disease. He was prepared to submit his investigations to a series of tests and if the claim proved successful, he would claim a reward of £5000' (equivalent to approximately AU$500,000 in 2024).

A deputation of growers viewed Marks' new plantation and were so impressed with its freedom from bunchy top that they lobbied the Minister of Agriculture to subsidise the reward, given that the government was a major creditor of the banana industry through the Soldier Settler Scheme.[118] The response of the government was that a formal agreement needed to be made with Marks, and no funds would be released until experts from the Department of Agriculture were satisfied that the treatment had worked.[119] Darnell-Smith was asked to assist with drawing up the agreement, which stated that Marks only had to keep 95% of the bananas in the test plot free of bunchy top over 2 years.[120] However, Marks was so confident in his remedy that he raised the stakes to 100% freedom from disease. On the 19 September, the shareholders of the Cooperative met and after a lengthy discussion, agreed to negotiate with Marks for the disclosure of his treatment.[121] The growers' contribution to the reward was to be raised by the imposition of a levy of one penny per case on all bananas dispatched from the district by rail or boat.[122]

After the agreement between Marks and the Cooperative was ratified, Marks disclosed all he knew about bunchy top. His hypothesis was that bunchy top was caused by a 'poison or the removal of some essential plant constituent by the action of insects which I cannot classify scientifically'.[123] He speculated that this insect was the lantana seed-fly (*Haematobia irritans*), which had been introduced by Henry Tryon from Honolulu to control lantana,[124] and which coincidentally appeared in the Condong Range about the same time as bunchy top. However, Marks conceded he had never seen a lantana seed-fly on lantana, so his identification was undoubtedly dubious. In hindsight, Marks was clearly referring to the banana aphid *P. nigronervosa*, as he described the insect as sharing many features with the rose aphid and living 'principally by sucking the banana juice from the young and tender leaves as they emerge from the heart … and at certain stages of these insects' life they develop(ed) wings'.[125] Tryon took umbrage at Marks' claim and was quick to respond that the lantana seed-fly did not cause bunchy top, as the fly was common in Hawaii, yet the disease was absent.[126]

The Fruitgrowers' Council was quick to arrange demonstrations of Marks' method of treatment to farmers throughout the region on both sides of the state border. 'His preventative was a kerosene emulsion, and he examined the plants by peeling back the leaves, and where he found the aphis (sic) he applied it'.[127] Specific instructions were given to prepare the spray: 1 lb soap (Limelight preferred) had to be dissolved in 1 gallon of boiling water, the mixture topped up if there had been evaporation, and then 1 gallon of kerosene was added. Tryon saw little that was revolutionary in this treatment, describing the kerosene emulsion as a well-known agent for aphid control.[128]

According to the terms of the agreement, two adjoining plots, each a quarter acre in size and containing 100 plants, were to be planted using suckers sourced from disease-free areas in Queensland, and one treated by Marks under the supervision of the Fruitgrowers' Council, the other to be worked entirely by the Council.[129] If after two years, the plot treated by Marks remained free of bunchy top, then the reward would be paid. The plantation of Thomas B. Sutton at Terranora, which was badly affected by bunchy top, was

[118] Anonymous (1922*a*).
[119] Department of Agriculture (1922).
[120] Darnell-Smith (1924).
[121] Anonymous (1922*i*).
[122] Anonymous (1922*d*).
[123] Anonymous (1922*c*).
[124] Tryon (1917).
[125] Anonymous (1922*c*).
[126] Anonymous (1922*b*).
[127] Anonymous (1922*c*).
[128] Anonymous (1922*b*).
[129] The methods and results of the field trial are described in detail by Darnell-Smith (1924).

chosen for the field trial that was planted on 9 November 1922. The treated plot was first sprayed on 19 December, and thereafter at two-weekly intervals for the first three months of the trial. Much to the disappointment of Marks, bunchy top appeared in the treated plot on 17 January 1923, which immediately disqualified him from receiving the award. However, there were signs that his treatment was having some effect on the incidence of disease, and he was encouraged by Darnell-Smith to continue with the trial.[130] On 16 January 1924, one year after the disease first appeared, 65 plants in the untreated plot were diseased, compared to 20 plants in the treated plot—a large difference but not a replicated result.

Sutton did not remain idle while the field trial was being conducted on his property. He obtained 103 cast-off suckers from Marks, which had been refused entry into New South Wales from Queensland for six weeks until a Department of Agriculture officer had inspected the plantation from where they were sourced.[131] These suckers were planted a month later and alongside Marks' trial and were dusted every two months with sulfur at a rate of one pound per 100 plants.[132] On 16 January 1924, only four plants had turned bunchy, compared to 20 plants in the plot treated with the kerosene emulsion. The sulfur treatment was heralded the best of all by Darnell-Smith, and the secret formulation was later manufactured and sold under the name of Bunchybane by Geo A. Church from North Creek, Ballina.[133] Marks was not perturbed by being surpassed by Sutton, remarking that it is 'gratifying to note that quite a number have, by different methods—but following my idea in the main—had such pleasing results'.[134]

Although Marks was unable to prove his claims that the banana aphid was associated with bunchy top, he did receive support for his theories from visiting scientists of the highest distinction. A paper on bunchy top was presented by Darnell-Smith in the agricultural session of the Pan-Pacific Science Congress in Sydney in August 1923.[135] A party of 18 delegates, led by Professor Watt, did a post-congress tour of the Northern Rivers region of New South Wales.[136] The touring party was welcomed in each town they stayed at with a grandiose civic reception and were even provided the full 'Aussie experience' in Grafton by being taken to a local football match![137] The two banana plantations chosen for the tour were Marks' plantation at Bungalora, and his field trial site on Sutton's plantation at Terranora. Among the party were eminent plant pathologist Professor Elvin Charles Stakman (1885–1979) from the University of Minnesota, and Edwin John Butler (1874–1943), who was director of the Imperial Bureau of Mycology at Kew, England.[138] The *Tweed Daily* newspaper reported that the scientists concluded that bunchy top was a type of 'mosaic'. 'The scientists (held) with the theory of Mr. Marks to the extent that the disease is probably spread by aphis (sic) or some form of minute insect life … These conclusions, coming as they do from men of the highest scientific authority, must carry weight with the Government when its future policy in regard to bunchy-top is formulated'.[139] Professor Watt, who had led the Bunchy Top Advisory Committee, was likely listening intently to these conversations, as it was the first mention that the disease may be caused by a virus.

Magee eventually confirmed the hypothesis that the banana aphid was the vector of the bunchy top pathogen by manually transferring aphids from diseased to healthy plants that were grown in caged tanks or in an insect-free glasshouse.[140] Great care was taken to ensure there was no chance of mechanical transmission of the pathogen, as a segment of diseased leaf tissue with accompanying aphids was placed on thick blotting paper and the paper then rested on a recipient healthy plant and the aphids allowed to move at will onto the new plant. Typical disease symptoms developed in the aphid-inoculated bananas within two to four weeks. In parallel experiments, various methods of mechanical inoculation were trialled such as using a hypodermic needle to inject the sap of diseased plants into healthy plants, but no transmission was obtained.

Magee is rightly given kudos for being the first in the world to demonstrate that the bunchy top pathogen was aphid transmitted. However, Magee's transmission experiments were premised on the careful observations of Marks, who recognised the close association between banana aphids and the appearance of bunchy top. Magee was careful to acknowledge the pioneering research of Marks in the

[130] Darnell-Smith (1924).
[131] Anonymous (1924*a*).
[132] Darnell-Smith (1924).
[133] Anonymous (1924*f*). A sample of Bunchybane was analysed by the agricultural chemist from the Queensland Department of Agriculture and Stock and found to contain a mixture of soil (insoluble ballast), sulfur (35.8%), charcoal and possibly lime (reported in appendix B of Goddard and others (1926)).
[134] Anonymous (1924*a*).
[135] Anonymous (1923*k*).
[136] Anonymous (1923*m*).
[137] Anonymous (1923*l*, 1923*m*).
[138] Christensen (1992). Magee (1927, p. 28, 1943).
[139] Anonymous (1923*c*).
[140] Goddard and others (1926). Magee (1927).

CSIR bulletin he authored,[141] but not so Goddard in the final report of the Bunchy Top Investigation Committee.[142] Goddard only offered faint praise to Marks, stating some partial control of bunchy top by spraying the plants with a kerosene emulsion 'appear to be suggested' by the experiments conducted at Terranora in 1922, and 'the most that can be said in favour of these methods of protection … is that a certain number of aphides would be killed and only a slight check, if any, could be imposed on the aphides and the role played by them in the transmission of the disease'.[143] Goddard also did not give credit to Marks for being the first person to recognise that the discontinuous dark green streaks along the secondary veins of the leaf were a characteristic symptom of the disease.[144]

Marks was rankled by Goddard's failure to give him due credit for the aphid vector hypothesis, as reflected in an article he wrote for the *Tweed Daily* newspaper in October 1925:

> It is with much interest that I notice the publication of Dr. Goddard's re his Bunchy investigations, and his dogmatic conclusion that aphides [sic] are the distributor of the disease.
>
> While it is necessary to remind readers that it was I, in 1922, who made this theory known to the world, founded on experiments and observation lasting pretty well a year, backed up with long previous experience with Bunchy Top affected plantations, with an article which embraced probably a much larger field than Dr. Goddard's recent report.
>
> While I fully recognise that, from a scientific point of view, it is probably necessary for a scientist to prove a theory up to the hilt, it is interesting to note that scientists previous to 1922 had spent five or six years together with many hard-working growers, endeavouring to elucidate this mystery, and got absolutely nowhere; and I venture the opinion that Dr. Goddard, too, may have still been in the dark, had he not had a basis on which to work.[145]

There is evidence that Goddard tried to discredit Marks to focus praise on himself and the Bunchy Top Investigation Committee. In a lecture to the Banana Sectional Group Committee in Queensland in February 1926, Goddard made a point of distinguishing the two bodies of people dealing with the bunchy top problem, the government, and the growers, and then self-identified as virtually being a member of the Department of Agriculture and Stock.[146] He then went on to humiliate Marks by calling his suggestion that the lantana fly transmitted bunchy top as 'utter nonsense', even though Marks had long since corrected himself that the insect was an aphid, albeit one that also lived on lantana. Marks was stung by the criticisms and responded in a letter to the editor of the *Northern Star* (Lismore, NSW) newspaper:

> I think it is now not necessary to impress on Professor Goddard and the public generally that men of years of experience in endeavouring to combat and watch the wiles of bunchy top and bananas in general are infinitely better equipped to carry out work of this nature, than those who have had only a few months in the affected area'.[147]

Marks finally received recognition from his peers for his discoveries in the form of speeches of tribute at the 1946 Annual General Meeting of the New South Wales Banana Growers' Federation (NSWBGF).

> Speakers recalled the many different remedies that had been tried by growers and recalled that the discovery by Mr Marks at Terranora that the aphid spread the disease was the first step forward in its control. Following this discovery Dr Magee and his staff of experts were able to evolve satisfactory measures for its control.[148]

Marks was also celebrated at a meeting of the West Burleigh and District Banana Growers' Association in February 1947, and in an ironical twist to the story, Goddard was forgotten in the speeches, leading the president of the association to offer a profuse apology to Goddard three days later, in which he stated that 'there was no doubt the whole investigation was dominated by, and conducted on the lines laid down by Professor E. J. Goddard'.[149]

Epilogue

The year 1927 marked the lowest ebb in the fortunes of the banana industry in New South Wales—production in the

[141] Magee (1927), p. 39.
[142] Goddard and others (1926).
[143] Goddard and others (1926), p. 23.
[144] Darnell-Smith (1919).
[145] Marks (1925).
[146] Anonymous (1926*d*).
[147] Marks (1926).
[148] Anonymous (1946*a*).
[149] Anonymous (1947).

Tweed Valley almost ceased because of bunchy top. In February of this year, a conference was convened in Mullumbimby to consider the recommendations of the Bunchy Top Investigation Committee.[150] Attending this conference were George D. Ross, the Under Secretary of Agriculture, Frederick Stuart (by this time, a Member of the New South Wales Legislative Assembly), Professor Goddard, and five delegates representing the banana growers from the Tweed, Brunswick and Richmond Valleys. All recommendations were endorsed, but only after vigorous debate over the compulsory nature of the proposed regulations.[151]

In November 1924, regulations relating to bunchy top were gazetted under the *Plant Diseases Act (1924)* (New South Wales). The Northern Rivers region was divided into twelve zones, which had the effect of demarcating badly affected from mildly and unaffected districts, which in turn allowed some variation in the way that the regulations were imposed in each zone depending on whether bunchy top was present or not.[152] A committee of three growers was created for each zone to provide advice to the Department of Agriculture about implementation of the regulations. Three fruit inspectors were appointed by the state government, whose job it was to enforce the regulations.[153] It became mandatory for the growers to destroy plants that were affected by bunchy top or were neglected or uncultivated for six months. New plantings of bananas, even in home gardens, had to be registered through the issuance of planting permits. Finally, it became illegal to move any banana plant or parts thereof out of a zone or even from one plantation to another within a zone unless a movement permit had been issued. Suckers for restocking initially came from disease-free areas in Queensland but later from New South Wales.

After the bunchy top regulations were introduced, it took two years for the banana growers to regain confidence in the industry and begin replanting in earnest.[154] As promised by Goddard, bunchy top was held in abeyance for several years. However, a banana planting boom was triggered by high fruit prices in the winter of 1932, and as inevitably happens, the shortage of fruit turned into a glut, causing fruit prices to collapse.[155] Treasury finances were hit by the Great Depression, threatening to derail the government-led bunchy top control program. In response, the NSWBGF made the decision in 1933 to impose a penny per case levy on all fruit dispatched by rail or boat, to be used to employ additional inspectors whose role it was to find and treat diseased plants.[156] Presiding over the NSWBGF Board meeting in which the decision on a bunchy top levy was made was Hubert Lawrence (Larry) Anthony (1897–1957), future Country Party politician and father of John Douglas (Doug) Anthony (1929–2020), Australia's longest serving deputy prime minister.

By 1935, the prices for fruit had fell to such low levels that many growers neglected their plantations, leading to a fresh outbreak of bunchy top.[157] In 1936, the NSWBGF initiated a special campaign to eradicate bunchy top, with free kerosene provided to the growers to treat the diseased plants for aphids before they were dug out, and men employed to assist the growers locate and spray the diseased plants.[158] The inspectors were instructed to report any breaches of the plant health regulations, and these breaches were immediately prosecuted with heavy fines.[159] The incidence of bunchy top soon dropped due to the reinvigorated control program and by the end of 1943, the industry was again back on a strong footing, with 2110 growers cultivating 15,945 acres of bananas between the Queensland border and Macleay on the mid north coast of New South Wales.[160]

Bunchy top is gradually disappearing from northern New South Wales and south-east Queensland, partially because of banana-industry-supported eradication programs, but also because of changes in land use in this region. In December 2023, there were only 167 banana-growing properties remaining in northern New South Wales, with one property accounting for approximately 72% of all BBTV-infected plants identified in the previous year.[161] When rail and road transport improved after World War 2, it was inevitable that the banana industry would return to tropical north Queensland, where the cropping cycles are much shorter, and the crops can be grown on flat land, allowing mechanisation. Today, 94% of the Australian banana crop is grown in three north Queensland growing regions: the Cassowary Coast (Tully, Innisfail and Kennedy), Lakeland, and the Atherton Tableland.[162] Bunchy top was introduced twice into north Queensland around Innisfail, once in 1926 and a second time in 1954, but on both occasions the disease was

[150]Anonymous (1927*b*).
[151]Anonymous (1927*a*).
[152]Anonymous (1927*c*, 1928*a*).
[153]Anonymous (1928*a*).
[154]Magee (1936).
[155]Magee (1936).
[156]Anonymous (1933).
[157]Magee (1936). Anonymous (1944).
[158]Anonymous (1936*a*, 1936*c*).
[159]Anonymous (1934, 1936*b*, 1936*d*).
[160]Anonymous (1944).
[161]Rosie Godwin, Australian Banana Growers' Council, unpubl. data 5 January 2024.
[162]https://abgc.org.au/our-industry-old/key-facts/, accessed 22 March 2024.

quickly eradicated before it became entrenched.[163] Nowadays, the rows of bananas that once cloaked the fertile volcanic slopes of Terranora have been replaced by housing. Bungalora, the homestead of Elija and Jack Marks at 858 Terranora Road, Terranora, is included on the Heritage Schedule of the Tweed Local Environmental Plan,[164] but there are no longer any signs of the 'model plantation' that once was admired by the touring party from the Pan-Pacific Science Congress.[165]

It took 65 years from the release of the final report of the Bunchy Top Investigation Committee to when it was finally proven that bunchy top was caused by a virus, and diagnostic assays were developed.[166] The BBTV genome has now been sequenced and gene functions determined, but surprisingly little progress has been made developing new disease management strategies. The recommendations of the Bunchy Top Investigation Committee remain current and stand as testament to the remarkable work that was done by the banana growers and scientists a century ago in the Tweed Valley.

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Author affiliation
[A]Queensland Alliance for Agriculture and Food Innovation, The University of Queensland, St Lucia, Qld 4072, Australia.