The banana industry in north Queensland

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Bananas are the major fruit crop grown in Queensland. In 1983, north Queensland produced 66 000 t from an area of 2 400 ha. This represented three-quarters of the State's production and an approximate value of $42.9 million to the 209 growers involved. All of the crop is marketed as fresh fruit except for small quantities of fruit unsuitable for market which are dried for the health food trade.

The industry has undergone large expansion in recent years, having doubled in terms of area since 1977. This has been largely at the expense of growers in southern Queensland and northern New South Wales. The reasons for expansion are the tropical climate and the high degree of mechanisation possible on the flat land, giving the north Queensland producers much greater efficiency of production than their southern counterparts. The crash in the beef market during the 1970s has also played its part with several graziers planting bananas or releasing land by lease agreement.

Location

The industry in north Queensland is centred in a geographically compact area on the coastal strip from Cardwell (18°20′ S) north to Innisfail (17°30′ S) (Figure 1). Two-thirds of the bananas are grown in the Tully, Kennedy and Murray River valleys while the remainder are grown on undulating country at Mission Beach and East Palmerston (Figure 2).

Soils

The region has five types of soil on which bananas are grown. Basaltic soils (krasnozems) are located in the Misson Beach and East Palmerston areas. Metamorphic soils (red–brown clay loams) are mainly utilised in the Mission Beach area. These two soil types are in undulating country and are subject to serious sheet erosion. The two alluvial soils in the Tully area are Tully Scrub (clay) and Black Forest (silty clay). Granitic alluvial soils (clays–sandy loams) are located in the Kennedy and Murray River valleys. These three

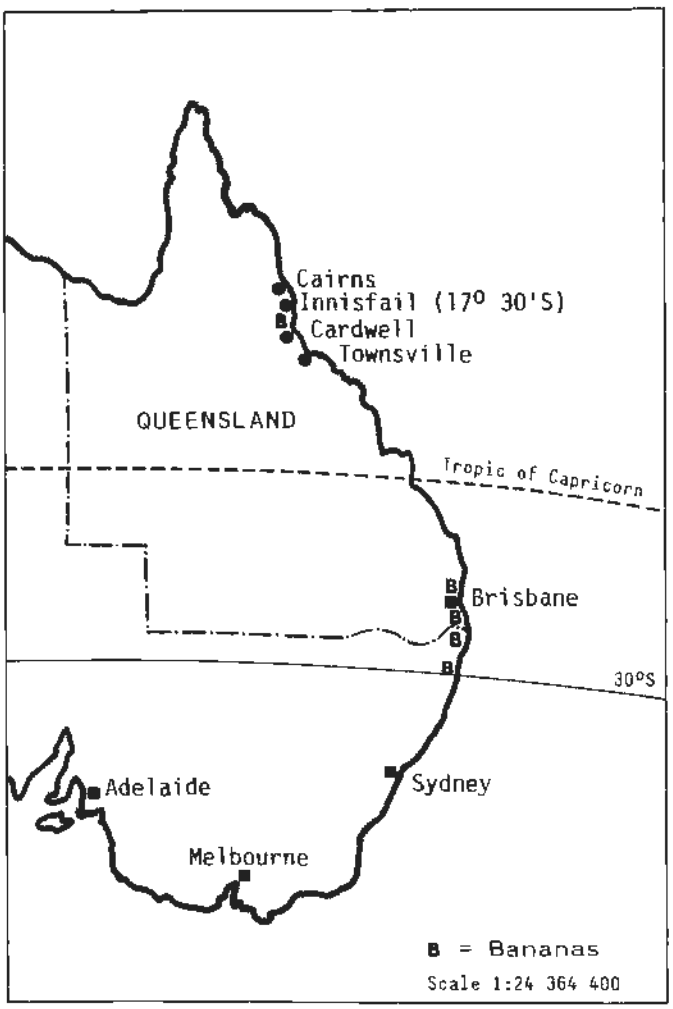

Figure 1. Location of north Queensland banana industry.

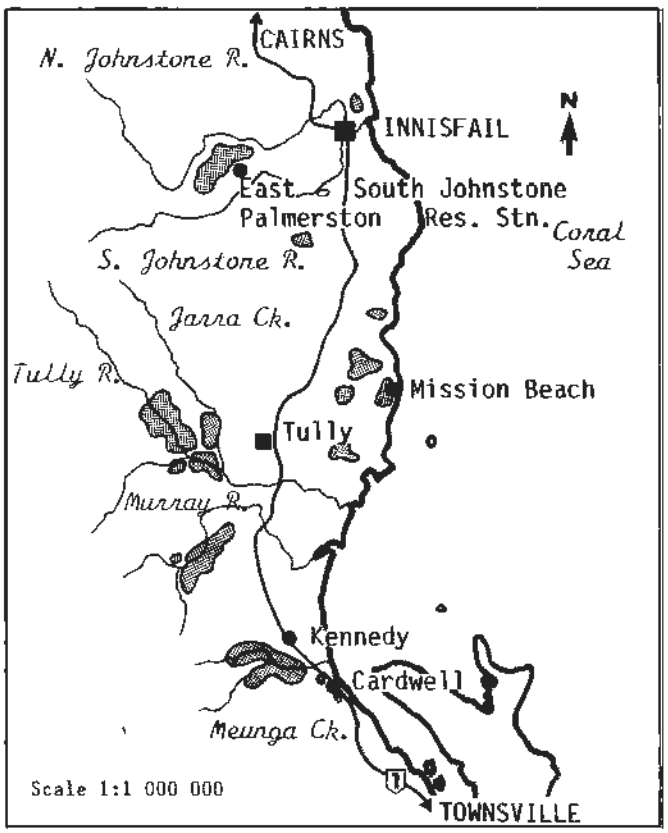

Figure 2. North Queensland banana growing areas.

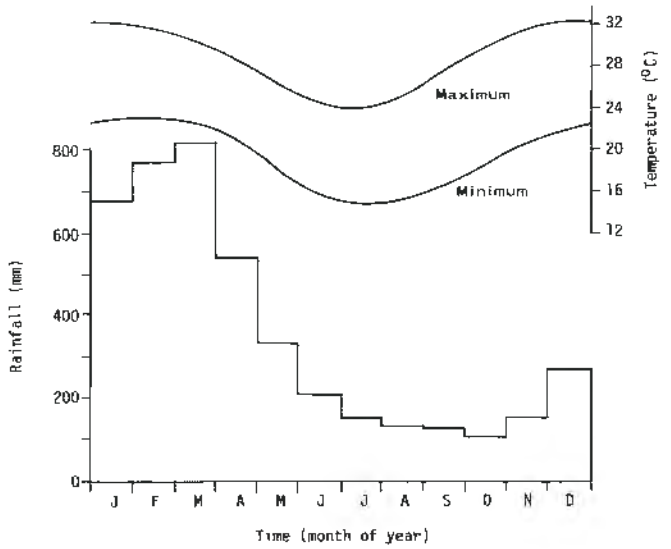

Figure 3. Average monthly rainfall and temperatures, Tully.

alluvial soils are seasonally waterlogged requiring 'hilling up' and surface and subsurface drainage for maximum crop production (Plate 1). All the soils are acid (pH 4.5 to 6.5) and once brought under cultivation require amelioration with lime.

Climate

The climate is tropical maritime with the dominant feature being the high rainfall in summer and autumn (Figure 3). Annual rainfall ranges from 2 500 to 5 000 mm per year in the region. Despite this high annual rainfall severe moisture stress can be expected in 3 out of 5 years in the September to January period. Winters are warm, and summers hot and humid. While there are generally no frosts some 'chilling' damage can occur to banana fruit and plants when temperatures fall below about 13°C. The region is subject to cyclones with severe damage caused about once every 5 years. Storms and flood rains also cause damage to plantations from time to time and disrupt harvesting schedules and transport of fruit to market.

Farm management

During the 1960s and early 1970s the north Queensland industry underwent some major changes in management practices. The most significant changes were:

- adoption of mancozeb/miscible oil sprays and misting machines to control leaf diseases;
- control of burrowing nematodes by use of 'clean' planting material and nematicides;
- application of irrigation water; use of Vicon® fertiliser spreaders to facilitate fertiliser application;
- increase in plant density;
- development of packing wheels;
- switch from wooden crates to fibreboard cartons; and
- introduction of more effieient transport to southern markets.

These changes contributed to greater efficieney of production in north Queensland. Fruit from north Queensland is now better able to compete with fruit

Table 1. The percentage of total area represented by farms in different size categories in 1981

Hectares	Percentage
over 20	51.4
10–20	24.5
5–10	16.7
less than 5	7.4

from southern producers outside of the traditional winter–spring period when production is seasonally low in the south. While there has been a shift towards year round marketing, the winter–spring, when prices are highest, is still favoured for production (Figure 4).

Over half of the properties are held under freehold title. Because bananas are demanding of time all year round, they are usually the only enterprise pursued. In 1983, the average farm size was 11.5 ha. However, at present 51% of the area under bananas is held in farms of greater than 20 ha (Table 1).

Planting material

The conecpt of producing planting material in nurseries was introdueed during the early 1970s. Previously, planting material had been obtained only from old plantations which were ready to be eradicated. Nurseries that are planted with 'clean' material in 'clean' ground produce planting material which is free from nematodes and exceptionally


Plate 1. Hilling up the rows reduces weterlogging problems.


Plate 2. Digging a nursery: a cutter bar cuts roots and assists lifting of butts.

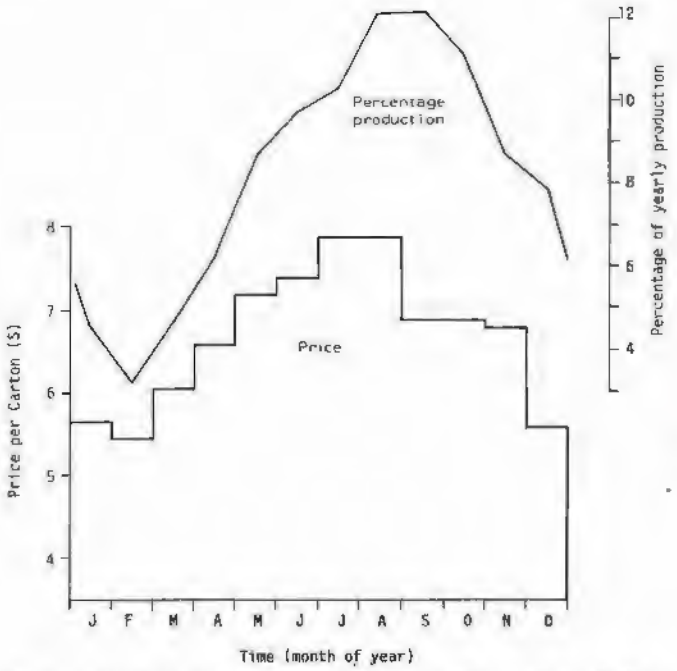

Figure 4. Average monthly prices for large and extra large fruit on the Sydney market and percentage of yearly production per month averaged for 1977 to 1982.

vigorous, giving a strong start which is important in maintaining the life of a plantation. Nursery material is usually 'harvested' 6 or 7 months from planting which coincides with the time of bunch emergence. Nurseries are usually dug out with a cutter bar (Plate 2).

Material obtained from old plantings is usually infested with nematodes. Such material is cut into sections each with a developing eye. Each piece is carefully pared to remove any diseased or nematode infected material and hot water treated at 53° to 55°C for 20 min. The minimum weight of material recommended to survive this treatment is 0.7 to 0.9 kg.

Despite the advantages of nurseries only 30% of growers make use of them. This is to some extent due to a lack of forward planning by growers who are pressed by other plantation work, and the ready availability of material from older plantings.

Time of planting

Most plantings are established in May–June and August–October. July is the coolest month and is generally avoided. Outside of the May–October period the weather is too wet and/or too hot, which promotes rots in planting material and subsequent plant failure. Furthermore, with the winter–spring plantings the time of production of the plant crop and the early ratoons is during the winter–spring when prices are highest (Figure 4).

Planting procedure

The soil is firstly cultivated to a weed free condition. This usually involves a cross-ripping, ploughing and two discings. Drills are then opened to a depth of 30 cm. Planting pieces are placed by hand in the bottom of the furrow and lightly covered with soil. The remainder of the furrow is filled in during early weed control cultivations and fertiliser treatments. Mechanical planters, both single and double row versions, have been recently developed by modifying sugar cane planters. They are capable of more than halving the time required to plant (Plate 3).

Plate 3. Mechanised planting of double rows halves the time required to plant.

Plant spacing

Bananas are grown in either single or double rows in north Queensland. The three patterns generally in use are single row-single follower, single row-double follower and double row. Single row-single follower was the only system used before the 1970s but has largely given way now to the other patterns. This has been caused by the trend towards higher plant densities with most plantings averaging 1 600 to 2 500 plants/ha. Using the single row-single follower pattern it is not possible to have plant densities above 1 600 plants/ha without accompanying severe management problems which include the inability to select a following sucker of consistent size in the desired position, and considerable damage to fruit by contact with neighbouring plants.

For the single row-single follower and double row patterns one following sucker is selected per plant and grows to become the next crop. The first crop is known as the plant crop and subsequent crops are ratoon 1, 2, 3 and so on. By selecting a single sucker the plant density is maintained throughout the life of the plantation. More than one sucker is usually selected next to gaps caused by plant failure.

The single row-double follower pattern differs from the above in that two suckers are selected from the plant crop, so doubling the plant density in ratoon 1. Only one sucker is then selected at each plant in subsequent ratoons. The three patterns with usual distances between plants and planting densities are shown in Figure 5.

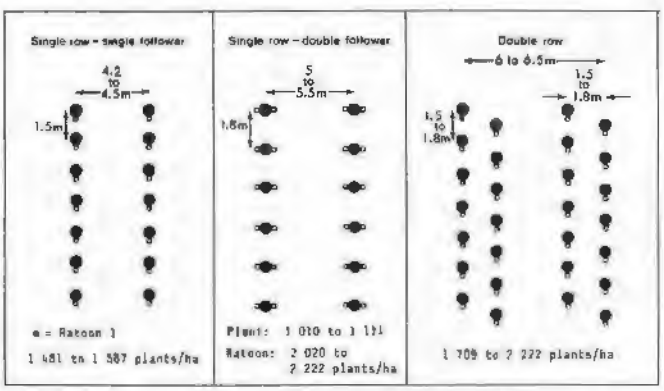

Figure 5. Planting patterns of bananas in north Queensland.

Plate 4. The 'Williams' cultivar.

Plant density affects many plant characteristics. Generally, as the density increases above 1 600 plants/ha the longer is the duration to harvest, the smaller is the plant and bunch, and finger length gradually decreases.

Varieties

Well over 99% of the bananas grown in north Queensland are the cultivar 'Williams'. Some of the plantings may be of 'Mons Mari' but because there is very little difference between the two cultivars the name is only of academic interest. The two cultivars are described as AAA Group, Cavendish Subgroup. They are similar to Giant Cavendish and Grande Nain grown overseas. In ratoons, their pseudostem height is anywhere from 2.5 to 4.5 m depending upon growing conditions (Plate 4).

Plate 5. Vicon® fertiliser spreader in action.

Plate 6. Fertigation essential components: from left to right, a filter, a fertiliser tank and an injector.

These cultivars have probably the highest yield potential of all bananas.

The susceptibility of these Cavendish types to black sigatoka (*Mycosphaerella fijiensis* var. *difformis*) and the new race of Panama disease (*Fusarium oxysporum* f. sp. *cubense*), two diseases looming on the horizon, has called for increased emphasis on banana plant improvement in the industry.

Plant nutrition

For best growth and fruit production, bananas require large amounts of mineral nutrients. Correct fertilising is essential in achieving this in the tropical north Queensland environment.

Rates, timing and types of fertilisers vary widely in the industry. Application procedures which give high yields are as follows. At planting a nitrogen: phosphorus: potassium mixture with an analysis of 11:2:18 is banded underground near the planting piece. Quantities range from 500 to 700 kg/ha depending upon soil type. Also at planting, dolomite or lime plus Granomag® is broadcast along the intended planting rows in a 1 to 2 m band at 1.5 to 5 t/ha depending upon pH and soil type. Granomag® is required at about 140 kg/ha. Because nitrogen and potassium are readily leached from the soil by the high rainfall, frequent (5 to 8 times per year) side dressings of nitrogen and potassium need to be applied usually with a Vicon® spreader (Plate 5). As well as these nitrogen and potassium side dressings, superphosphate and dolomite (or lime plus Granomag®) need to be applied once a year during the life of the plantation using the same rate as at planting. This gives application rates per hectare per year of about 500 kg nitrogen, 30 kg phosphorus and 800 kg potassium.

In the last few years, application of fertiliser in the irrigation water (fertigation) has become popular with those growers using undertree trickle or microspray irrigation (Plate 6). Fertilisers can be applied as frequently as the plants are irrigated to ensure that nutrients are always freely available. Nitrogen and potassium are applied usually in the form of urea and potassium chloride, or urea and potassium nitrate. The former combination is the cheaper but has residue problems from talc used in the manufacture of potassium chloride which requires frequent cleaning of filters to avoid clogging of the irrigation system. Because fertiliser is applied to the active root zone already dissolved in water it is readily available to the plant, giving efficiencies of fertiliser use much greater than those achieved by broadcasting.

Plate 7. Travelling irrigators are the most common method of irrigation.

Plate 8. Microspray irrigation is ideally suited to double row plantings.

Irrigation

A 15 to 20% increase in yield is obtained by irrigating during the dry spells that occur from September to January. High fruit quality is also assured by regular watering.

Supplementary water first began to be applied towards the end of the 1960s to increase yields. Travelling irrigators (Plate 7) quickly became the most used method, and remain so to this day. They are set up in the interrow passageway and 'shoot' water 30 to 47 m on either side as they move along the interrow.

Towards the end of the 1970s research work by the Department of Primary Industries had demonstrated the usefulness of trickle (synonymous with drip) irrigation in bananas. The last 4 years has seen a steady increase in the utilisation of the undertree systems—trickle and microspray (Plate 8). They now represent 25 to 30% of the irrigation systems used in the production area. Undertree systems are used to great advantage on undulating country and where there are shortages of water. A small percentage of the area is now being irrigated by overhead solid-set sprayers (Plate 9).

Irrigation is applied about every 7 to 14 days with the overhead systems and every 2 to 4 days with the undertree systems. The difference between the systems is largely related to the amount of soil wetted. The plants require 20 to 40 mm of water a week depending upon the prevailing weather.

Little use is presently made of objective irrigation scheduling methods such as tensiometers and there is little automation. Growers determine when and how much water they apply largely from experience. Irrigation is generally given lower priority than other jobs on the farm. This may be associated with the high, yet unpredictable rainfall. Hence water is not always applied when required by the plants and often there is a tendency to overwater.

Erosion control

Control of soil erosion is essential in undulating areas. In these areas a system of contour banks and grassed waterways needs to be constructed. Contour banks are very compatible with other aspects of banana crop management. At present about 70% of the erosion prone areas have some form of erosion control. Help in

Plate 9. Overhead solid-set irrigation is gaining popularity.

Plate 10. Nematicide application in young bananas.

Plate 11. Fungicide application with a tractor-drawn air-blast mister.

Plate 12. Aerial spraying gives cheap and efficient control of leaf spot and scab moth.

design and layout of contour banks is provided by Soil Conservation Services Branch, Department of Primary Industries, South Johnstone.

Windbreaks

About half of the industry makes use of windbreaks, either natural forest belts or plantings of pine. They give protection from the prevailing south east winds and help reduce damage from strong winds associated with storms and cyclones. Windbreaks reduce leaf tearing and transpiration and, therefore, give more efficient use of water.

Weed control

Weed control usually consists of a combination of pre-emergent herbicide (diuron), and chipping along the rows and discing of interrows during the first 3 months from planting. After this, the plants are well established so that spot sprays of paraquat or sodium arsenite can be used. In ratoon crops, because of the large vegetative cover, weeds are shaded out so that occasional spot sprays are all that are necessary (mainly along the headlands).

Pest and disease control

The burrowing nematode (*Radopholus similis*) is a major pest attacking and destroying the roots of the plant. Plants 'fall out' readily under windy conditions or from the weight of a bunch. Plants also suffer more from water stress and nutrient deficiencies. Nematodes are controlled by planting 'clean' material in 'clean' ground. Nurseries are particularly effective in suppling clean material. In established plantations, granular nematicides are applied 2 to 3 times per year as a band around the base of the plant with a modified seed spreader (Plate 10).

Banana scab moth (*Nacoleia octasema*) is a widespread pest of young banana fruit in north Queensland. Until recently, control was by individual bunch dusting with DDT/BHC Shirdust® as the bunch was emerging. This labour intensive operation has been replaced in areas accessible to aircraft by fortnightly aerial sprays of chlorpyrifos. Where aerial spraying is not possible chlorpyrifos applied with knapsack sprayers or ground rigs is becoming popular.

Other important insect pests are:

- banana beetle borers *(Cosmopolites sordidus)* which attack the corm;
- rust thrips *(Chaetanaphothrips signipennis)* and flower thrips *(Thrips florum)* which damage the fruit skin; and spider mites *(Tetranychus* spp. and *Brevipalpus* spp.) which damage the leaves.

Sigatoka leaf spot *(Mycosphaerella musicola)* and leaf speckle *(Mycosphaerella musae)* are the major diseases of bananas in north Queensland. Without good

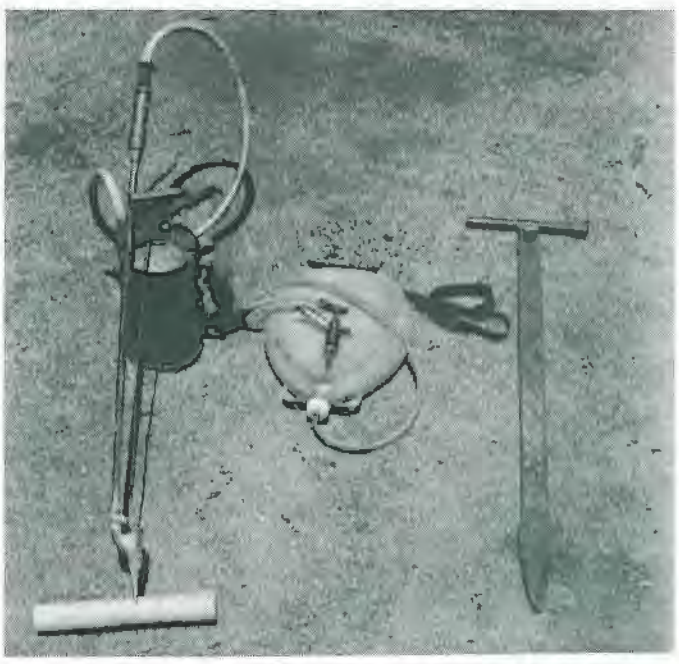

Plate 13. Three desuckering tools: from left to right, a kerosene injector, a 2, 4–D applicator and a gouge.

control of these diseases, crops cannot be successfully grown. They are controlled by fortnightly misting with a mancozeb plus miscible oil mixture using either tractor-drawn airblast misters (Plate 11) or light planes (Plate 12).

Sucker selection

The timing of selection and the size of the following sucker depend on the grower's attitude and work loads. Selecting the following sucker when it is about 30 cm tall is generally preferable. The parent plant is then usually near to bunch emergence. A grower may wish to keep his plants on or about a 12 month cycle and so keep his production to the winter–spring months when returns are highest. He could achieve this by selecting smaller suckers. Alternatively, he may opt for the largest sucker and probably increase his production per hectare per year but miss some of the better prices. Whatever the case, the grower tries to maintain his planting array for as long as possible. This is usually achieved by selecting suckers along the row all in the same direction.

Desuckering

Desuckering is required to remove all but the following sucker. The methods are:

- The plant is cut and kerosened. This is the most widely used method in plant crops. Suckers are cut off just above ground level and 2 to 4 mL of lighting kerosene is injected into the centre above the growing point (Plate 13).
- A spoon-shaped gouge is used to remove the sucker. This method is popular in ratoon crops but is not generally used in plant crops as the suckers are too deep.
- The end of a crowbar is flattened to a chisel end and used to sever the sucker below the growing point.
- Or, lastly, 0.5 mL of 2,4–D amine (5% a.i.) is placed in the throat of unwanted suckers. This is the fastest and easiest of the four methods and is applied by using an automatic vaccinator. However, there is high risk to the remaining plants if applied by unskilled operators.

Detrashing

Dead, dying and diseased leaves are removed periodically. Otherwise they spread disease and harbour insect pests. Removal allows better penetration of fungicide sprays and more effective use of nematicides and butt sprays for banana beetle borer.

Bunch support

Plants require support to stop them from being pulled over as the bunch fills. This also helps keep the interrow passageway clear. This support is particularly important in ratoon crops which are taller and have larger bunches.

Up to the 1970s plants were supported with hardwood or bamboo props, but with the development of the double row and single row-double follower planting patterns it became possible to make use of synthetic twine (polypropylene) tied between plants for bunch support. (Plate 14). The twine gives better support than single hardwood props, is cheaper and does not obstruct the passage of farm machinery. The plants are tied as soon after bunch emergence as possible to prevent leaning of the pseudostem. Twine is used a couple of times while hardwood and bamboo props last 3 to 5 years and 2 years respectively.

Plate 14. Synthetic twine is a cheap and effective support for bunches.

Bunch covering

Bunch covers are widely used to increase yield and fruit quality. Yield is generally increased by 10 to 15% due to an increase in finger length and the slightly quicker rate of filling. Fruit is also protected from fungicide sprays and mechanical damage.

The polythene covers are placed like sleeves over the bunches as soon as the fingers begin to curl upwards. The cover is secured to the stem above the bunch by a staple or tie and left open at the bottom. Covers are predominantly clear/silver plus some blue/silver, blue and clear. The clear/silver has the advantage of not requiring lifting to assess bunch 'fullness' during harvest. The reflective silver is put to the sunny side to protect from sunburn. A leaf is often pulled down inside the bunch cover to protect against sunburn. Covers are used 3 to 5 times.

Debelling

The male bud is generally removed during bunch covering and bunch trimming operations. As well as increasing yield by 5 to 10% it also eliminates one place which can harbour scab moth.

Bunch trimming

Some growers remove the lower one or two hands to increase finger length in the hands immediately above. This is done within 1 month of bunch emergence. One finger of the last hand is left to overcome bunch stem rot. Whether this practice is economically viable in north Queensland is dubious.

Maturity bronzing

Maturity bronzing (red blemish) is a serious physiological disorder affecting the skin of banana fruit near harvest. While it occurs elsewhere it is at its greatest severity in north Queensland. This seems to be related to the extremely intense wet season which follows the drier months.

The blemish produced on the fruit skin does not affect yield and eating quality. However, the blemished fruit is unattractive which affects its marketability. The only means of 'control' is to cut the fruit 'thinner' before the damage becomes severe.

Harvesting

Bunches are harvested so that the fruit reaches the market in a hard green condition. It is then artificially ripened with ethylene gas before being sold on the

Plate 15. Centreboard trailers for transporting fruit from paddock to packing shed.

Plate 16. Dehanding bananas onto a packing wheel. Note the water sprayed on fruit as the wheel rotates and the overhead rail system.

retail market. The emphasis here is in being able to bring all fruit in a ripening room to a uniform degree of ripeness to facilitate marketing.

Depending upon the season and cultural practices, especially irrigation and plant density, the time from planting to harvest is from 9 to 12 months and subsequent ratoons are harvested every 8 to 11 months. The time taken from bunch emergence to harvest is 100 to 150 days.

Time of harvest is subjectively decided by the grower. He judges maturity by the angularity of the fingers which is otherwise known as the degree of fullness. This is learnt largely by experience. The more distant the market (increased transit time) the thinner the fruit is cut.

The rate at which a bunch fills is greatly reduced by such things as moisture stress, Sigatoka leaf spot damage and cooler weather. Fullness is then no longer a reliable guide as to when to harvest because such fruit ripens naturally at a smaller size than well grown fruit. Fruit may not then reach the market in a firm green condition, arriving 'mixed ripe' ('sprung') instead.

Bunch maturity in a crop of bananas is far from uniform. Harvesting is usually spread over a period of 2 or 3 months in plant crops and becomes progressively longer in each ratoon. Harvesting is done by hand usually by teams of three men. A nick is made in the side of the pseudostem nearest the bunch with a cane knife, the bunch is lowered onto the shoulder and the bunch stem severed. The pseudostem is cut off at 1 to 2 m above the ground so that nutrients and moisture in the pseudostem can be redistributed to the following sucker. The top of the plant is cut up and left in the interrow space.

Fruit hauling

Bunches are loaded in an upright position onto foam plastic padded trailers drawn by tractors. They carry from 30 to 60 bunches each (Plate 15). At the packing shed bunches are lifted by hand from the trailer and suspended from an overhead rail system and moved to the dehanding area (Plate 16).

Table 2. Destination of bananas from north Queensland in 1982 by percentage of production

Destination	Percentage
Queensland	12.1
New South Wales	40.1
Victoria	29.7
South Australia	13.6
Western Australia	4.4

Dehanding and packing

The hands are cut off the bunch stalk with a thin, straight bladed knife by cutting through each cushion. Distorted and damaged fingers are removed from the hands. They are graded and placed on the packing wheel where they are washed and moved on to the packing area (Plate 16).

Bananas are packed in telescopic fibreboard cartons with a plastic liner, as whole hands or part hands. Usually 13.25 kg of fruit is packed so that the carton reaches the market with a nett weight of 13 kg. The grower's name and address must appear on the carton.

Fruit grades

There are three grades depending on finger size:

- Extra large at least 216 mm long and 115 mm around.
- Large 177 to 216 mm long and at least 108 mm around.
- Medium 140 to 177 mm long and at least 101 mm around.

In practice, growers pack considerable quantities of extra large fruit as large and large fruit as medium.

Transport

Most farms do not have cool storage facilities and so must send their fruit to market soon after harvest. Handling is greatly facilitated by palletisation of loads which is increasing in use. All fruit is transported to the southern markets by semitrailer or rail wagon. There is very little precooling or refrigerated transport as the increased cost at present is not justified by greater returns. Fruit transport is co-ordinated by the Committee of Direction of Fruit Marketing (COD).

Marketing

Apart from a small quantity for local consumption, most of the bananas are sold in the southern capital cities (Table 2). The more distant markets are only 4 or 5 days away by road transport. There is no export trade at present.

The wholesale market prices of bananas in the capital city markets vary widely within and between seasons. They are very sensitive to consumer demand and the level of supply. Average annual price received by north Queensland growers in 1982 was $7.57 per carton (Sydney market price) (see Figure 4).

Yields

Average yield in the industry in 1982 was 2 130 cartons/ha (27.7 t/ha). However, best yields in ratoon crops are about 4 000 to 5 000 cartons/ha.

Plant crops generally have bunch weights ranging from 20 to 40 kg on 7 to 11 hands and ratoons 40 to 60 kg on 11 to 14 hands.

Plantation life

The economic life of a plantation depends upon several factors. Firstly, yields slowly decline after the second ratoon. Growers must decide at what point the declining yields justify the expense of replanting. The reason for the decline in yield in later ratoons includes damage by nematodes, soil erosion, soil compaction, low organic matter and low pH.

Secondly, seasonal price fluctuations mean higher prices for winter–spring crops. After a few ratoons it is very difficult to maintain control of cropping time. If plants are still producing well, the grower may use the 'nurse' sucker technique to bring production back to the winter–spring.

This technique involves skipping a ratoon cycle by cutting down the crop (the 'nurse' sucker) before bunching, when the pseudostem is 2 m or more high, and gouging out its growing point. This forces early sucker development on the 'nurse' from which the follower can then be selected.

Thirdly, as the industry is highly mechanised, the plantations must have a more or less orderly arrangement of plants to allow the easy passage of farm machinery such as spraying equipment. In practice, suckers can not all be set in the original rows and there comes a time when the layout is too irregular to be satisfactorily managed.

The usual life of plantations in north Queensland is 5 to 7 years which means 6 to 8 crops. The plants are then cut down and ploughed out. Such areas are usually left to weed. However, cover crops such as green panic (*Panicum maximum* var. *trichoglume)* help build up soil organic matter and improve its physical condition while not allowing a buildup of banana pests, especially burrowing nematode. Time spent in fallow is dictated by the available land. At least 2 or 3 years fallow is recommended.

Legislation

To help control the spread of pests and diseases there is legislation (the Banana Industry Protection Act) demanding the issue of permits for the movement of planting material from one area to another. Because north Queensland is free from bunchy top disease and the new strain of Panama disease affecting Cavendish, only planting material from Mackay north may be used in the north Queensland industry. Introduction from elsewhere is prohibited. Planting permits are available from the local Banana Inspector or Horticultural Adviser.