HISTORY OF BEDDING CITRUS GROVES IN THE INDIAN RIVER DISTRICT TO IMPROVE DRAINAGE

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Abstract. The economic success of a citrus grove in the Indian River District depends on its drainage characteristics. The history of various bed designs used to improve drainage along with their advantages and disadvantages is discussed. The development of the equipment used to construct beds is outlined.

In most citrus growing areas of the world three decisions determine the economic success of a newly planted grove. These are site selection, variety, and rootstock. As the citrus industry in the Indian River grew, and the available naturally drained areas were planted, improved drainage was critical in the other land suitable for planting. The need for irrigation arose later, so we now think in terms of water control which includes both drainage and irrigation.

This need was answered by various systems of controlling water called “bedding”. Since most of the audience reached by this talk is somewhat familiar with these systems, time will not be spent describing them. However, for those not thoroughly familiar with these systems they can refer to Systems and Costs of Developing Poorly Drained Soils by the agricultural engineer Kenneth A. Harris (1964).

This article details the design, costs, advantages, and disadvantages of each of the seven systems described. My opinion of what he gives as advantages and disadvantages will be given as the talk develops. One caution for the reader is that the soil types described are the ones used at the time the article was written, rather than the current ones, and citrus culture has now extended to additional soil types.

The Dummitt grove. The first commercial Indian River grove was planted by Captain Douglas D. Dummitt, a native of Barbados. This was another connection for the Florida citrus industry to Barbados. That is where Count Philippe found the grapefruit, which was a natural cross between a pummelo and an orange, he brought to Safety Harbor, Florida in 1823. Barbados was called the Paradise Island and that was the reason the grapefruit was given the scientific name *Citrus paradisi* in 1830.

The Dummitt grove was planted in Brevard County toward the north end of Merritt Island in what is now the National Wildlife Refuge (Fig. 1). It was planted flat on a sand ridge by removing the underbrush and leaving the large existing native trees. Although the date of planting is not known, the first fruit from this grove was shipped commercially in 1828 (Williams, 1962). Like most early groves planted in the district, it was an orange grove. Grapefruit production became widespread in the Indian River District after World War II. This helped replace the volume the packing houses lost when concentrate started using most of the oranges.

The historical significance of the Dummitt (sometimes spelled Dummett) grove to the Indian River citrus industry is so great that it deserves further discussion. Because of its location on a narrow strip of land between the Indian River and the Mosquito Lagoon, the grove survived the very severe 1835 freeze. On a recent visit to the site I estimated the distance between the two bodies of water to be less than one mile. In addition the existing native trees acted as a cover to reduce the loss of heat from irradiation. The grove also survived numerous minor freezes but was damaged beyond recovery by the 1893 hurricane and the Dec. 1894 and Feb. 1895 freezes (Brevard Historical Commission, 1976).

Because it was the only grove in the area to survive these earlier freezes it was a source of budwood for many groves planted after the freezes in all of the district’s counties. The Dummitt grove was one of the first, if not the first, to be budded. Andrew Jackson, an old slave who worked for Mr. Dummitt, said he got the bud wood from a Mr. Jones who lived near Port Orange (Williams, 1962). In this case it was called “top-grafting” because it was done several feet above the ground on sour orange seedlings. Using sour orange as a rootstock was also a factor in helping the grove survive freezes (Brevard Historical Commission, 1976).

The first citrus beds. As the citrus industry expanded to the south after each freeze the groves were planted where there

Fig. 1. Map showing location of Dummitt grove (Puetz, circa 1850).
was good natural drainage. On the barrier islands off Brevard and Indian River Counties they were planted flat with hand dug ditches providing drainage where needed. Later some were planted using shallow single beds.

On the mainland they were planted in hammock areas and along natural creeks such as Ten Mile Creek in St. Lucie County. During the early 1900s bedding began to be used to improve drainage. The first beds were single beds thrown up by plows pulled by mules. The name single bed comes from the fact that one row of trees were planted on each. Multiple passes would be made with the plow until the desired height of the bed was reached.

Plowing resulted in the top soil from the water furrow sides of the bed to be concentrated in the tree row. The organic matter in the top soil was of great benefit in growing a young tree. Where the soil was good the trees grew to be large and productive. My observation is that, to have an economically viable single bedded grove, you must have the best of soils. This is because the high water table in the area limits the rooting depth and the narrow width of the bed limits the amount of roots on each side of the tree.

Advances in bedding equipment. Before factory produced tractors became available and affordable in the early 1920s, tractors were made by converting Model A’s to that use. Both factory and converted tractors had steel rims with cleats. These were suitable for plowing up beds. However, growers did not want them in existing groves because they thought the cleats would cut roots. It wasn’t until after 1928, when Hoyle Pounds of Pounds Motor Company in Winter Garden, Fla. received the patent for putting pneumatic tires on tractors, that tractors were widely used in groves.

Up until this point mules were still used for most work in the groves. After the use of pneumatic tires become common in the 1930s the mules were replaced by tractors. I heard an interesting story about the mules used to pull fruit carts from the groves to waiting trucks. These four wheeled carts had a capacity of eighteen boxes. When the last of the eighteen boxes was loaded the mule would take off and stop at the truck. This brings up the question, can mules count?

The next advance in bedding machinery was a grader blade mounted on a frame that allowed it to be pulled by either a tractor or a dozer. The operator of the blade rode on a step toward the back. The operator controlled the blade by turning a wheel which turned the gears that moved the blade. Riding in the open on the back of this piece of machinery was a dangerous occupation. If the blade hit a stump or large rock it would throw the operator off (Fig. 2).

Development of the double bed. As the industry moved from the naturally drained soils into the poorly drained soils it became evident something needed to be done to increase the rooting area available to the tree. Talking to several people who were around in the 1940s it became evident that this need was first recognized by Bob Edsal.

Bob’s idea was to increase the rooting area through use of a double bed on which two rows of trees are planted. Johnny Moose called Bob “the father of the double bed” and others agreed when I brought it up. The earliest double bed I could document was three years old in 1946 when Dan Richardson started working with it. Bob was the production manager for that operation and Dan feels sure he planted the grove.

Improvements in graders for bed shaping. Barney Greene, who started working with Bob in 1947, said he was still using a pull grader, as described above, and a dozer to construct double beds as late as 1949. Soon other growers picked up on the double bed idea. George Lambeth said his father built one in 1946.

About this time what we now call a “road grader” became available. The first were made by Caterpillar and became available around 1947-48. This machine moved soil more efficiently than the old pull type grader and by the early 1950s was being commonly used. The first graders had gear driven blades that were hand adjusted like the pull graders described above and had four rear wheels and two in the front. The frames were straight which resulted in all the wheels on one side of the grader running in the furrow. Only the four rear wheels were powered. Second hand airplane tires were mounted on the rear wheels to give more flotation but were slick and gave poor traction because of the furrow normally being wet.

By the late 1950s another manufacturer, Austin-Western, produced a grader with a hydraulically powered blade. All six of its wheels were powered so it could move more soil. It also had an articulated frame which allowed the front wheels to be in the furrow but the rear wheels could straddle the furrow which made for a smooth surface in the bottom of the furrow after the cut by the blade. It also used old airplane tires which resulted in better traction because they were on the dry sides of the furrow rather than in the wet bottom. Today’s graders have the same features but use conventional tractor tire treads.

The availability of the Austin-Western resulted in the ability to eliminate a problem in the final product that was a characteristic of the Caterpillar. If you stand at one end of old double beds you will see that the elevation of the end tree or two on your left is lower than the ones on your right. This is because the grader operator extended his blade to the right and as he first started to make his cut he moved soil out of this area. At the other end of the treerow he raised his blade which deposited soil. Making all the cuts in the same direction resulted in a noticeable difference in elevation in the trees at the end of the treerow. This of course resulted in less rooting area for the lower elevation trees. Also, in flood irrigated groves the low end tree would go under water which resulted in root damage.

Because changing the Caterpillar blade required muscle power it stayed extended to the right and all the cuts were made this way. With the hydraulic system on the Austin-West-
ern the blade could easily be extended to the left. This enabled the operator to start in the opposite treerow on half of his cuts which resulted in the end trees being approximately level. Of course this would depend on the operator knowing this needed to be done.

In every bedding system the end tree is always bigger than the rest of the row. This is due to the end tree having a bigger root system which extends under the adjacent road. This was pointed out to me by Dr. T. W. Young around 1968. Often the second and third trees will also be larger than the rest of the row. Where this occurs you notice that where the trees are larger the elevation of the bed is higher which gives the trees more rooting area.

Water furrow pipes. Tiling is the word we often use for the pipes at the ends of the water furrow that allows a road to be built over the furrow. The clay pipes that were first used were tile pipes and were from a factory in Ocala that produced tile pipe for water mains. As with any manufacturing process some of the tiles were seconds and the factory just set them aside since they had no use for them.

The early single beds did not need tiles because the water furrows were shallow and equipment could maneuver over them when traveling across the end of the grove. When the double bed started being used it was necessary to use some sort of pipe so that roads could be built over the ends of the water furrows.

The first pipes used in deep single beds about 1942 were four inch clay tile. They were eighteen inches long and were the same tile used for septic tank drain fields. Concrete was poured around the joints to make the connection water tight. Because of their small opening they often became clogged and were difficult to open. After the December 1962 freeze there was an increase of planting in the area. In the early 60s Mr. Arthur Helseth of Fort Pierce acquired a distributorship from the pipe factory to sell their seconds in the area. By this time the factory had run out of 4 inch seconds so the 6 inch seconds were used. Later both the 6 and 8 inch seconds were used until the supply of both were exhausted in the middle 70s.

Both the 6 inch and 8 inch clay tiles were available only in 5 foot lengths and came with a bell on one end to take the even end of the joining pipe. When these pipes were used they were very heavy and required two men to carry each pipe down into the trench. The early ones required a concrete mixture or plumber’s okum to make the connection water tight. Later a gasket was inserted into the bell end at the factory to make a water tight seal. When these were used a third person’s responsibility was to apply grease to the gasket on the inside of the bell to make sure the joining pipe slide in for a good fit.

When clay tiles were no longer available one of the pipes to be used was made from a tar paper like material and was very cheap. However, after a period of time the pipes collapsed and had to be replaced. They were only available in a 6 inch diameter. They were made by Sonoco in 10 foot lengths that were connected by a coupler.

When PVC water main pipes became common, the seconds of these were used in groves and continue to be used today. These were available in both 6 and 8 inch sizes. Being light and available in 20 foot lengths this also reduced the cost of pipe installation.

Pipes of any material in 6 inch size and less became easily clogged, especially in grapefruit groves. In flood-irrigated groves anything less than 8 inch pipes resulted in longer pumping times to fill the furrows and a slower drain time than desirable. I have replaced 6 inch pipes with 8 inch and cut the total time of flooding in half.

In early use the length of the water furrow pipe was shorter than they should have been, probably because of cost. This resulted in a steep incline for equipment coming out of the water furrow and would often result in the tractors spinning their wheels to get out which would create holes. When exiting a water furrow with something like a sprayer the wheels of the sprayer would often break or crush the ends of the pipe. To avoid this I started installing at least 50 ft of water furrow pipe which reduced the incline and allowed turning without damaging the water furrow pipe. While this increased the cost of installation it reduced the long term maintenance cost and increased equipment efficiency.

Evolution of bed leveling. The next advance in increasing rooting area was leveling the beds to achieve a uniform rooting depth. Having a level bed produces trees of more consistent height and leaf density. While this is important for pounds solids production it is more important in raising fresh fruit because it produces fruit of more consistent quality, both in size and appearance.

While the need may have been recognized earlier, an efficient means of doing it was not available until around 1960 when the first large self-propelled pans became available. While this procedure would be valuable in any bedding system, a lot of groves have been planted without it being used.

When leveling was first used it depended on the ability of the operators to judge elevation. The grader would begin the bedding operation and the pan operator would pick up fill from the high areas and deposit in the low areas. The usual result was that when finished the high areas would still be high and the low areas would still be low but with less difference than when the operation was started. Also, beds in the high areas would be more rounded than beds in the low areas.

When lasers became available the preferred method was to level the field as much as possible and then use laser equipped pans to complete the job. This resulted in all the beds in the field having the same configuration.

The low areas in groves not leveled have a reduced rooting area which was particularly troublesome since all groves were flood irrigated until recently. When groves were flooded the trunks of the trees in the low areas would soon be covered and the water would go up the bed past the treerow. This results in a rapid downward movement of water forcing air out of the pore spaces and creating an anaerobic condition. Most of the soils in the low areas are sandy which made this problem worse. To help correct this problem I hauled soil to the top of the double beds to raise them. A grinder with a modified blade was then used to push soil under the trees as close to the treerow as possible. This method increased the rooting area enough to improve tree condition to some degree.

Mixing soils to improve tree growth. Early in the use of double beds it was recognized that sand pockets needed to have their fertilizer and water holding capacity improved. The usual method was to amend the soil by digging up the clay beneath with a dragline and mixing it with the sand. A study by Koo and Driscoll (1970) outlines three procedures for doing this and reported the improvement in soil quality.

With the equipment necessary to deep plow unavailable for many years I settled on the use of a dragline or hydraulic backhoe as the preferred methods. After a double bed is partially constructed the backhoe would dig a hole at the end of...
one treerow and set the soil aside on top of the bed. The width of the hole can vary with the desires of the grove owner to improve whatever percent of the double bed he wants. My normal width is about 12 ft wide centered on the treerow with instructions to the backhoe operator to dig until he has two feet of clay to mix with the sand.

After digging the first hole the next soil that is dug is dumped into the hole just dug. Because the backhoe bucket digs at an angle it will pick up some material from all soil layers. When it dumps the soil there is a mixing action. This results in clumps of clay being surrounded by sand. The backhoe operator will dig his way to the end of the treerow and end with a hole. He will then move over to the next treerow to dig and throw the soil into the hole in the first treerow. After reaching the end of the second treerow the backhoe will use the soil from the first treerow’s hole to complete the job.

This method is also useful in muck soils. This buries the muck so it won’t oxidize which would reduce the elevation of the bed.

Renovating existing beds. In the previous discussion the work is being performed on ground virgin to citrus or when changing the bedding system of an existing grove. My recent work has been on good existing double beds where the main objective is to replant the trees. Once the trees are removed and burned there are several ways to proceed.

One is to disc the entire bed and use a grader to reshape and smooth it. Recently a contractor suggested a slightly different method that I feel is better. Because water furrows fill in over time they need to be deepened with a grader. In this method the grader cuts to the desired depth and rolls the bed.

Comparing bedding systems. In 1965 I was hired as General Manager of a 1,700 acre grove operation in St. Lucie County. The acreage consisted of 14 groves that used all of the bedding systems described by Harris except the four row bed and tile systems. Operating and changing them for 20 years gave me the experience necessary to compare different systems. I soon learned that the water we see is not the problem; it is the water we don’t see that reduces our root volume.

Because I was a friend of the manager of a large four row bedded system in St. Lucie County, I became thoroughly familiar with it. Several times we rode this grove, together with two other grove managers, trying to come up with a way to change the beds to correct their faults. We never succeeded. One thing Harris does not mention in his evaluation is that the four row bed system requires 25% more equipment to cover the same number of trees acres in the same time as the other systems. This is because of the large ditches between the beds and the travel pattern the equipment must follow. The travel pattern results in two trips in which only one side of the equipment is working and then a deadhead trip back to the road.

In his 1965 article Harris discussed the single row bed, swale outlet, 12” bed, not leveled and stated its disadvantage “System not in use long enough for absolute conclusive results”. In his article he favored this system and in practice he recommended it. As a result several large groves were planted using this system. In his article he also stated “Satisfactory subsurface water table control” as an advantage.

One of the groves I managed was this system planted in 1940. One block in this grove averaged 77 boxes of grapefruit per acre over a five year period. When I took it over one of the first things I did was to install water observation wells in the treerow to monitor the water table. After rains we observed the water table being as close as 8” to the top of the bed for prolonged periods. Since Young (1953) observed that no roots would be found nearer the water table than one foot it became obvious why this system was not economically viable. Dr. Young’s bulletin has been my “soil/water bible” my whole career and should be read by everyone working with flatwood groves.

In recent years most groves have been planted on the double bed system. My experience with various bedding systems has convinced me that the double bed system results in the highest volume of rooting area and is the easiest to work.

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The author has a BSA and a MAg in Horticulture from the University of Florida. He has been a grove owner, a grove manager, consultant, and active in citrus industry organizations since 1949.

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