HARVESTING, LOADING AND TRANSPORTING SUGAR CANE IN PUERTO RICO IN THE PAST, PRESENT AND FUTURE

Lawrence R. Partridge (Chairman)
Puerto Rico Sugar Technologist’s Committee

INTRODUCTION

Historically Puerto Rico’s Sugar Industry has been beset time and time again with calamity. In 1533 the first sugar was exported amounting to some 23,500 pounds. By 1582 sugar furnished the Island with its principle source of income. Around 1600 this initial growth began to decline because of a lack of credit and a diminishing work force. It was not until 1815 that Puerto Rico was freed from its exclusive commercial ties with Spain by a royal decree that the sugar industry began to flourish anew. People came to the Island to take advantage of the new opportunities this event afforded. Many workers and slaves were brought in to work in the fields. The years between 1870 and 1879 were very productive but in 1879–1880 a plant disease attacked the principle sugar cane varieties. This event greatly affected the workers in the fields but little by little a partial recovery was effected only to be wiped out almost completely by a hurricane at the close of the century.

Along with the crippling result of nature came the Spanish American War when the United States took over the destiny of Puerto Rico. With the inflow of capital from the United States a new era entered the Island and the sugar industry began to build anew under a new system of large holdings and an abundance of impoverished labor.

The first significant change in sugar growing practices occurred with the rebirth of the industry. New mills, roads, railroads, the use of fertilizers, the removal of duty into the United States, abundance of capital and the available labor force set off a rehabilitation of the sugar industry never equalled in Puerto Rico.

Growth was continuous up to the First World War where it levelled off for a time in spite of the high price prevailing at that time. The post war years also saw only a moderate upward trend. In 1923 disease hit again and production was set back to pre-war level of 1912.

Our position today is somewhat similar to the situation in 1923. The research men, plant scientists of the Federal and Island governments set to work to overcome the disease problems without delay. New varieties were developed resistant to prevalent diseases. Yields increased with the introduction of the new varieties. A phenominal upsurge of production followed up into the nineteen thirties when production hit 1,110,000 tons. But then the depression was experienced. The price fell. The sugar act came into being to help prop up the sagging situation. Production levelled off around one million tons annually. The hurricanes of the late twenties and early thirties evidently from observation of the statistics did not affect the annual production too drastically although they were highly destructive.
A point to note about the thirties is that the industry was receiving aid from the government in exchange for production quotas. The industry was taking and giving little other than sugar at a set price. The law did eliminate child labor and force wages up a little but it was easy at that time to improve the productivity of the worker and to keep costs under control; however, the industry began to awaken to things to come.

Apparently the rubber tire tractor began to appear on the scene during the thirties to replace the ox cart. Prior to this time tractors for cultivation work had been showing up in the fields, but certainly not to the extent that we see them today. It appears reasonable to say that field mechanization did not begin until the late thirties and then very slowly as the large surge did not come until the fifties.

With the event of the Second World War, in 1942 to be exact, the quota restrictions were removed for Puerto Rico and reinstated again at the end of 1947. While production did not change appreciably the surplus that had been accumulated vanished during the war years. Production after the war started to move up again appreciably but then too the returns to the workers did likewise and furthermore productivity of the labor began to drop off. It was at this time that the problems of the present times began in earnest.

In 1952 the industry reached its peak with production of approximately 1,360,000 tons which of course was in excess of the Island's quota which was, fortunately, disposed of through re-allocations provided Puerto Rico. Up until 1957 production remained stable around one million one hundred thousand tons as provided under the quota. The hurricane of 1956 followed by a dry spell caused production to drop below one million tons. At this time further legislation assisted the industry. The processing tax on sugar and molasses was removed; the legislature rescinded the property tax assessed on sugar and molasses inventories; funds were appropriated to secure loans to growers and to pay incentives to the growers to enlarge their plantings. In part this legislation helped but mostly it did not get to the root of the real trouble.

The production from 1950 on has remained around the one million ton mark and generally below it with every evidence that it will be a long time before it exceeds one million tons, if ever.

This history that we have been providing has a very direct bearing on the subject of this paper. The vast number of different systems in harvesting, loading and transporting of sugar cane still in use today are all derivations from our past history. Our attempt to work our way out of a dilemma has given us more methods than we have time to describe in this paper. Years ago methods were fairly standard but now we find as a result of our committees investigation that we have wandered into a swamp which could easily engulf us; however, as technological changes take place the large majority of these methods will disappear. They could also disappear by attrition of the work force or the cane owner going out of business. Probably all three possibilities will occur.

METHODS

Cane has traditionally been harvested by hand in Puerto Rico since 1500 up to the present day and it appears that it will continue for some years to come. In the nineteen
thirties and forties the rubber tire tractor and the crawler tractor began replacing the ox and the ox cart in cane hauling. In the southwest this did not come until 1950. In the fifties the Louisiana type cane loader began appearing in the fields to replace the hand loading operation. Along with this cultivation practices changed somewhat towards the system used in Louisiana. Also the cane cart began to appear with large rubber tires. For example, one large company acquired three Louisiana type loaders in 1953 and today they have approximately forty in operation in the fields supplying their mills. Of prime importance to note is the fact that while loading and transporting has become more mechanized in the past twenty years the harvesting has changed in a negative direction to a ruinous position costwise. About the only improvement has been the introduction of a lighter knife. While mechanization in loading and hauling has enabled the industry to hold the cost line in these operations with a relatively unchanging sugar price, the hand harvesting cost has skyrocketed to ruinous proportions.

Although there are slight differences throughout the Island in the productivity of labor and in labor costs, they generally are in the same dangerous area. It is quite apparent that methods have to be changed to keep the industry from folding up in the long run. We are sure no one here believes that the sugar price will rescue us from our ruinous harvesting costs. We are only too aware that we have a protected price under the United States quota. We would like to point out that our problem here in Puerto Rico is not confined to Puerto Rico. This problem has been solved in Hawaii, Louisiana and currently being solved in Australia. It should be obvious to us all that each of these areas has solved their problems in their own way. Does this mean that the rest of us must solve this problem in our own way? Are conditions everywhere so different that each sugar producing area must develop its own answers and machines? Let us face the facts, only the people are really different. We in the Caribbean Area have similar conditions and we must work out our problems together. Many of us are not big enough to do our own development work so must rely on others and the manufacturers to help us develop the machines that inevitably must come. The grower or the small company can assist by preparing experimental fields for the machinery trials. They must plant fields occasionally like the large companies so why not cooperate with a manufacturer and prepare a field or two for their use either with present machines or experimental models. Throw away the old idea that it can not be done because our conditions are different. Consultants with experience in these problems are becoming available to assist us in our mechanical problems.

In Puerto Rico 1942 was the beginning of a long trend of increasing labor costs and slackening productivity. Change in government, change in social conditions, the Second World War, government legislation, migration of labor to industry and to the United States and other such changes have upset the old labor situation. While the agricultural worker’s economic status has been changed for the better, the industry has failed to effect the required technological changes to keep the harvesting costs under control. Our labor force while dwindling is also growing older. As a result of an inquiry into the average age of the field worker in the southwest part of the Island, we found 60% of them between 55 and 60. The younger men are the migrants. The problem here in Puerto Rico is only too obvious and it is coming rapidly in the other sugar producing areas too. Where would Florida sugar industry be without their imported labor from Jamaica? This they realize and are taking steps to provide an
alternative before the axe falls. Puerto Rico, Peru, Ecuador, Colombia, Mexico, Costa Rica, Trinidad and others are so aware of the problem that they are seeking the machine that will handle their particular conditions. The problem is real and it is here right now.

Since the Louisiana Loader has come to Puerto Rico the hand cutters working in pairs cut the cane long, each man taking two lines. The top is cut off and the stalks placed across the cane lines between the two men with the top in between the rows of cane so piled. The resultant windrow consists of four lines of cane piled as it is cut by the two adjacent cane cutters. There is a lesser method still in use where one cutter will cut three lines by himself making his own little windrow. Occasionally you may find a cutter cutting four lines.

Up to fairly recent years, let us say ten years ago, all the cane was cut green. Now a large percentage is cut after the cane has been burned. This burning practice commenced at about the same time and as a result of the importation of the Louisiana cane Loader. At the time two important cost factors arose which helped doom hand harvesting in the long run. First it was feared that the loader was going to put a large segment of the labor force out of work so a penalty was levied against the person operating a cane loader for every ton loaded by the machine. Secondly, it was believed that cutting burned cane was bad for the cutter's health and more costly to him personally because of the carbon, so a penalty was levied against the cane owner who burned his cane before harvesting amounting to time and a half of the cutter's hourly pay. This penalty applied to every man handling this cane up to the point of delivery into the railroad car or in the mill yard whichever occurred first. This generally came about in 1953. As mechanization increased so did the volume of these special condition payments. 1943 saw the beginning of the minimum wage law; 1949 saw the Employment Security Law; in 1956 the minimum wage was raised; in 1957 the Union became influential and wages went up again; in 1957 the sugar price wage escalator came into being; special funds were set up such as the cane workers rehabilitation levy; since 1957 wages have been negotiated upward continuously.

To offset the rapid rise in hand harvesting labor cost and sagging productivity incentives of various sorts have been attempted. A large percentage of the harvesting labor force is working on an incentive basis but the productivity has not kept up with the more rapid rising cost. Incentives have met only with moderate success and are far from being generally acceptable by union and labor.

There has been no real change in hand harvesting other than an increase in its cost and a decrease in the daily output per man. General figures for the entire Island are approximately a 142% increase in cost per ton of cane cut between 1933 and 1943 with the real upswing starting in 1941; a 52% increase between 1943 and 1953; and, a 24% increase between 1953 and 1963. In thirty years costs have gone up 355%.

The productivity figure is a difficult one to analyze because in some areas the burning of cane resulted in an increase in daily output per man of some 10% to 20% but on the other hand over a period of time the productivity of the men decreased as a group because of the increase of average age. Incentives also entered the picture and confused the figures further. The net result has been that it takes more man hours to get a ton of cane cut now than it used to. In comparison to some other sugar producing
areas the productivity is approximately 50%. How and why this is we do not really know. We would rather leave the answers to the productivity question to those more qualified to provide the answers.

As far as harvesting is concerned the past is still with us in the present and is likely to be with us in the future. As for the present there are virtually no mechanical harvesters in full production in Puerto Rico. Several have been tried such as the Louisiana machines but several conditions have defeated them thus far. An attempt was made to install the Louisiana system in Puerto Rico but it was not followed precisely therefore creating difficulties for the machines which were designed to operate under very precise Louisiana cultural control. Contributing factors to this failure was the terrain, the soils, the human element on the part of the grower, the resistance to mechanization on the part of the unions and labor and the rapid growth and resultant recumbency of the cane in Puerto Rico. If the grower could make his cane stand more erect the Louisiana machine may have a chance. This is not beyond the realm of possibility. In the drier areas several companies have installed a stricter Louisiana system and it is hoped that they will be able to use the existing machines in these fields so prepared for them. Another company is also preparing an area adaptable to an existing Australian machine which will not only cut the cane but load it in the same operation. Several machines have been built and tried out in the past recent seasons. It is anticipated that in the 1964-65 season we will see four identical machines in productive operation in Puerto Rico as a result of work carried out during the last season. These machines also cut and load the cane in the same operation.

Puerto Rico has a cane condition different from those areas where they have already mechanized the harvesting. There are many other sugar producing areas in the same situation. The cane is not erect as in Louisiana and Australia nor is it extremely heavy and blanketed or lodged as in Hawaii. Our cane is in between and there is certainly no abundance of cane machinery on the market that can handle the tonnages existing in a large part of the world under local cultural conditions. One of the largest deterrents to developing a harvesting machine for a large segment of the industry is the human element for or against changing existing conditions. One school of thought is that the Engineer must provide a machine that will handle the existing conditions. Another school of thought is that conditions should be changed to suit the machine. From actual experience here in Puerto Rico both the above views are deterrents to progress. Such attitudes can and are contributing to the financial destruction of the industry institutions. There has to be a compromise somewhere in between these two attitudes. What are the requirements that must be met to mechanically harvest cane here in Puerto Rico successfully? Well, no one really knows because it has not been spelled out to where two or more persons agree on the necessary requirements. The Agricultural Department of the University of Puerto Rico is spelling out what they believe are the requirements and are building a machine accordingly. It remains to be seen to what extent this program contributes to the relief of our problem. Manufacturers want to push their own products; engineers want to push their own ideas; every sugar cane man wants to push his pet theories; and, every amateur wants to get into the act. Developments are painful to be sure but we suppose the problem will be solved after many fortunes are expended and potential profits are passed over and over again.
Hand harvesting incurs other costs on an increasing scale. In many sections of the Island the grower must pay for transporting the labor to and from the fields. With large numbers of people involved this is becoming increasingly more costly. The seasonable foreman or Capataz is finding it more difficult to get good cutters and takes anyone who comes along and offers them to the grower. Transportation facilities are in short supply resulting in dangerous overloading in hauling labor which of course results in police action against the violators. Government assistance to the needy and unemployed has affected the will to work. The habit or tradition of eating a warm meal in the middle of the work day means that many growers are required to transport meal pails to and from the fields. The inevitable water boy and the timekeeper are still required by these gangs of cutters. The large numbers of people, many of which do not turn out to work consistently, require a large office force to keep track of and make up the payroll, calculate the social security, the workman's compensation, deduct the union dues, and so forth.

The hand harvesting of the past was not much different from other parts of the world. The cane was cut, topped and stripped of leaves and piled for loading into ox carts with a capacity of 1.25 tons. The ox cart was replaced commencing in the late thirties and in the forties by the rubber tire steel cart. You will still see some iron tire ox carts in use today by some cane farmers. In the thirties you would have seen considerable amounts of such hand cut cane loaded onto small narrow gage rail cars on portable tracks. In 1936 the American Railroad Company of Puerto Rico went out of the picture and generally with it went the use of portable track and the small rail car. You still would have seen some portable track in use as late as 1962. This operation did not disappear suddenly but gradually dwindled out as a general acceptable method of transport. Loading these carts mechanically never was a major Island wide operation; however, it is interesting to note that some cranes appeared on the scene in the western portion of the Island around 1924. A few trucks were also noted at that time. Up until present years you will still see cane cutters piling cane for hand loading into rubber tire carts. This is mostly confined now to steep areas and small farms. The major change in the hand harvesting pattern came with the Louisiana loader when two men piled two lines each into one windrow across the lines for the loading machine. Stripping the leaves off the cane disappeared also with the introduction of the Loader.

In summary of the harvesting operation, Puerto Rico is in a serious dilemma in the harvesting of their sugar cane crops. It is another large milestone in the history of their sugar cane industry. Will it be solved before many more growers go out of growing cane; before many more factories are forced to close down; and, before a large portion of the economy of Puerto Rico is destroyed? Machines must be developed and jobs created for our cane cutters. Our educational system is helping indirectly to discourage our youngsters from wanting to cut sugar cane. Perhaps it is only a question of time before you will not be able to find a single person willing to get out into the cane field to cut cane by hand. Perhaps we can hasten this eventuality for the good of the Island's economy. This is coming to pass slowly but it is being very costly particularly in lost income to the Island. A loss each year of 300,000 tons of sugar or potentially more is serious to a growing population which has a concentration of more people per square mile than any area in the world. Our committee has looked into costs both past
and present in all sections of the Island and the picture is the same. The industry must have technological change and quickly. While some sections are cheaper than others the trend is towards the same horrifying end. It was noted that the section which has about the lowest harvesting costs today is the one that is most likely to mechanize their harvesting first. Other than a forward looking management there are other points related to this occurrence. Principally they have favorable terrain and a partial acceptance by the local labor. Attempts are being made to mechanize. This season will see a number of machines in the field on a production basis for the first time in our history and others will be on an experimental basis.

Loading progressed from hand loading into carts and into portable rail cars, onto slings for drag line to a loading point, loading by small grab onto carts and portable rail cars to the method still in general use of loading by Louisiana type loader into carts. The standard Louisiana loader created a factory sugar recovery problem when they appeared in the fields in large numbers. These machines being competitive in the machinery market do not entirely adapt themselves to the rougher field conditions here in Puerto Rico. An attempt has been successfully made to improve the quality and reliability of the work performed by these machines. The piler was redesigned to lift the cane off the ground before the grab was made. This improvement has been noticeably successful in the factory by a marked reduction in dirt and stone delivered. The quality of the cane of course is still not as good as hand loaded cane but it still enables the factory to produce at an optimum rate. Larger carts have been introduced in practically all parts of the Island. They are of all shapes and sizes now. The Louisiana loader in general has controlled the height of cart but even this has been changed to some extent. There are Louisiana loaders now available at slightly higher cost which will load a cart which is 11 feet high as measured from the ground. This enables you to carry sizeable loads and reduce spilling by using a closed cart of good capacity. The old style cart has been greatly abused by the operation of the Louisiana loaders because of the overloading and the use of chains to tie the load into the cart. The use of chains is expensive in that it requires a great deal of time and labor in the field and at the delivery point. The chain itself is expensive and is lost quite easily. Spillage of cane in Puerto Rico while loading, along the route and at the transfer stations has been and still is ridiculously high. This is inherent in the system and is expensive to recover regardless of whether you use hand labor or mechanical means or both. The move then is towards closed carts and vehicles where chains are not required and spillage is reduced to a minimum. The new carts that have been tried and which have successfully come into the picture carry from 4 tons up to 20 tons. There are various sizes in between. The sizes are determined by the rest of the system in which they must fit. This phase is very definitely in the evolutionary stage.

Along with the development work done in the loading and cart hauling operations there has been some developments in the tractor line. Several years ago you would find in Puerto Rico only rubber tire tractors of the 50 horsepower or 2-3 bottom plow class. These small standard farm tractors would pull as a rule 3 of the standard cane carts which contained 2 to 3 tons of cane well chained in. This was and still is quite a load for a small tractor when conditions became a little unfavorable such as uneven terrain, rain, and so forth. When things got too difficult one cart was dropped off or the wheel tractor was replaced by a crawler tractor. Initially when an exchange
was made from wheel to crawler because of unfavorable condition, the intent was to transfer the carts back to a rubber tire tractor at some adjacent point where the exchange was feasible. For one reason or another the people involved ended up going all the way to the transfer point with the crawler. In many cases this made sense but where it did not it still happened that way. This can lead to a tendency towards higher cost created by increased turn around time, higher maintenance cost for the tractor and damage to roads. The rubber tire equipment manufacturers began to develop kits which could replace the conventional front axle to make the tractor a four wheel drive unit. Some of these have been acquired in large numbers in Puerto Rico and have created a transitional development. We would like to point out that this was an interim development on the part of the manufacturers in order to create a larger demand for the use of the wheel tractor. These tractors were not designed as a four wheel drive tractor and as a consequence their maintenance costs have been somewhat on the high side and the units not too dependable for our short season. Our industry has pointed this out to the equipment manufacturers and we are sure other industries throughout the world have too. They have in recent years come out with tractors in the larger sizes which you might say are four wheel drive tractors from the very beginning. We might add that these units are rather heavy users of rubber tires when used as pulling units on paved roads. By the use of these larger more powerful tractors we have been able to load higher and heavier and to eliminate the exchange between rubber tire and crawler and back again. In one respect this has been discouraging in as much as some of our old timers can be found to be pulling the same three little carts with this larger tractor which is capable of pulling twice as many carts and also which costs twice as much as the little tractor. There are many reasons and excuses as why this happens but little by little this situation is improving by training and preplanning. The intent is to work into the present system, involving the Louisiana type cane loaders, cane haul units that can be loaded by our current loaders in our fields which can get in and out of the field under their own power and that are capable of making fairly long hauls to a transfer point or the Factory. Since we have a large number of Louisiana type cane loaders and old carts which will and can not be replaced immediately the old tractors can be replaced with better units which greatly reduce the necessity of acquiring expensive crawler tractors which are generally used exclusively for pulling cane carts for a short time during the year.

The hilly terrain still poses a problem in Puerto Rico because there is so much of it. The system has been and still is to load carts by hand. These carts are pulled by crawler tractors up into and down out of the steep areas where the rubber tire tractors can not go safely or at all. A person can also see the vast amount of hill country which has been taken out of cane cultivation because of the costly hand cutting and loading expense. The labor supply today has dwindled to a point where it is extremely difficult to find some one to load cane by hand. Recently the Louisiana type loader was mounted onto a few 74 inch gage crawler tractors with the idea in mind that a larger percentage of the steep hilly country could be loaded mechanically. It was soon found that there are definite limitations to this idea and we would be inclined to say that this practice is not too successful. The first tendency noted was that the personnel overdid things a bit and went too high into the hills resulting in a very perilous operation and as it turned out a costly one. Hill country is rapidly disappearing for cane culture.
Another practice which was attempted in the hill areas was piling of long hand cut cane onto cable slings and onto chains. A man or a crawler tractor took the cable out from a large crawler crane and the cable fastened to the large sling bundle of cane. The crane then pulled the bundle into a loading spot where it could be safely loaded into the carts or into trucks. This again was expensive primarily because of the high cost of cutting and piling the cane onto the slings not to mention the cost of acquiring and operating the crane. We must admit though that the method is good and is an excellent way to get cane off steep hills with very little damage to the ratoon. This dragline method was used in Hawaii many years ago during their transition period between hand methods and their present mechanical methods.

Another method attempted was to push the hand cut cane down the hill with a push rake tractor to a point where the loaders could load the cane into the carts. This was injurious to the ratoon and to a factory without some means to remove large quantities of dirt and rocks. It also put all the trash into the mill. In 1953 on an irrigated plantation on the South Coast a push rake method was employed on flat lands where the tractor made windrows out of hand cut cane piled 4 into 1. This cane was then loaded into large trucks with trailers by crane equipped with a crane grab. This cane went to a mill which had a small but fairly effective cleaning plant. This operation is still in use today and may be for some time to come even though some soil compaction has been noted. There are not many companies in Puerto Rico who can afford to install adequate cleaning plants these days although there are some of us who feel that this must come since we know the system will work; however, any harvest system that results in damage to a one year crop must be looked at very closely since the yields in the next crop can be affected rather drastically. Replanting can be expensive and of little value in the next crop. We have to face this problem if we are to succeed in mechanization.

The cut-load system has worked in trial quite well but it too has some points which must be looked at quite closely. Cane roots in Puerto Rico, as in other tropical soils, have a tendency to be quite shallow. There are some of us that contend that this condition is caused by our cultivation practices; nevertheless, it will be some time before this condition changes. The stools or roots come up with the ground cutting blades and pickup attachments in quantity that is frightening. While the cane appears clean and the field looks in good condition after the harvester has passed by, the fact remains that the observations of the first expressed juice where no washing has been done is quite depressing. The stools that are pulled up, though low in number, muddy up the juice considerably even in dry conditions. It was also observed that the amount of replant required is substantial. It is expected that this problem can be corrected in time. Again some sort of cleaning facilities can be put to good use. Chopping of cane for loading by these machines bears further studies as far as potential sugar losses are concerned. Chopping certainly facilitates the handling of the cane.

As far as loading of cane in Puerto Rico is concerned it appears that the Louisiana type loader will be in use for some time to come and we must learn to live with some dirt in our juice. The attempts to minimize it have been fairly successful yet statistics over the past years show that the use of these machines has contributed to the lowering yields experienced in Puerto Rico.

In connection with this dirt problem this past season saw a trial transloading
machine which was equipped with a dry cleaning plant. This transloader was portable so that it could be moved from one trans-load station to another. The cane was side-unloaded over the top of a more modern cane cart by hydraulic operated unloading tower onto a feed table. The cane was then fed onto a conveyor which elevated the cane up into the air over the rail car where it passed through knives which chopped the cane into small pieces. Upon coming out of the chopper the cane fell at a fairly good speed through a blast of air from a blower mounted on the portable conveyor. With proper rail car moving a good load factor was obtained of what appeared to be very clean cane. The cane was clean except for, as mentioned before, a number of stools which contained dirt which did not look too serious until the juice at the crusher was observed. From all evidence around the dry cleaner transloader a sizeable job of work was eliminated from the mill in the form of trash, dirt and cane tops. This operation is worthy of further developments. At present it appears that better cultural practices will help most in cleaning cane in this manner. Failing in this perhaps some washing in the mill can take care of the residue dirt while the dry cleaner takes care of the trash and tops. It was found that waste disposal out along a well chosen transfer point was very favorable as against getting rid of the foreign matter from around the mill. Of course a direct haul to the mill would mean that the foreign matter would have to be disposed of in the mill area. This perhaps could be done by funneling it into a fire. Hauling it out to a field can be extremely expensive.

Transportation has been touched on briefly in connection with loading and harvesting. In the past the carts developed from ox carts to the rubber tire tractor cart. Four wheel carts are not found in abundance here probably because of the large number of transfer stations operated which are usually located near the harvest field. Hooking and unhooking from tractors is at a minimum. Where crawler tractors are used in the field and a transfer made to rubber tire at the transfer point, a person can note a crawler tractor using his grousers to raise and lower the draw bar of the carts. This unique practice on the part of many of the operators year after year gives our cane carts a peculiar shape which is costly to correct. If you have this problem of hooking and unhooking two wheel carts this may be a method you could employ but we do not recommend it. The two wheel cart is found to be more satisfactory since so many of our fields have tight corners and poor exits which require a great deal of backing up and good tracking of the carts in the train. The Island is well equipped with the old small rubber tire carts. Many now are equipped with the large surplus airplane tires. It seems that trials in the past have indicated that the single large tire works much better in Puerto Rico than the duals that you see in Florida. These large single wheels are being included in the design of the newer carts appearing in the Island which makes unloading over the top necessary rather than out through the side which you can do if the Florida type were used. It seems that our soils on wet days render the dual type useless. Some of us are inclined to stick with the large tire for maintenance and initial cost reasons. Chain net unloading has been tried in carts and it offers no particular serious problem. The future will see the present two wheel type on the outside of the cart and also the type with small, 4 to 8, under the cart in the drier areas. Local conditions will dictate what kind will eventually appear in the newer units. The chain system of fastening the bundle into the cart will eventually disappear as a general practice. Losses by spillage will gradually be lessened. The larger closed carts are
beginning to appear on the scene. The size and shape is determined by the subsequent portion of the operation which is the size and shape of rail car compartment, the size of the transload conveyor, the size of the millyard feed table, and so forth.

Trucks of all types and sizes have been in use for many years now in Puerto Rico. Most are loaded at a derrick transfer point from carts. Some are directly loaded in the field by hand, Louisiana type loader and by crawler crane. By far the most common truck operation in the past and even today is the cane bundle transferred from the cart to the truck by a stiff leg derrick operated today by a small engine operated winch. In the old days a mule or ox was used to operate the derricks. Some electric winches are used where power is available. These small trucks have the many bundles, which are placed on their backs, tied down with chains and off to the mill they go most likely not to be seen again until the next day because they get lost in the congestion around the mills where trucks wait their turn to be weighed and then unloaded either into the feed tables direct or into bundle storage. This operation is very unsatisfactory during this period in our history. This condition drives up the trucking rates and results in added expense in the field. This is another serious cost item in our industry today and it must be solved by the joint efforts of the growers and the mill operators. The growers haul only in the day time so this congestion can not be spread out and it puts a strain on other methods of supply and onto the millyard facilities because of the necessity to store for the night shifts. This is a serious problem throughout the world. It is hard to predict how much longer this system will continue. It is amazing how far some of these trucks travel to get to the mill of their choice. As a side note the grower must declare which mill he wants to send his cane to by November 1 of each year. He usually is granted his choice by the sugar board and arguments arise only when a mill’s quota is filled up. Usually the mill and the grower work out their daily quotas but it must be declared in advance by the grower. It is not unusual to see two cane truck drivers wave at each other as they pass going in opposite directions to deliver their cane to different mills. This may be good for the trucking industry but it is ridiculous in the sugar industry. Old customers appear to have a preference over a new arrival. It is not difficult for a grower to change from one mill to another where he believes he may gain a better yield or because he is mad at the mill personnel in the mill nearest him since the mills are usually short of cane these days.

The methods in cane hauling vary more than any other method in the Puerto Rico Sugar Industry. In the old days everybody went to the closest mill with the help of their ox carts. After the turn of the century railroads began to come into the picture in the large sugar cane holdings. A railroad linking most of the coastal areas to San Juan came into being which enabled some of the cane to go longer distances to the mills. The around-the-island railroad went out of the picture in 1956 but some of the companies still rely heavily on their own railroads to bring their cane and cane of others into their mills. It appears now that the days of the remaining railroads are numbered. Facilities have become old and run down. The equipment is old and costly to keep going. Rail ties are difficult to replace in tropical climates at present costs. A one track system makes movement into and out of the mill difficult. Steam has been replaced by diesel and for this reason perhaps the railroads are still in use coupled to the fact that the highway system in many parts of the Island is very poor. Roads are numerous but of a very poor quality for large cane haul trucks and semi-trailers. On the South Coast the Ponce & Guayama Railroad stretches for approximately 40 miles.
to bring cane into one large mill. A short time ago it served others. This system is still
in fair condition and consequently they use it for live storage which means they put the
cane into the rail cars somewhere along the line and park the cars at the mill and
other marshalling areas until the cane is needed. This enables the mill to have a good
backlog for grinding right along during the season. This is an advantage yet on the
other hand it is costly by introducing double handling, maintenance of a large number
of steel rail cars and a condition which may assist the cane in obtaining a ripe old age
after it has been cut and before it is ground. As we travel westward we find that some
narrow gage portable type rail system has been discontinued and replaced by large
trucks and trailers. Further on another railroad disappeared in the mid thirties and
replaced by cane carts of various sizes with four wheels. In this area ox carts and a
narrow gage portable railroad used to serve the large railroad which hauled the cane in
18 ton capacity cars. Further westward we find that the railroad was replaced entirely
by 1960 by a least five different size of cane trucks, semi-trailers, and trucks with trailers.
Some distances traveled here are 60 kilometers. The farther the haul the larger the
hauling unit. Before a recent truckers strike the costs here were the best in the Island.
It must be pointed out that cost figures are not easy to get or to correlate throughout
the Island but from all appearances this area appears to have the best hauling equip-
ment and system with the least highway and traffic problem. In Puerto Rico a large
hauling unit can be a problem on the highway. Further along as we round the Island
we again find where a narrow gage railroad which used portable track has gone out of
existence and replaced by the Louisiana type operation of loading into carts which are
taken by crawler tractor to the road, transferred to a rubber tire tractor and thence to
a transfer crane where the cane is put into trucks and trailers carrying up to 30 tons
for further transport to the mill. As early as 1924 trucks began to appear for hauling
cane to the mill as well as the railroad. We do not run into a large railroad until we pass
San Juan going East. Up to this point there is one small railroad serving a mill with
40% of its cane the balance being supplied by trucks and trailers. This season this
railroad will be operating with chain nets for side unloading into a mill table. Trucks
and semi-trailers and trucks and trailers are used to transport most of the cane to the
mills today on the North coast. Tractors and carts are still used too. Back in the
interior the tractor and carts are in use as well as trucks. East of San Juan a railroad
runs from the edge of the municipal district to the Eastern end of the Island and
down the Eastern coast where it branches towards the South and into the Interior.
This railroad serves 4 mills. Each of these mills also gets their cane by trucks of all
sizes and some trucks and semi-trailers. Only in the last few years have direct hauls by
field tractors and carts been made. Portions of this large railroad system is being
abandoned a little at a time. The central East coast area has only one mill and the cane
is transported to it in semi-trailers and tractor drawn carts equipped with chain net
side unloading. A large volume of cane in this area is transported long distances by
truck to Juncos, towards the interior, and by railroad to Fajardo. Cane is brought by
barge from the island of Vieques, a distance of about 12 miles, to Humacao Playa
where it is transloaded into railcars for delivery to Fajardo. All these hauls are very
long. Two mills in this area closed down in recent years and considerable railroad was
abandoned to be replaced by tractors and carts hauling to transfer stations where the
cane was put into semi-trailers and into rail cars. Both systems appear in the entirety
of the North East and East central part of the Island. The mill at Yabucoa not only
has side unloading as mentioned before but a feeder table with a washing plant which
is used only as needed. Further South there is a cooperative mill which is fed by trucks
and tractor drawn carts.

Considerable experimental work has taken place in this portion of the Island
which happens to be the wettest part. Larger carts are now in use and 4 wheel drive
rubber tire tractors are replacing all the conventional tractors and the crawlers. New
transfer sytems are in general use in this area consisting of chain net side unloading.
Where direct hauls to the mill are made you will also find the side unloaders in two
millyards to unload large carts and semi-trailers. While chain bundles are still in
general use by the growers the companies are doing away with them and using
side unloading. During the past season one company introduced a side unloader
mounted on a crawler tractor so that it could move quickly to the next rail car
instead of moving the rail cars which always has been a headache with the trans-
load system into rail cars. Two carts of 4 tons each are unloaded into the rail cars in
under 3 minutes. More cars can be parked on the siding and the whole hauling cycle is
speeded up thereby reducing the cost per ton handled. Combined with the Louisiana
type loader in the field and with 4 wheel drive rubber tire tractors with large closed
carts this operation is very efficient for this type of a system. This company has added
more of these units for this season and has retired more of the old derricks, old style
carts, crawler tractors and small rubber tire tractors.

This past season saw two portable side-unload conveyor rail car loading units
put into experimental operation. One had a dry cleaning plant included in the unit as-
described previously. Both units worked satisfactory for the first units and another
will be added this season also equipped with a cleaner. Two units will be in use on
the South Coast this season while the third unit which was strictly experimental in
the East Central part of the Island is not operating this season because of economic
reasons.

With the introduction of the higher loading Louisiana type loader, dump trucks
have been loaded in the field and sent directly to the mill. These trucks carry 7 to 10
tons and are able to get in and out of the field because of their all wheel drive, or, a
tractor is placed in standby to pull them out depending on the conditions. Three
operations of this type exist on the North Coast now and one in East Central. This
season will see more of this type of operation. The nice part of this operation is the
direct haul to the mill even though the trucks are small. Self loading trucks have been
tried here but for some reason they have not been successful.

An Australian loader was used experimentally to load a large 24 ton semi-
trailer directly from the normal hand cut windrow, catching two such windrows per
pass of the loader and truck, so that the haul could be made as ideal as possible. The
truck took 40 minutes to get loaded but never came back from the mill because it got
lost in the traffic bottleneck at the mill. The next day it rained considerably and the
truck could not move in the field. The extra controls and lack of piler on the front of
this loader made it very unpopular with the operators. From the standpoint of poten-
tial efficiency this operation stands a good chance of being developed into a cheap one
and should probably be pursued further.
Contributions made to this paper were by the members of the committee who are as follows: Lawrence R. Partridge, A.L.M.S.; Guillermo Guerrero, C. Brewer, Puerto Rico; Richard K. Giles, Central Mercedita; José A. Blanco Lugo, Land Authority of P.R.; Joselo Sanchez, Land Authority -- Guanica; Federico Freytes, Land Authority -- Cambalache; Francisco L. Rafucci, Central Coloso; Richard T. Symes, Luce & Company; Guillermo Esteves, Central Plata.

Contents of the paper are based on local company records and historical events. In several instances farmers were interviewed to determine past and present methods. Early history as stated in the paper is based on local knowledge and is not necessarily true to written accuracy.

SUMMARY

The history of the Puerto Rico Sugar Industry is an old one going back to the early sixteenth century. Production has gone up and down reaching its peak in 1952 when 1,350,000 tons were produced. At present the industry is in a very precarious economic position. Technological developments have been made in Loading and Transporting but little has been accomplished in Harvesting. In the past thirty years the labor costs have increased 355% with no increase in cutting productivity.

Experimental work has been going on in mechanical harvesting with no major break through having been made. The future trials look promising and we must be successful if the industry is to survive. This can only be done with the combined effort of the equipment manufacturers, the growers, the government agencies, the sugar companies and the unions and labor.

Loading is done principally by the Louisiana type cane loader. Hauling is accomplished by rubber tire tractor, cane cart, small truck, semi-trailers and some railroad. The railroads that were constructed early in this century have mostly been replaced by truck. Two major railroads remain and one smaller one. The loading and hauling are still considered in the evolutionary stages.

Such is the situation in Puerto Rico in the past, present and future. While technological developments have been made in loading and transporting we still face a ruinous situation because of our hand harvesting. The cost per ton of cane from the time the cane is cut and loaded into rail cars or trucks was from $1.25 to $1.50 in 1946 as compared to $2.40 to $4.00 in 1963. This is an increase of 100% to 170% since the war and most of this is contributed to the lack of technological development and achievement in the harvesting. There are many problems to be worked out by the company, the grower, the union and the local government. So far they have worked out virtually nothing. The past labor relations of the companies and the governmental actions of the nineteen forties because of this situation has led the sugar industry into a period of chaos resulting in a tremendous loss to the Island's economy, to the worker, to the farmer and to the company. The parties must join together to work out the problems to obtain a healthy situation. Operation Bootstrap seems to have helped everyone but the principle industry. We must retain our work force for which tremendous funds have supposedly been accumulated yet unspent; we must improve our research in varieties, cultural practices and equipment technology; we must upgrade our supervisory force and train them to do better in supervising machinery and the operators thereof and in exercising cost control; we must develop more and better personnel in the trades to take care of and maintain our machinery; we must be more intelligent in our land management; and, above all, we must learn to work out these problems amongst the parties involved forgetting the past abuses to labor and to the corporate entity to a degree that has been accomplished in Queensland for example. The guiding hero has yet to appear on the scene. In the meantime our local technologists group should take these problems on as a crusade to blot out this terrible chapter in our long sugar producing history. We owe it to our people and to our neighbours to assist in finding solutions to our harvesting, loading and transporting problems which are contributing so much to the curtailment of our principle Industry in the Caribbean Area.