University of Sao Paulo

ESALQ - Piracicaba - Brazil

Department of Economics, Administration e Sociology (LES)

Characterization of the Australian sugarcane production

Focusing logistic processes: harvesting, loading and transportation

0110601 - Agriculture Engineering Internship

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ABSTRACT

This report refers to the final internship of the Agronomy Engineering student Samuel Ferreira Balieiro as the final step of his degree. The student has studied Sugarcane Logistics Processes – focusing in Harvesting, Loading and Transportation systems, as a comparison between Brazil and Australia. This project represents the agreement between University of Sao Paulo (Brazilian University) and an Australian sugarcane related association (Canegrowers), in order to exchange Brazilian students to be in contact with Brazilian and Australian sugarcane agents, improving the knowledge about both countries.

This project is organized by the PECEGE Research Group (Continued Agrobusiness Education Program in Economics and Company Management), oriented by Professor Pedro Valentim Marques. As a support for this internship, the ESALQ-LOG - Group of Research and Extension in Agroindustrial Logistics, oriented by Professor José Vicente Caixeta Filho and University of Queensland, by Professor Malcolm Keith Wegener.

The student made visits to several sugarcane groups (sugar mills and growers) as well as research institutes, once that project was divided in two main steps – First step was made in Brazil between August and September, where the student followed and made interviews with important Brazilian agents in order to improve his knowledge and enrich the exchange information; and the Second step was realized in Australia, where the student made the same method of research in order to know better all of Australian sugarcane logistics system focusing in characterization about it and comparison between both countries. This report aimed to demonstrate the equipment, politics, infrastructure, software and all of components that participate of these systems.

1. INTRODUCTION

1.1. PROJECT IMPORTANCE

This project is an exchange student's project, aiming exchange knowledge between sugarcane agents and students. As a main objective this project realized a comparison between Brazilian and Australian sugarcane logistics process, in order to know the characteristics about both systems and exchange possibly useful informational.

That subject has chosen because it has been an important point in the Brazilian sugarcane production systems, once it can demand up to 40.38%[1] of it. Australian is in sugarcane mechanization, the project aimed to exchange what is the reality in Brazil nowadays and seeks for to understand possibly different, and if it could be apply both countries. Also, the project could exchange information about our markets, once there was a presentation about the perspectives and investments (logistics mainly).

1.2.OBJECTIVES

This project has as an objective an analysis of the production chain of sugarcane, to undertake research about this important crop for both countries – Australia and Brazil. The objective with this work is to understand the full production system, from the production process until the final phase of marketing and use of the products. It has focused in sugarcane logistics processes – harvesting, loading and transportation.

1.3.PROJECT SPONSOR – ORGANIZATION

1.3.1. ESALQ/USP

ESALQ and its originating organizations accepted its first group of students in May 1901. It is one of the most important institutions in science, technology, teaching and extension in Brazilian agriculture. Dedicated to the education of professionals in agriculture it admits around 200 agricultural students each year in a highly competitive entrance process. The University is located in Piracicaba, a city of around 400,000, in a rural area approximately 150 klms west of Sao Paulo and 200 klms from the South Atlantic Ocean. Piracicaba is often described as the sugar capital of Brazil. The largest

[1] Referent to the PECEGE sugarcane costs – season 2008/2009 "traditional region".

sugarcane processor group headquarters and many of the largest manufacturers servicing and supporting the Brazilian sugar industry are located in Piracicaba. Many of the students at ESALQ travel to and live in Piracicaba for the duration of their education from their homes in other cities and states of Brazil.

1.3.2. UNIVERSITY OF QUEENSLAND

University of Queensland (UQ) is located in Brisbane, the capital city of the Australian state of Queensland. In 2009, 40,583 students, including 8,824 international students, were studying at The University of Queensland, of which 2,242 were enrolled in the Faculty of Natural Resources, Agriculture and Veterinary Science. UQ commenced classes on March 14th 1911 with 83 students (including 23 women) and has grown now to operate from about 50 sites throughout Queensland, and is involved in a further 118 centres and institutes. The University's main campus sits on just over 100 hectares of land at St Lucia, along the banks of the Brisbane River. St Lucia was named after the sugar producing island in the West Indies, and was the location of a sugar mill, washed away in floods during 1893. Brisbane is a sub-tropical city of approximately 1.9 million inhabitants, located 350 klms south of the Tropic of Capricorn on the Eastern coast of Australia.

1.3.3. CANEGROWERS

Canegrowers is the peak representative organization for the Australian sugarcane growers. It represents about 80% of all growers of Queensland State. Canegrowers aims to defend all of growers; defending its interests, markets and looking for protect the grower's interests in front of Australian Government and Sugar Companies (mills). The association has a participation in research activities, seeking resources and strengthening relations between research institutions and growers. A long time ago, Canegrowers belonged to the Australian government, where all of growers were required to be part of this institution. Nowadays, the participation is non-required but most of the growers (80%) believe to be a good way for to have representativeness (voice). The resource for this organization is provided for each associated, without any government participation.

2. MATERIAL AND METHODS

The student made visits and interview with several sugarcane agents, in both countries – Brazil and Australia. In order to understand better about the Brazilian sugarcane logistics process, the student went to two sugar mills (trying to see a big sugar mill and a small one – different realities), where was made questions about the characteristics (machinery, politics, perspectives, costs and other). Also, in those visits the student accompanied the "field" activities going to the harvesting and loading areas, talking with the workers, making pictures and videos about the components of these systems.

As a Brazilian research institute, the student went to CTC (Sugarcane Technology Centre), once it is an important reference in all of sugarcane researches. The student went to ASCANA (cane growers association), being a different case in Brazil. Finally, the student visited the Case Harvester Factory (Piracicaba-SP), because the both countries using the same Brazilian machinery.

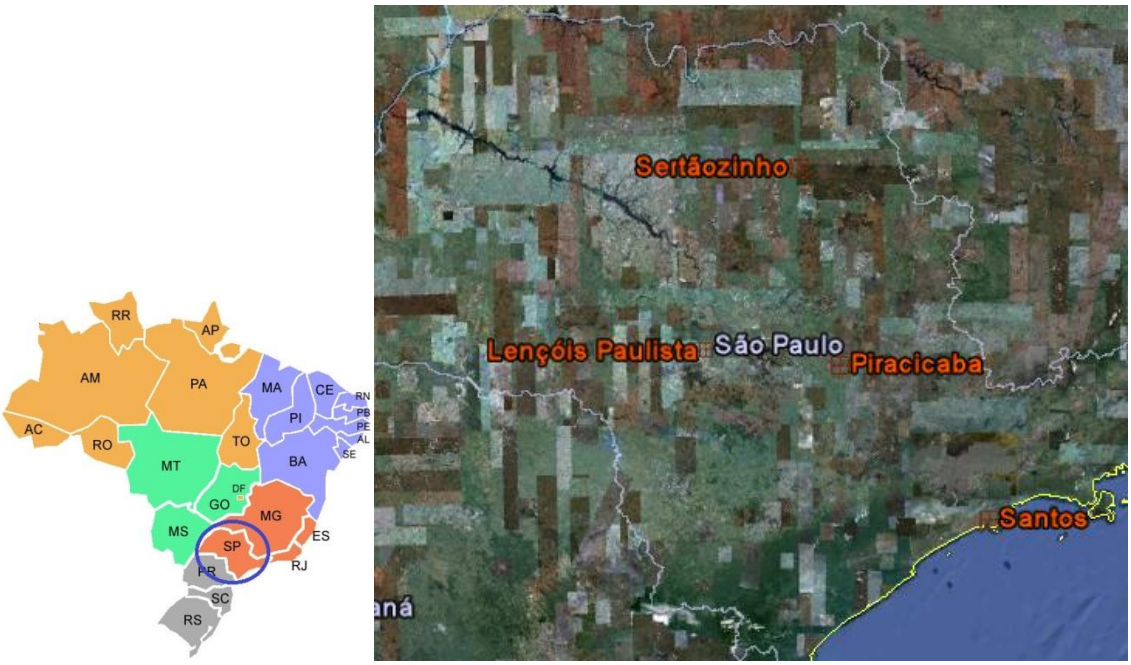
During the Australia diagnostic, the student stayed in farms, in order to understand the Australian cane growers reality, staying in two different regions (New South Wales and Queensland), mainly because the difference between them about logistics process. Besides these visits, the student went to BSES and Canegrowers office, keeping contact with the sugarcane agents and accompanied the routine of these associations. At the end of this internship, the student was asked to make a presentation at the Proserpine Canegrowers Office, where was discussed the information collected by the student about both systems.

During the last week in Brisbane, the student was invited for to give a presentation at a meeting of the *Australian Agricultural and Resource Economics Society (Queensland Branch),* where the student could to discusses about Brazilian Sugarcane Industry, perspectives and logistics (ethanol and sugar).

3. BRAZILIAN DIAGNOSTIC

3.1.INTRODUCTION

The Brazilian diagnostic was made between August and September of 2010, when some sugar mills, growers, research institutes and machine factories were visited. These visits aimed to understand better about logistics process, focusing in harvesting, loading and transportation. The Sao Paulo State was chosen because it represents around 63% of all of sugarcane processed in Brazil (UNICA, 2010). In order to know the different realities, were visited two sugar mills: Costa Pinto (COSAN) Piracicaba/SP and CIA Albertina – Sertãozinho/SP. Also, was visited the Associação dos Plantadores de Cana do Médio Tietê (ASCANA) – Lençóis Paulista/SP, mainly because of the different system for sugarcane supply. As research institute were visited Sugarcane Technology Center (CTC) – Piracicaba/SP; and the Case ih Factory (Harvester Factory) – Piracicaba/SP, mechanical harvester factory. (Picture 1.)



Picture 1. Brazilian visited areas. source: Google maps, 2010

Is important to note that this "Brazilian diagnostic" was made with interview a several sugarcane agents in Brazil, which may not represent all of sugarcane company as well as Brazilian sugarcane industry.

3.2. SUGARCANE HARVESTING

The sugarcane harvesting consists in to cut the sugarcane stalk (near the ground) and cleaning the vegetal excess, making possible to transport this raw-material to the sugar mills (MUNDIM, 2009). In Brazil exist mainly two types of sugarcane harvesting – manual cutting (burnt sugarcane) and machine harvest (green harvest). In most of the areas harvested by machine, we do not have the burning sugarcane practice, once it could cause environmental problems.

The mechanical harvesting has been a reality in Brazil for several years, where the harvester quantity and quality has been improved, once that practice allow less human-resource and possible efficiency gains. But some of "ground characteristics" may affect this type of harvest as: declivity, area shape, planting spacing, presence of stones, ground hydraulic system and etc. As these characteristics are much variable among the sugarcane areas, the percentage of mechanical harvester has ample variance, resulting in greater variable in use of manual cutting.

3.2.1. Manual Cutting (Burnt sugarcane)

This has been the elder method of sugarcane harvest, once allow greater versatility of area conditions. Manual cutting consist of the cut of the sugarcane stalk utilizing a "cane knife", and this action is practiced by human (picture 2). In order to make this operation more efficient and safer to the cutter, the sugarcane is burned before harvest. This operation (sugarcane burning) is important for to reduce the leaf amount, reduce possible danger animals and it may possible increase at the sugar availability (reduce of water). Thus, this operation has been important in areas where the manual cutting is realized.

Picture 2. Manual sugarcane cutter - Sertaozinho/SP. source: Balieiro, 2010

Is important to note that is possible to use manual cutting without sugarcane burning, but this practice is more expensive, once the cutter yield is less, mainly because of the higher cut difficult. Therefore, it has been used mainly in seed sugarcane harvesting, where is possible to have better quality of seeds, once the harvester machines may cause more damage to the buds and it would result in planting fails.

Since 2002, the laws have aimed to reduce and to finalize the burning practice in Brazilian sugarcane. The Sao Paulo State law number 11.241 (19 of September of 2002) had as aim to finalize all of sugarcane burning until 2031, but after agreement signed between Sao Paulo State and UNICA (Brazilian Sugarcane Industry Association), this deadline was changed to 2017 for Sao Paulo State. Also, all of areas with less 12% of declivity (and up to 150 ha) must stop the sugarcane burning until 2014, because these areas are considered mechanized (SETTEN, 2010). It means that the most important sugarcane region in Brazil must stop to burn its sugarcane in 7 years and this quick change might cause other problems (social problems).

The visited areas presented around 1 to 30% of manual cutting, which show the increase of mechanical harvesting in that region, where the ground conditions allow it. In most of these areas, the sugar mills have used the sugarcane burning practice, and most of times as an exigency of the harvester (cutters). Recently laws have improved the cutters work conditions, once they must have: fresh cold water (or isotonic drink), all of personal security equipment (EPI, in Portuguese), adequate local for eat (table, seats and tends), bathrooms, elongation class (with a professional) before start to work, good transport conditions and others. It has helped to avoid work accidents and improved the work environment.

The manual cutting payment system works in different forms in each mill, but usually is considerate certain number of row (5 to 8), and it is call "eito". Each cutter has its own "eito" and through a relation between productivity and meters cut, they earn the wages. The average remuneration is USD 2,06/t[2]. The sugar mill has a responsible (lead) for the manual harvesting team (controlling the payment), and each cutter's team has its own lead. In some cases, these responsible have PDA where they upload the amount cut by each cutters, then when the day finish, they send these dates to the central database at the sugar mill. So, every day each cutter knows how much sugarcane they cut and how much will be the remuneration for it.

This average remuneration does not reflect the real cost of manual cutting, because when all of other inputs as: transport, lowers (judicial problems), staff for trainee (work security) and others, the real cost may be higher than mechanical harvest. It can be a problem, because some of the sugar mills do not measure these auxiliary costs and it can result in false diagnostics. Also, the cutters have earned for the transport time (way from sugar mill to the field). Usually the manual cutting has happened 8h daily.

3.2.2. Mechanical harvesting (Green harvesting)

In the last few years the sugarcane mechanical harvested area has increased, especially in regions with appropriated conditions. This operation consist of to use the

[2] Average cost observed in Manual Cutting (burnt sugarcane);

harvester machines for to cut the sugarcane stalk, take the leafs off, cut the stalk in small pieces and tip this material into the transshipment equipment (MUNDIM, 2009).

In 2003, just 30% of Sao Paulo sugarcane areas were harvested by machines, but that percentage must increase quickly in the next years, because of several facts as increase of harvesting cost and scarcity of human-resource (ALCOBRAS, 2003). But the main reason is the government laws that regulate the reduction of burning sugarcane, once without burning, the manual cutting is inefficient.

The harvesters are made mainly in Brazil, and usually it represents an important investment (cost) for the sugarcane agents. Thus, to have efficient in this operation is essential when these agents are seeking to ensure profitability (picture 3).

Picture 3. Harvester – Lençois Paulista/SP source: Balieiro, 2010

In the visited groups, usually they have the harvester machines, which sometimes may be expensive to the growers (providers). Then, the sugar mills make the harvesting in the growers areas and to charge this operation, depend of the

agreement fixed before start the harvesting season. This model allows “small” growers remain at the sugarcane business without to buy these expensive machines. Each mill has its “way” of to charge the harvesting and depend of the grower size, or necessity of raw-material by the mill, it can be variably.

Some of the Brazilian sugarcane company has tried to have providers harvesting companies, which allows the mills to have less machinery, less employees and it could means reduction of production costs. That practice has been more common, but in some cases is being a problem, because some agents have difficult to make good agreements and it can result in noncompliance of harvesting goals by providers or high costs (over-estimation of costs/t). It usually has happened because is hard to measure all of costs involved in that operation and exist many environment variables which may change the operation efficiency. For example, in an unusual “wet harvest season”, the sugarcane supply goals can be difficult to meet by the providers, mainly because these operation would be hampered by the clime. In that case, the providers would have losses (non-use of machinery) and the sugar mill would have problem with raw material supply.

Therefore, because of the difficulty of measuring costs, some of agents have tried to work in different ways, as “open costs spreadsheet” which allow changing the variables during the harvesting season. Thus, if unusual facts happen, possibly compensation for both parts can be discussed.

3.3. SUGARCANE LOADING

This is the follow operation after harvesting; consist in to catch the sugarcane from the field (harvester/cutters) and to take to the mean of transport. It happens in both harvest systems – manual and mechanical, even though with different equipment. The sugarcane loading system usually presents a wide variation among the groups, being one of the agent’s strategies for to reduce costs and possibly impacts to soils conditions. The machines used in that operation usually are made in regional companies, which allow great diversification and adaptability with sugarcane areas characteristics.

According different harvesting systems are used specific machines.

3.3.1. LOADING OF MANUAL CUTTING

In areas where the manual cutting is the main practice, the loading consist in to catch the sugarcane harvested at the ground – the cutters have to cut and to stow in certain points - lift this material and to tip into the trucks. In that operation the trucks and the transshipments come together in the field (picture 4.). Usually the transshipments are one tractor adapted with a lift system, which allow the utilization of this tractor for others operations. It might means reduction in machinery investments and better utilization of them.

Picture 4. Transshipments – Loading manual cutting source: Balieiro, 2010

In the visited areas, that operation has been made by providers, which means that the sugar mills (or providers) pay per ton of sugarcane tip at the trucks. Thus, when the trucks arrive at the sugar mill, they weight and the providers earn referent it.

3.3.2. LOADING OF MECHANICAL HARVESTING

After mechanical harvesting, the sugarcane is chopped in small parts, and it is tipping into the bins (haul out) by harvester elevators system. Thus, this transshipment goes to the “tipping zone”, where the chopped material is transferred to the trucks.

Utilizing that system the trucks do not come to the field, because who make the loading is the transshipment (haul out). Thereby, these areas do not receive all of pressure that the trucks might cause in the soils, reducing problems as soil compaction, trampling in cane harvested, excess of ground transit and enabler less utilizing of trucks, once it can wait at the “tipping zones” for loading.

Most of the visited areas, the loading has been made by the same agent which make the harvesting (sugar mill or provider), mainly because it is necessary a good synchrony (both drives) and similar sizing of the equipment, making easier if the both operation are made by the same group. Also, it is necessary good communication between the harvester driver and the transshipment driver, once it can minimize extras transits, harvester stops (lack of transshipment) and all of items reduce the harvesting efficiency, resulting in rising of costs.

Another factor that has interfered in the loading efficiency is the distance between harvester and “tipping zone”. It happens because when the distance increase the number of transshipment might increase as well, once the flow of sugarcane being harvested is the same, and more equipment are necessary. Also, the similar volumes between transshipment and trucks is important, because when it is different might happen downtimes, the trucks waiting for few tons or transshipment that cannot tipping all of volume in one truck.

The usually configuration of the Brazilian transshipment is one tractor with 2 transshipment compartments equipped with hydraulic system. It is use during the sugarcane tipping into the trucks. Also, it has been common the utilizing of high flotation tires, trying to reduce soil compaction (Picture 5). The transshipment compartments usually have capacity of 8 – 12 t.

Picture 5. Transshipment (“haul out”). source: Balieiro, 2010

When that equipment reaches the tipping areas, the harvested sugarcane is transferred (tipping) into the trucks. Some of agents have tried to improve that tipping time, changing hydraulic systems and increasing the transshipment (haul out) used.

Because of the wide different of sugarcane trucks, in some cases, is being necessary to make a small platform, where the truck is a bit below in relation of the transshipment level, making the tipping easier (Picture 6).

Picture 6. Tipping area - Sertaozinho/SP source: Balieiro, 2010

3.4. SUGARCANE TRANSPORTATION

That operation consists in take the harvested sugarcane to the sugar mill, where it will be processed (SILVA, 2006). The Brazilian sugarcane transport system is based in trucks (road transport), which has showed high costs and mainly environmental/social problems. This transport model is utilized mainly because of the less logistics infrastructure for others means of transport, as train and waterways, not allowing diversification by the sugarcane agents.

The massive truck utilizing is not interesting when we think in environmental/social issues, once these trucks might rise the road accident, damage in the road system, incommode to the city habitants (when are necessary to pass through cities) and increasing of the CO_2 emission. Others means of transport would be more interesting in that point of view, once they use a special infrastructure

(railway and waterway), avoiding competition with civil cars (buses), like happen in road transport. Also these means of transport presents less gases emissions.

In the visited areas, the main transport equipment used in sugarcane transport were “rodotrems” and “treminhão”, once these equipment have good charge capacity and it is able to reach areas with hard traffic conditions (Picture 7).

Descrição	Esquema	Nome popular
Caminhão plataforma		“Truck”
Caminhão plataforma com um reboque acoplado		“Romeu e Julieta”
Caminhão plataforma com dois reboques acoplados		“Treminhão”
Cavalo-mecânico com dois semi-reboques acoplados		“Rodotrem”

Picture 7. Sugarcane trucks source: Silva, 2006

In recent survey realized by ESALQ-LOG (unpublished data), which was seeking to explain how the sugarcane freight is compost, and was observed that it happens in different ways, depend mainly of the agreements and volumes accorded between the transport agents and the sugar mills. But, in most of the cases, the main sugarcane freight components are: distance, sort of trucks and road conditions.

It shows us that some strategies might being used for to try reducing sugarcane transport costs, as better road maintenance, more aggressive lease politics, which could result in reduction of distance average and improving equipment efficiency.

Another strategic has been the use of “hook and drop” system, and it consists in to have an ideal (or most close possibly) proportion of trucks and trails, which allows

the truck just drop the empty trails, at the fields, and hook the full one, taken to the sugar mill. Thus, if we could increase the system use, we probably could use less trucks and it would result in better equipment use (machinery productivity), once these trucks would be able to do more “trips” in the same time (day). Also, this system can reduce possibly harvester and “haul out” stop, because we always have “empty trails” in the “tipping zone” (pictures.). In conventional systems, if happen a delay of the trucks, these equipment must stop and wait until the next truck.

Picture 8. Empty trails waiting in the tipping zone. source: Balieiro, 2010

In this system is necessary a place where the “haul out” tips the sugarcane into the trails, and sometimes, it has been the problem during the system installation. Some of the farmers do not want to “waste” these production areas for to set up the “tipping zones”, making impossibly the system utilizing.

About the transport costs, it also has been variably in each sugarcane group, but most of the agents visited, believe in a possibly reduction of it could results in

representative gains (profit). It represents one necessary cost to the sugarcane agents, and yearly representatives amount are spent in that operation.

Because of the high costs involved in this operation, some of the agents have used overweight practices, trying to reduce the cost/ton transported, but these practices might improve the problems (above cited), once these equipment are not project to carry that overweight (in some cases, twice more than allowed by law), increasing the road and trucks damage, and rising the gases emissions. Even, it may bring more risks to the drivers (mainly the truck drivers), because the brake system cannot operate in the right way with that weight, causing serious accidents.

4. AUSTRALIAN DIAGNOSTIC

4.1. INTRODUCTION

This Australian diagnostic was made between October and November of 2010, when the student visited and stayed in some sugarcane groups – farmers. This Australian step was divided in two – New South Wales State – where the student stayed at the Foyster's farm (Moobal, Au). The second part was made in Queensland State, where the student stayed at the Peter Quod's farm (Proserpine, Au) and Michael Porter's house – Manager of Proserpine Canegrowers office.

Looking for the adaptation (language and difference time), the student stayed the first week in Brisbane. Also, the student visited the Main Canegrowers Office, BSES office and others important Australian Sugarcane agents.

This schedule was made in that way, mainly because these are the main Australian sugarcane states and because they present different ways of sugarcane transport. Therefore, to know these regions helped a wider knowledge about Australian logistics system.

In New South Wales, the student followed all of operations – harvesting, loading and transportation, once the weather enabled. Also, the student had meeting with AGTRIX – Australian Software Company, who has developed important tools for

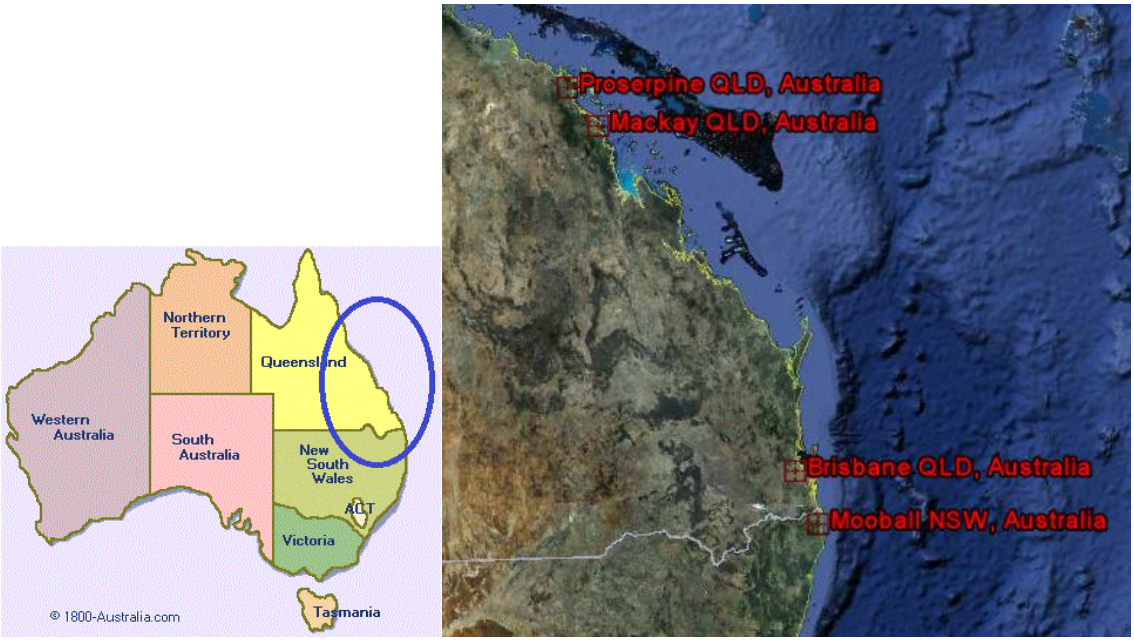
these studied operations. Finally, looking for to understand the last step of these operations, the student stayed one day at the Sunshine Sugar Mill (Condong, AU), where was visited the transport operation room and all of sugarcane unload systems.

After, the student went to Mackay (QLD, AU), where it followed the BSES officer Kevin Moore, which showed the loading, transportation and milling system, once because of the bad weather conditions, the harvesting was stopped. Also, the student had some important conversation about the Mackay Sugar GPS Tracking System, which will be explain in the "control software" chapter.

The student went to Proserpine (QLD, Au), where it followed the Proserpine Canegrowers Chairman - Peter Quod, to the sugarcane presentation day with the Kate Jones, the Queensland Environment Minister, where the growers made some presentation about new technologies, which have been used for to reduce the environmental impacts (mainly at the Great Barrier Reef*).

In these two weeks in Proserpine, the student followed the Canegrowers Office routine, as well as BSES office, which was very important for to understand better about the region sugarcane issues. Also, the Proserpine Sugar Mill was visited, where was possibly to see all of the process as well as the transport control. As the last step still in Australia, the student made two presentations, one at the Proserpine Canegrowers office (mainly about the Brazilian logistics process) and another one at a meeting of the *Australian Agricultural and Resource Economics Society (Queensland Branch)*, where the student has focused in to show statistics, perspectives and some research preliminary results. It was important for the divulgation of the rising Brazilian sugarcane industry, and where we made an information exchange – main project objective.

Because of the difference observed in NSW and QLD sugarcane transport models, this report will present subdivision when it is necessary. The picture 8 shows the visited areas in Australia.



Picture 8. Australian visited areas source: Google Maps, 2010

4.1.1. NORTH OF NEW SOUTH WALES

In north of New South Wales exist a co-operation leading by sugarcane growers which have three sugar mills and 1 sugar refinery (white sugar). The Condong sugar mill is one of smaller sugar factories in Australia, with annual average crush around 600.000 t of sugarcane. That sugar mill has tried to introduce (recently) an electricity co-generation plant, utilizing straw and bagasse together at the boiler. Some problems has turned non-economical interesting it yet, as the transport, which has been expensive (low density material) and for environmental problems, because the "straw separator" result in high sounds which has disturbed the neighbors.

The Condong sugar has the local market as its main market (around 50% of all sugar consumed in Australia) mainly raw sugar. This sugar usually is being used by feed industries - sweeties, ice-cream and soft drinks. About 10% of this product is sold to supermarket in commercial small packs, directly to final consumer.

This region has suffered strong influence of others crops as avocados e water melons, mainly because of the big market closeness – Brisbane. It has turned these other crops, in some cases, more interesting than grow sugarcane.

4.1.2. QUEENSLAND – MACKAY AND PROSERPINE

The Mackay sugarcane organization is a bit different than others Australian regions, because the growers are the owner of the sugar mills, which together are 4 sugar mills (1 of them with refinery), crushing around 8,0 millions of tons per year. This region has suffered strong completion with the mines industry, once it has paid better salaries (wages) and many workers have switched to this sector.

The Proserpine Sugar Mill is owned by growers (co-operation), and it has crushed around 1.8 or 2.0 millions of tons yearly. The sugar mill has a new factory for to make furfural from the bagasse, and it has provided important economic gains. This product can be used in plastic factory, food artificial essences and many others functions. In 2010 they have had many problems because of the unusually wet season, and around 28% of all sugarcane was not harvested. It must cause financial problems this year to the growers (reduction of incomes) and it might cause effects in the next season as well, once these areas where the crop was not harvested might present yield reduction. The excess of rain has brought problems to CCS yields, once the quality of the sugarcane crushed in the lasts days was low (much water).

Both of cities have an active BSES and Canegrowers offices, which mean important regions in development of new varieties, researches and politic representation.

4.2. SUGARCANE HARVESTING

In both visited regions around 100% of the harvesting is done by green harvesting (machines) and the machinery is not different that is being used in Brazil. But there are some differences about the management of the “trash blanket” (straw), once the environment conditions in Mackay and Proserpine allow fast straw degradation, avoiding possible problems which happen in New South Wales, mainly because of the floods and strong “wet seasons”. Because of that problem, in some cases, the growers have chosen to burn the straw, after the harvesting. It minimizes the flood problems and can help the sugarcane sprouting.

The harvesting has done by growers or “harvest contractors” – it can be a group of growers or agents that have the machinery and provide that service. Differently that usually has happened in Brazil, the Australian sugar mills do not have harvester machines, and it is not a function of them.

In Proserpine around 26 harvesters are responsible for to harvest 2,000,000 t crushed yearly by the sugar mill, and in the most of cases, it works in co-operation. Usually the business contracts are done without participation of sugar mill. It is not so different which has happened in Mackay and in NSW.

In the visited areas in Queensland, the harvest time is 8 to 12 hours daily, once the drivers cannot work more than it. For remain the sugarcane supply, the harvest groups have switch, once a part of them start early (3:30am) and other can start a bit later for to ensure the flow of sugarcane to the sugar mill (which crushed 24 hours daily).

The usually harvesting team has 1 or 2 harvester and 6 or 7 transshipments (“haul out”), once it is variably depend of the harvesting conditions, mainly distance from the field to the “siding”. Siding is the used name in Queensland for the “tipping areas”, where the “haul out” tip the sugarcane into the bins (picture 9).

Picture 9. Siding source: Balieiro, 2010

In these regions the ground conditions are appropriate for the mechanical harvesting, predominantly flat land, which allow high harvester speed – between 7 and 10km/h, without significant yields losses. Another important factor is the plating spacing, because it has influenced the harvesting efficiency. They have used two main different types – Dual row and Standard. The dual row usually has row spacing as 30 to 40 cm between rows and 1,8m between "dual rows" (picture 9). In Standard spacing, the rows are distance around 1.5 to 1.8 m.

4.3. SUGARCANE LOADING

In both visited regions the diversification sort of transshipments has been used, and it happens because each harvesting team prefers one. Most of the transshipments are make in regional companies, which allows wide chose capacity to the agents.

Australian sugarcane transshipment has been done mainly with three different kind of equipment: **1.** It is similar than used in Brazil, composite by 1 tractor and

transshipment compartment (1 or 2), which has hydraulic system allowing tipping into the bins; **2.** The second is call “power haul out”, because they are just 1 equipment made for this operation; **3.** It is similar than the second (“power haul out”), but with a different system for to upload (tipping), using “belts” which spread the sugarcane in more than 1 bin.

In New South Wales around 80% of the harvesting team has used “power haul out”, because it has showed better durability and efficiency during this operation. But, this kind of equipment does not allow the utilizing of it for another operation, as they have used when the transshipment is moved by tractor (use the tractor) – Picture 10.

Picture 10. Transshipment (“Power haul out”) source: Balieiro, 2010

In Mackay around 80% of the loading has been done by tractors and double compartments, almost the same in Brazil, but these compartments have the same size than the Bins (6 or 8 t), allowing better efficiency, because they do not have “wait time” caused by differences equipment sizes. Also, they have used other sort of transshipment (“loading belts”), which allow bigger control of the process. These

transshipment has capacity for 24 t, allowing fill in around three bins, in approximately 2 minutes (picture 11).

Picture 11. Transshipment ("power haul out with belts") source: Barbosa, 2010

Differently, in Proserpine the bins (train bins) have 10 t of capacity, which means each "haul out" has 10 t of capacity as well. They believe it allow more efficiency during the transshipment. Also, they usually use 1 tractor with 1 compartment (picture 12), different than Mackay where they usually have double. Each "haul out" can tip in around 35 sec. In both regions they use a "head bin", because if they do not use this accessory might they would problem with fill the bins in and possible turn the bins off, during the tipping process.

Picture 12. Transshipment (“tractor and component”) source: Balieiro, 2010

The typical harvest team in that region consists of 1 harvester for 3 “haul out” (transshipment). It depends of the distance between harvester and bins, because how much far, more transshipment will be necessary, once the sidings do not change. It is different of Brazilian system, mainly because in Brazil usually we do not have tipping points (sidings) fixed, it means more flexibility and possible less distances.

In both visited areas the loading is made by the same harvester provider, looking for more efficiency and because usually the charge is for both operation. About the transshipment efficiency, it has depended mainly of the distance between the field and “siding”, because when bigger more transshipment is necessary.

4.4. SUGARCANE TRANSPORT

4.4.1. NORTH OF NEW SOUTH WALES

In North of New South Wales the growers have used trucks (road transport). It has happened because the region does not have enough railway, and it means that the transshipment would have to transit for a long distance for to reach the “siding”.

The visited sugar mill (Condong) has just 7 trucks for to do all of sugarcane transport, around 0.6 million of ton. It has been possibly, because they use software to control these processes and the distance average is favorably (smaller than Queensland). In specifics points among the farmers, they have “concentration points” where the sugar mill has to provide the bins and where the transshipments tip the sugarcane into the bins. So, these 7 trucks do not wait for loading, they just go to these “concentrations points” and utilizing a “hook and drop” system, the trucks drop the empty bins and take the full one – it takes 2 minutes. Thus, they have got just 120 bins and these 7 trucks.

The control software allocated the bins at the ideal location, looking for supply the harvesting team necessity and making sure that these bins will not be there for unnecessary time. Each bins worth around 4,000 dollars and they usually are made in China (picture 13).

Picture 13. Concentration points, Trucks and Bins . source: Balieiro, 2010

The Bins usually has capacity for 24 t (9 m^3), but they have transported around 22.5t, because the maximum capacity permit by law is 43.0 t total weight (truck + charge). The transshipments usually tip three times in each truck, but sometimes, mainly because of different sugarcane density, they have had overweight problems. The overweight law penalty is around AUD$ 10,000, and it must be paid by the sugar mill.

Even the harvesting period is 8 – 12h daily, the transport service works 24 h daily, and because of this, the supply manager has to plan all of raw-material flow necessary for to supply the sugar mill in the whole crushed time.

4.4.2. NORTH OF QUEENSLAND – MACKAY AND PROSERPINE

In Mackay and Proserpine, almost all of sugarcane is transporting by train, once they have infrastructure for it, railways, locomotives and bins - it belongs to the sugar mills (growers – co-operation). The spacing between rails is different than the used by

exportation, once it is shorter with around 70cm. The railways are keeping on (maintenance) by the sugar mills and every years still being improved, adding news stretch, trying to keep the average distance in between the harvester zones and the “siding” (tipping zone) in 800 – 1200m.

In some cases, if these distance to be bigger than 2 or 3 km, they have a special truck which take the bin on and go to the harvester zone, fill it in and come back to “siding”. In Proserpine they do not take the bins off the railway, because they believe it can cause damage at the bins, so they have used a special truck which has a “transshipment system”, and it go to concentration point (at the field), take the sugarcane from “haul out” and go to “siding”. It does not happen very often (Picture14).

Picture 14. Truck – long distance loading source: Balieiro, 2010

In Mackay that region the bins capacity is 6 t, which is different in Proserpine, where it is 10 t (Picture 15). These bins are pulling on by diesel locomotives, which usually can pull 1,200 t. The locomotives speed is around 24 km/h.

Picture 15. Sugarcane bins – Mackay source: Balieiro, 2010

As both sugar mills use the FREDD system for to control the sugarcane transport, the transport manager at the sugar mills knows what is going on all of harvesting team, it allows to plan the deliveries of empty bins, avoiding harvesting stop, and also allows the manager makes an optimized locomotive schedule, seeking to remain the raw material (sugarcane) flow and minimizing costs.

The sugar mills have different policy about the maximum time between harvesting and crushing, but both aim to have times less than 24 h. In the most of cases this time is around 4 to 8 h. If the sugar mills cannot fulfill that time, it has to pay certain amount (bonus) to the growers, looking for to recompense the sugar loses, once the transportation is responsible of the sugar mills. Other important point is remaining the raw material supply during 24 h daily, once the harvesting has been done around 8 to 12h daily. It means that the sugar mills have to have an efficient sugarcane transport chronogram, seeking to avoid crushing stops and bins delays, which mean more costs (bonus).

The maintenance of the railways is made by the sugar mills, which usually has taken significant resources. The trains are moved by diesel; with around 1,200 t each one and it transit in 24 km/h approximately. Each locomotive is operated by two employees, once for to transport the same volume in Brazil we need around 27 trucks and certainly more employees.

5. CONTROL SOFTWARE

The labor cost in Australian business has been one of the most important costs, which have been used researches resources in development new and interesting tools for to reduce the needs of human-resource. Those technology tools have allowed important reduction in the production costs, because all of process are integrated and it enable better management.

In Australia 85% of all sugar mills have used this system and it means around 35% of reduce costs in the first year after start to use the software (FREDD - AGTRIX). Most of Australian farms have GPS bases, and it is being used for to track the suppliers' area. In logistics process, the utilization of track systems, GPS, dates, has been each day more common. The sugar mills use the optimization software, using FREDD and other software trying to reach the optimization systems. With those systems, one person is able to supervision all of sugarcane supply chain, once the harvesters, trucks, bins and pad are monitored in real time.

Those systems use GPS bases which allow knowing of important indices, like productivity, areas and where all of machines are. The sugar mill can know in real time operations characteristics (time, productivity and downtime) which allow the supply manager to plan the system conform of these characteristics. If they have less sugarcane as supply, they can change the crush characteristics and to reduce the risks of stops. These dates are processed in real time which means the harvester driver can change some points (e.g. cut length) if the system show more trash than ideal; it has reduced loses and improving quality for the harvest.

Where they have used these systems, all of machines have the board computer, which send all of information to FREDD (database), allowing it to plan who is the better truck/train for to do this transport, always seeking to reduce the costs (distance) and quantity of equipment. The system compose the information possibility track that all of process, analyses (sugarcane samples) and times. Also, the field blocks have ID, with dates about the farm, size, productivity, details about the farmer and some others historical dates.

In practice when the harvesting starts, the harvester GPS send dates to the central database (coordinates, distances and productivity), allowing the logistics manager to send the bins and to schedule the locomotive/trucks for to take these full bins after the harvesting. The sugarcane harvested in that area will be tipping in the "haul out", which remain the sugarcane ID. When the transshipment (haul out) reaches the bins for loading, it transmits the sign to the bin electronic board (using the electricity of the transshipment) with all of information. So, when these bins arrive in the sugar mill, it has sensors which recognize and send the information to the central database. In that way, they are able to track all of the process and to know in real time what is happing.

When the sugarcane is crushed, an infra-red system measure the amount of sugar (and others indices) in that material, uploading this information at the central database. Thus, the sugar mills can pay that farmer according the amount of sugar and his sugarcane (CCS).

About transport characteristics, they have used this system either truck systems or train system. The software allows major watch about these processes, because every time the manager of sugar mill can see where all of trucks/trains are and the important details about the system. They have used these programs for to minimize transport costs, because the fleet can be small once all of system looks for "just-in-time" process. Operating in real time, this tool advice the manager about possibly problems (e.g. fog, holidays traffic, rain), which enable change in strategies before supply problem at the sugar mill.

6. COSTS

The cost structure has been different, once each group has difference characteristics, as logistics infrastructure, percentage of lease areas (Brazil), sort of transport and others. So, these ideas were collected during the interview and chat with several agents.

The harvesting and loading usually have been charged together, once it would be hard to measure these costs separately. In both countries these service are charge by volume (weight) – US$/t. In the Brazilian visited areas, the sugar mills measure these costs and they have a fixed average value. But, in Australia this charged has made in different way, once the providers charge a fixed value – depend of distance between field and siding, volume and other, and the grower has to provide the fuel for all of operations (harvesting and loading). They highlighted this factor as really important, because since they started to charge in that way, the growers have tried to improve the operations conditions, once if the machines spent less fuel, it means costs reductions.

In Brazil visited areas, the costs structure of transport – about providers/growers, they usually have to deliver the sugarcane at the sugar mill, which means that the transportation costs is being paid by them. Thus, distance average, sort of trucks and volume delivered become more important, given different strategies for each case. In Australia (visited areas), all of growers are charged the same value for the transport system, because the sugar mills are owned by the growers (co-operative), and then it does not matter where the farm is, everybody pay the same amount/t for transport costs. In Proserpine (Au), the growers are charged in 4 points of CCS (Commercial Cane Sugar), and this amount is used by supply all of sugar mills costs – staff salaries, industrial costs, transportation, maintenance of infrastructure e others.

It is interesting to note that the cost of the growers (variables – harvesting and loading), they finish when the growers deliver the sugarcane at the Siding. But in some cases, the distance between field and siding is long, and it could disadvantage that

grower. Then, for distances more than 1 km between field and siding, the growers earn more US$ 0.20 as reward.

The chart 1 shows some indices and costs that were collected during that research.

Chart 1. Indices and Costs collected .

Indices and Cost		
Indices (Average)	**Brazil**	**Australia (QLD)**
Area mechanized (%)	78	100
Harvesting speed (km/h)	4,75	8,0
Consumption (L/t)	0,95	0,90
Maximum Slope / Grade (°)	15	*
Harvesting time - daily (h)	24	12
Productivity of Harvester (t/h)	45[1]	75[2]
Average cost harvester + loading (US$)	12,48	9,01[3]
Transportation costs (US$)	3,06[4]	0,97[5]

USD$ = AUD$ 1,029

USD$ = R$ 1,664

* Usually areas with less than 5°

[1] 1000 t/day/harvester - 22h of harvesting daily

[2] 900t/day/harvester - 12h of harvesting daily

[3] AUD$ 7,30 + fuel (1,2 L of diesel = AUD$ 1,2)

[4] R$ 6,00 - Average freight for 25km (average distance)

[5] AUD$1,00 - Proserpine S. M. cost (fixed and variable costs).

Other important variable is the “Harvesting speed”, because the Australian harvesting teams have worked faster than the Brazilian speeding average. It might means better machinery efficiency and can influence reducing the cost/ton, once the some fixable hours costs are being less of an impact on cost per ton harvested. Some of the possibly explication must be, the better Australian topography, allowing the harvester work in high velocity and without problem with driver security; most of the areas are being prepared for mechanical harvesting; less problems with hydraulic soils system, once they land conformer is flatter. In Brazil we still have some areas with few mechanical prepare and soils with steep slope.

It reflects an increase of the “Productivity of Harvester”, once the same machine can harvest more sugarcane in the same time (t/h). Therefore, these

Australians harvesting teams can have almost the same harvest yield in 12 hours of harvesting day then Brazil with 24 hours daily.

The transportation average cost presents high difference, the Australia system (trains - railway) requires more investments in infrastructure but it has presented cheaper sugarcane transportation costs when compared with Brazilian costs – road transport.

7. CONCLUSIONS

This internship searched to characterize the Brazilian and Australia sugarcane logistics, focusing in Harvesting, Loading and Transport. In this context, was observed the important participation of these costs in to the sugarcane production costs and was observed that there are many different variables, conditions and regional characteristics, which change the way of these processes has been made. It means that each sugarcane group or regions must to adapt its conditions trying to improve and reduce costs.

The Brazilian sugarcane industry has presented significant increase and it might means expansions of new areas, where the logistics infrastructure might be decisive to success of the investment. Each sugarcane group has applied different policies in these operations and it happen because many other environmental, political, infrastructural and social issues must be taken in consideration. The environmental issues can bring more attention to the logistics process, once it has participated effectively of gases emissions, being necessary researches and investments which tried to improve the efficiency in that systems.

The utilization of control software must increase quickly, mainly with the necessity of systems optimization, bringing more profitability and sustainability to the sugarcane industry. As well as the Brazilian politics for to reduction and finish the burning practices in sugarcane, have increase the investments in technology and in machinery (harvester, transshipments and trucks), seeking reducing cost. The ground conditions in Brazil (mainly) have required the machinery sophistication, once it has

represented important costs. Therefore, it is necessary to be attention to these processes and in development of new tools which tried to improve the competitive of the Brazilian and Australian sugarcane industry.

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