Sensory, chemical, physical, and microbiological quality of meat from various production systems in Uruguay



Report prepared by

Chris R. Kerth

Associate Professor, Meat Science

Auburn University Department of Animal Sciences

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Project description

The purpose of the project describe in the following text is a collaboration between the author and the Instituto Nacional de Investigacion Agropecuaria (INIA) and funded by the Fulbright Scholar Exchange Program. The project is divided into two parts, with the first consisting of a six-week visit to Uruguay beginning in August, 2008 (Discovery phase) and the second a six-week visit to Uruguay in February, 2009 (Project phase). In the Discovery phase visit, I will be touring the many different regions of the country along with all of the various segments of the meat industry in Uruguay. These initial investigations will primarily be supervised by Dr. Gustavo Brito (INIA, Tacuarembo). It is my aim in this initial visit to document to the best of my ability the successes and challenges in the Uruguayan meat industry. At the conclusion of the Discovery visit, I will meet with leaders of INIA and Dr. Brito to propose a research and/or demonstration project intended to address one or more challenges facing the Uruguayan meat industry. During the interim between the Discovery and Project phases, the project will be designed and necessary resources will be identified. Upon return for the Project phase, the designed project will be conducted, data collected, analyzed, and reported to the appropriate authorities in Uruguay and the U.S. in addition to publication in appropriate scientific publications.

Overview of Animal Agriculture in Uruguay

Agriculture is a vastly important industry in the small South American country of Uruguay. The temperate climate and ample rainfall (900-1300 mm or 23-33 inches) support the production of food and fiber and are responsible for agriculture providing about 9% and agricultural industries about 15% of the Uruguayan Gross Domestic Product. Additionally agricultural products account for 70% of the exports from Uruguay. Of these products, cattle, dairy, and wool production account for the majority (58%) of agricultural production and beef alone accounts for 35% of Uruguayan agriculture. As a result, a full 83% of land use in Uruguay is in native (71%) or improved (12%) pastures supporting the production of 11.5 million head of beef cattle, 10.8 million head of sheep, and 750,000 head of dairy cattle. An interesting points is that, with the estimated human population of 3.1 million, there is about 7.4 head of total livestock or 3.7 head of beef cattle for every man, woman, and child in Uruguay.

To process these beef cattle, which is the focus of my visit to Uruguay, 35 slaughter houses are present in Uruguay with 19 of those approved for export to the US and EU. In 2007, 2.3 million head of cattle were slaughtered comprised of about half steers and half cows. Of these, 30% were consumed domestically, and 70% were for export with an estimated 75% to be exported in 2008 and a record $960 million (U.S. dollars). Cattle are currently sold on a live

weight basis and while carcasses are graded based on age and conformation, a marketing system is not in place to pass on the value or discount from grading to the producer.

Agricultural Organizations

To assist the packers and producers of beef in Uruguay, a number of organizations exist to provide oversight, marketing, and research for the beef industry. First is the Ministry of Agriculture which is the primary governmental agency that provides oversight and especially provides the inspection to the processing plants and therefore serves much the same purpose as the USDA-FSIS in the United States. This is the only agency solely funded by the government, but the Ministry also provides funding and assistance to the other primary groups discussed next.

MINISTERIO DE GANADERÍA AGRICULTURA Y PESCA
REPÚBLICA ORIENTAL DEL URUGUAY

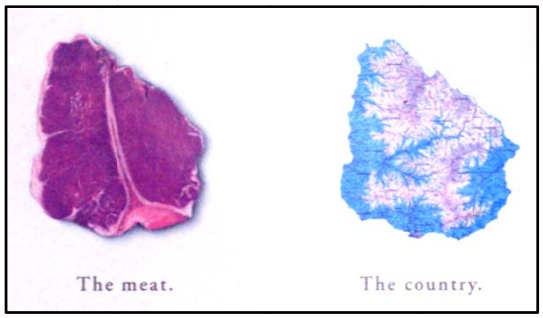
The agency that is hosting this project is the Instituto Nacional de Investigacion Agropecuaria or INIA and function much like the Agricultural Research Service (ARS) branch of the USDA in the States. It was initiated by the Ministry in 1914, re-organized in 1960, and became its current state in 1989 to focus on the needs of producers to be competitive in the world market. INIA is funded through a 0.4% levy on all farm sales and those dollars are matched by the Ministry along with a small amount of funding from royalties and private sources. Additionally, the Board of Directors is comprised of members from five national farmers associations along with 2 members from the Ministry of Agriculture. Because INIA is funded in large part by the producers through the levy on their sales, the work of this agency is very focused on the current issues of producers and the projects that are carried out are a direct result of the needs of the producers and the results are delivered to the producers in field days that are held at the various experiment stations at various times of the year.

To be able to maximize the impact of INIA with producers, there are five stations around the country that focus their efforts on the segment of agriculture dominant in their geographic area. The main INIA offices are located in Montevideo with stations in: 1) Salto Grande working primarily with citrus, 2) La Estanzuela in the Southwest focusing on fattening cattle including feedlots and intensive management and is the oldest station, 3) Tacuarembo in the North with extensive range management including meat and wool production and the Merino nucleus herd, 4) in the Southeast is Treinta y Tres with pastures and range land for Angus and Hereford herds, and 5) Las Brujas focusing

on biotechnology, horticulture, and Holstein dairy. Collectively, these stations encompass 11 research programs, 5,300 ha, 17 labs and 590 people, including 148 with advanced educations (MS and PhD) and 47 PhD and MS thesis students.

Finally, the third major organization that falls under governmental jurisdiction is the Instituto Nacional de Carnes (INAC; National Meat Institute). The function of INAC is very similar to the function of the USDA-AMS in that it develops and oversees the standards for carcass grading, specifications, and marketing. INAC is a public organization whose purpose is to add value to all of the meat chain and is governed by a board of directors whose members are from the Ministry of Agriculture, packing and other ag industry, and farmers. The specific directives of INAC are: 1)To improve the domestic market through strategies that include public health, sanitation, butchers, transportation, and certifications, 2)To improve export markets and conduct market research, 3)To provide technical services including quality audits, training, and certifications, 4)To provide information and economic resources to all segments of the meat industry, 5)To administrate certifications and national programs, and 6) To provide legal support to all segments of the industry.

As a part of these programs, 35 slaughterhouses, including 19 that are approved for export to the U.S. and E.U., slaughter and process about 2.5 million head each year for a recent record $960 million (U.S.). This includes about 52% steers and 48% cows, of which 70-75% are for export with the balance in domestic trade. The programs created by INAC are part of an effort to move the industry away from the production of a commodity to that of a branded product. In fact, Uruguay has the only “branded” product in the USDA process verification program that is outside of the U.S. Another major effort is in traceability. Uruguay has had group traceability since 1973 in which the group of animals is traceable back to the farm and today, the most significant program is the creation of the “black box” in the packing plant in which the information about the animal from the electronic eartag of the animal (the electronic ear tag was made mandatory in 1996) is transferred to the carcass and subsequently to each of the cuts as the carcass is fabricated. Each box of beef has the lot numbers of the cuts on the outside of the box and the cuts contain the individual animal information retrieved via bar coding.



The Federation of Uruguayan Central Region of Enterprises in Agriculture (FUCREA) was patterned after similar organizations started by the French after World War II and was established in Uruguay in 1966 by 6 groups. Today representatives from 45 different groups with interests in beef, dairy, and

crops are included representing more than 500 farms and 340,000 hectares (840,000 acres). Groups of 10-15 farms meet once each month to discuss business and collaborate on buying supplies in bulk and marketing strategies for the group.

Another part of FUCREA is a sub-group called CarneCREA, which is responsible for vertical coordination of the meat chain. This group, created in 2005 has a board consisting of farmers, a business coordinator, and general coordinator and includes 3 slaughter houses and 55 farmers representing about 9,000 cattle. Its mission is to set criteria to receive certain prices so that the producer knows the value of reaching certain criteria (teeth, weight, fat, grade, etc.) based on a grid similar to that of the USDA Quality and Yield Grade grid in the U.S.

Research and Production of Beef

INIA Tacuarembo. The Northern INIA Experiment Station at Tacuarembo is focused on cattle production and meat quality. Numerous challenges exist in the production of beef in Uruguay. Currently pregnancy rates average about 65% due in part to nutrition, management, and genetic factors. Additionally, little incentive currently exists to improve this as the value of open cows is very near that of a fattened steer as the market for beef in Uruguay is in high demand and volume is more important than quality. Interestingly, many of the production challenges in pasture management are very similar to those found in the southeastern U.S. Poor forage quality during autumn months and economical protein supplementation sources along with new competition from crops and forestry create a need for balance in production of cattle. Many cattle producers adopt management systems that allow them to be very flexible in their production and quickly change systems to match the demands of the markets. Research projects include emphasis on increasing the efficiency from weaning to fattening, genetic influence, forage and feedlot systems for fattening, meat tenderness and quality. Additional emphasis has recently been placed on the effect of rate of growth on meat quality, packing plant yield, fatty acid composition of grass and grain diets, and breed differences on meat quality. Until the late 1990's, the research program of INIA was limited to animal production traits and was organized largely by the species of animal. In 1998, the structure of INIA was re-organized to include the study of meat quality across all species.

Glencoe Station. One of the research units of INIA is the Glencoe Station located about 120 km (75 miles) west of Tacuarembo. With 1,300 ha (~3.200 ac), this station is home to about 900 head of sheep and 1,000 head of cattle allowing a vast variety of research and demonstration projects that directly benefit cattle and sheep producers of the region. Research studies include stocking rate and supplementation rate for both sheep

and cattle and include both animal production traits along with meat quality assessment. A large function of the station is the Merino Nucleus Herd. In this herd, producers bring ewes to the station where the station maintains the herd and breeds the ewes to the best Merino genetics available from imported genetics. Once a year, the rams that come from this herd are transported to a central location and re-distributed to the producers who furnished the ewes. The purpose of this program is to increase the quality of wool production in Uruguay by introducing the Merino genetics that are known for very fine, high quality wool that significantly increases the value of the wool compared to the coarse wool normally produced with local Coriedale genetics.

Finishing or fattening studies are also central to this station where organic fattening, limited use of improved pasture (4-6 hours of ryegrass grazing, 18-20 hours of native pasture), different improved pastures, and different sources and amounts of supplementation are all studied. Finally, to improve the afore-mentioned challenges with pregnancy rates (especially in 2nd calf heifers), a program for including legumes in native pastures to improve the nutrient value have been initiated.

MARFRIG Tacuarembo. The Brazilian-owned packing plant located in Tacuarembo is a modern packing and processing facility capable of slaughtering as many as 1,500 head each day with an average slaughter rate of close to 700 head/day. From the holding pens designed by Temple Grandin to all modern HACCP and GMP regulations, MARFRIG has been HACCP certified since 1997 and is also a certified supplier for McDonald's products in the domestic market. As previously noted, the "black box" system has been incorporated into this plant and consists of a bar-coded tag that is placed on the carcass. As the carcass is broken down into smaller parts, various stations are located throughout the plant that read the carcass tag and generated the required number of bar-code tags needed for each of the subsequent parts that will be generated from the carcass as it is fabricated into wholesale cuts. At various places, pH is measured on each cut to make sure that it does not exceed the requirements for its intended market (usually 5.8 to 6.0 maximum pH). In addition to slaughter and fabrication, this plant also does a limited amount of further processing. Numerous different types of jerky products are produced including a restructured jerky and several marinaded, whole-muscle jerky products contracted to export markets primarily in the U.S. A unique cured and dried beef product (Tasajo Montevideo) is made for export to Cuba and Miami. It is made from the outside round

flat (biceps femoris) which is butterfiled and rubbed with salt and sodium nitrite. Each day for four days, the cuts are rubbed and re-stacked on pallets. Next the cuts are hung and placed in a drying chamber at about 40C (~104F) for 5 days at which point they are removed from the hangers and dipped 3 times in heated beef tallow with beta-carotene added to it to give it a yellow color.

Rural Society of the Black River. Located in the west-central part of the country in the Rio Negro State and town of Young, the Sociedad Rural de Rio Negro is a semi-commercial unit that is a part of a farmers union consisting of 14 different members including the Ministry of Agriculture, INIA, and others. Approximately 80% of the funding of the SRRN is from INIA in the form of salaries and the biggest effort of the Society is in extension and promoting the business of agriculture. As a part of this effort, a 140 ha (345 ac) research and demonstration farm is located just outside of Young and includes plots for analyzing crops and improved pastures. The largest portion of the effort in cattle production is in feedlot fattening as feedlots have become much more common in this region of the country. In 2002 only 2 feedlots existed but today 12 feedlots can be found, but only average 300-100 head in size. Additionally, with the global increase in the price of grain, crop production has become big business in Rio Negro and crops are regularly incorporated into cattle production with improved pastures being rotated with crop production to maintain soil fertility. The feedlot feeding at the SRRN uses Torta or cake silage with varying amounts of grain from 30 to 50 to 80% sorghum in the diet. Interesting, daily gains are usually in the 1.1 to 1.3 kg/day (2.4 to 2.0 lb./day) in order to manage the amount of fat on the carcass as too much fat is often discounted at the packer and with the predominantly British genetics, inducing gains more than this will often produce carcasses that are too fat. To support the station research, often research projects are also carried out on producer farms or in commercial feedlots found in the area to encourage the adoption of modern production techniques. Producers are typically reluctant to change practices rapidly and often will incorporate new techniques on small portions of their farm. As an example, often times the feedlots used on farms have cloth or plastic feeding troughs instead of concrete so that the land can easily be converted back to pasture or crop ground without permanent and costly capital investments. The final mission of the SRRN is to promote social health especially in rural schools in a way that relates to all classes from producers to public administrators.

Don Estaban. A good example of agriculture in the Rio Negro area is found on the farm of Don Estaban. Located about 100 km (63 miles) east of Young, this farm includes crop production, where the land is leased to outside contractors for the production of grain, cow-calf

production, grass-fattening, and feedlot fattening. Unlike many producers in Uruguay who solely use Hereford genetics, this producer has found the Herefore x Angus cross to be very useful in their production system. Approximately half of the steer calves are fed in a feedlot using Torta (~50% silage and 50% sorghum grain), the other half are fattened on improved pastures in a rotational system to maximize the utilization of the forage present. Again the feedlot was set up in the middle of a native pasture with temporary feedbunks so that the pasture could easily be converted back to pasture as needed.

Canelones Packing. Located about 30 miles (50 km) north of Montevideo, Canelones Foods began in 1946 as a producer of canned fruits, vegetables, and processed cured meats. In 1960 it began slaughtering cattle and then underwent a major renovation in 1994 to modernize the plant and increase its size. Passing through ownership by the IFP group in 2002, it is now part of the Bertin group, purchased in 2005. The plant has a daily slaughter capacity of about 1,000 head and specializes in producing fresh meat cuts along with cooked and canned corned beef. Current focus of the plant is in producing the highest quality meat products even at the expense of volume. One of the company's slogans is "Volume without profit is like eating soup with a fork. You stay busy, but go hungry".

Tarariras and Cardona Producer Visits. Just north of Colonia we met with producers that are part of the FUCREA; El Estribillo, Don Ildefonso, and La Paisanita. In Tarariras, El Estribillo covers about 680 hectares with about half in crop production and half in livestock production. The livestock production consists of purchasing Holstein steers and then putting them on an 18 month stocker and fattening program. The use of Holstein steers is important as this area is dense with dairy production so the steers and relatively inexpensive and readily available. The steers are sold in the spring months at a final weight of about 450 kg. While cattle are still a major part of the activity today, the manager indicated that this farm was on its way to 100% crop production. Argentine companies come in and rent the land for $350-400/ha (~ $140-160/acre) to plant to crops so the land owner gets the income with zero risk.

Also in Tarariras, Don Ildefonso has 1,500 ha with about 25% in crop production and the balance in native and improved pastures. This farm is also increasing the amount of land devoted to crop production, but while maintaining the current number of cattle requiring more intensive management techniques. Unlike the predominantly Hereford beef cattle genetics found throughout Uruguay, the

cattle here are crossbred with a Hereford-Angus base with Zebu and Limousin in the terminal cross. Also somewhat unique is that the calves are placed in feedlots after weaning with hay and sorghum grain to boost performance and reduce the mortality/morbidity of the young calves. Once they reach about 300 kg, they are placed in native and improved pasture to fatten and taken to the packing plant when they reach about 430 kg. While heavier weights are often the goal in the fattening phase, often times the packers will call looking for any calves over 400 kg in the winter months since supplies are very low, thus making it difficult to justify putting more weight on when the same price can be received for the smaller calves.

In Cardona, Pablo Olivera showed us around La Paisanita which consists of 1,500 ha with about 40% in crops and the rest for beef production. In this production system about half of

the 2,200 head of calves are grazing and half are finished in the feedlot. Because of poor soils and the presence of an abundance of rocks, not all land is suitable for crop production. Where crop production is possible a 3 or 4 year rotation of soybeans, wheat, oats and cultivated pastures are used to keep the land in good condition and maximize the profits. Mr. Olivera has part ownership in a purebred Angus ranch so many of the genetics used are from this facility, but Holstein steers are also purchased because of their availability and cheap price.

La Estanzuela Experiment Station. Located just outside of Colonia in the southeastern corner of Uruguay, the oldest of the research stations in INIA, La Estanzuela began as a farm owned by the German immigrant Alberto Boerger. In addition to agricultural production, Mr. Boerger also conducted research on this farm and eventually donated the ground and facilities to the government and eventually became part of the INIA system and served as its very first research station. Here extensive crop research is conducted including most cultivars of crops as they are evaluated for disease and drought and heat resistance for this region of the country. Additionally, a fully functioning dairy unit is present conducting research on the production traits of Holsteins on various grazing and dietary treatments. The average milk production for the cattle in the dairy is just over 35 liters per milking or about 71 liters per day.

Numerous cattle production facilities are present including native and improved pastures along with intensive and commercial feedlot feeding facilities. The feedlot facilities

include applications for intensive nutritional studies, including fistulated steers along with more traditional feedlot pens with also include runoff studies where the effluent from each pen can be collected and analyzed for environmental impact. Much of the focus on the feeding and fattening of steers is centered on the impact of daily gains during both the stocker and finishing phases and current studies are being conducted to determine the

impact of two levels of growth in both the feedlot and grazing for both the stocker and fattening phases. This includes cattle that will graze and those that will be in the feedlot for both phases along with cattle that will begin in one system and then cross to the other for fattening. Meat quality and growth characteristics will be collected and this project will likely be the major research collaboration between INIA and Auburn University.

Improved pastures are largely comprised of combinations of red clover, white clover, lotus, and annual ryegrass. Grazing intensity is a major source of research focus and the estimated dry matter of available forage is then used to calculate the percentage of live weight of the animal to determine the stocking density. Research to improve existing pastures and the find new alternatives to forages that perform poorly during the autumn is a major focus for the beef unit.

Colonia Packing (MARFRIG). Also located just outside Colonia, Colonia Packing is an extremely modern packing plant undergoing numerous revisions and growth and is a part of the MARFRIG group as is the packing plant in Tacuarembo. Unique to this plant is a brand new, state-of-the-art slaughter facility with twin kosher slaughter restraints imported from Italy that restrain the animal, then rotate the animal 180 degrees to expose the neck area for ritual slaughter. This system was evaluated by Temple Grandin and received very positive comments. Unlike most abattoirs, the area at this plant is very well-lit with plenty of sunlight and space around all of the equipment and processing lines. As with the other plants, fresh and frozen beef is the major part of their production, but specialty products unique to this plant include cooked tripe as well as carpaccio, which is a thinly-sliced, raw beef product made from the longissimus muscle of the pistola. Because it is never cooked, major food safety regulations are in place to insure the safety of this product. With a capacity of 1,200 head per day and the most modern facilities, this plant was most impressive.

Glencoe Field Day. On a cold and windy day, the "Alternative intensification, specialization, diversification and enhancement of sheep and cattle" field day was held at the Glencoe Station Experimental Unit west of Tacuarembo. Approximately 100 producers from around the country attended this field day which included touring various demonstration plots around the unit to gather the latest information on beef and sheep production and pasture management. Touring each of the demonstration plots, researchers from INIA presented the latest data resulting from each plot and included improved and native pasture management, organic beef production, the Merino nucleus, and several others.

PRADO Show. One of the biggest commercial agricultural events in Uruguay is the PRADO Show in Montevideo. This event is an agricultural trade show, livestock auction, and

livestock show all in one. All species of livestock are found at the PRADO including horses, chickens, goats, rabbits, sheep, pigs, and all breeds of cattle. In addition to the traditional livestock evaluations similar to those found in the U.S., there are also ultrasound evaluations of cattle and sheep, with prizes given in various categories of animals for traits like ribeye area and fat thickness. The ultrasound is conducted by certified INIA personnel and is a very large part of the opening events of the livestock part of the show. Additionally, many of the animals are sold by auction bidding following the judging evaluations. As an example, the grand champion Dorset ram brought $4,000 U.S. at their special auction. All of the different breeds of cattle are well represented at the show and in addition to the cattle in the barns, almost all of the breeds are represented by booths or buildings around the grounds providing information and services for cattle producers from around the country. While fine examples of cattle were at the show, many commercial producers consider the steers at the show to have excessive fat compared to those that are found in commercial settings. For many, the PRADO show is the highlight of the year and certainly is a good opportunity to see the current state of the cattle industry in Uruguay.

Coral de Palma. Found in the far eastern department (state) of Rocha, this ranch has a mixture of rice production along with both a cow-calf herd and a very progressive and modern 2,000 head feedlot. This part of the country is extremely flat and lends itself very well to the production of rice where the fields are flooded with water. Following the harvest of rice, the fields are planted to improved pastures. To do this, airplanes fly over the fields and apply ryegrass seed and fertilizer since the muddy conditions of the fields make it very difficult to plant the pastures any other way. The field are then grazed by cows, heifers, and young steers. Each of the fields is in a rotation with rice and pasture to maximize the utilization of the land for production of both grain and beef. You can see the dams in the pictures used to contain the water when the rice fields are flooded.

In addition to the excellent grazing on this farm, a newly-constructed, very modern feedlot can be found. It consists of 10 pens with 200 head/pen with 9 pens for fattening steers and 1 pen for fattening old cows. Each of the pens has been given a concave shape with the elevated portion running from front to rear including the feedbunks themselves.

Between each pen is a space to catch the runoff from each of the adjoining pens. Finally, a new system is in the process of being installed that will automatically deliver grain to each of the feedbunks through an auger system. While a 100% grain diet was first used, problems with bloat forced them to add hay to the diet. The target gain is about 1.5 kg/day and a final weight of 470kg on the farm is required for the packing plant. Note the palm trees in the middle of the feedlot pens and in the middle of the rice fields and pastures. Federal law protects every palm tree and it is illegal to touch or disturb any palm tree. Therefore crops must be planted around the trees and feedlots are built around them as well.

On the way to this facility, we also passed a "bull hotel". At this facility, producers deliver bulls after weaning that they intend to keep for servicing their herds. The facility develops the bulls by providing good nutrition and testing the reproductive efficiency of the bulls through sperm counts and other measurements. The bulls are then returned to the producer to take back to their farm to breed their herds.

Treinta y Tres Area Producers. The first ranch that we visited was "Las Tacuaras" owned by the Rado Family. This ranch consisted of 2,500 ha (~6,000 acres) with a total of about 2,500 head of cattle and 1,100 head of sheep. As with many farms in Uruguay, this one also included cropping as a part of its production system. A rotation of sorghum production (7,000kg sorghum grain/ha) with improved pastures has proven a very effective way to manage the land resources here. The cattle are Hereford and Hereford x Red Angus crosses and include a cow/calf system along with a fattening system. The steers graze the improved pastures and also receive 1% BW in high-moisture sorghum grain. The improved pastures consist of Lotus, red clover, ryegrass, and fescue. The goal for fattening is to market the calves at 470 kg in less than 3 years of age and transport them 200km to slaughter. Along the way they will lose 6 – 8% during transport. Emphasis on reproductive efficiency is especially important at Las Tacuaras and has resulted in an 80% pregnancy rate.

Next was "La Cartuja" owned by Marcelo Gigena. His farm is 672 ha and focuses on raising calves and fattening steers and old cows along with a small amount of wheat production – a first for this year. A total of about 700 head of cattle pass through La Cartuja each year with about 15% of those being old cows for fattening. These old cows can be purchased very inexpensively, put about 150 kg of weight on them and market them to the slaughterhouse for about 10% less than fat steers

(~$3.30/kg carcass for steers and $2.95/kg carcass for cows). Improved pastures are mostly white clover plus some ryegrass and lotus. With such a high amount of clover, bloat has been a problem, so a topical anti-bloat agent is sprayed on the forage just before grazing to prevent bloat. The fence is then moved only about 5 meters for new grazing and the process is repeated each day. Again a sorghum/improved pasture rotation is utilized to improve profits from the land.

INIA Treinta y Tres. The newest of the INIA experiment stations, the Treinta y Tres station consists of a main office and two field research stations: Palo a Pique and Paso de la Laguna. The Palo a Pique experimental unit is focused primarily on the rotation of sorghum crops and improved pasture with cow-calf production and steer fattening the primary animal research. The stocking rate and residual pasture forage remaining prior to planting sorghum is important agronomic information for this region, so animal fattening research concerning rate and type of supplementation along with the time at which animals are removed from improved pasture are studied to determine the effects on both animal and plant production and quality. Additionally, animal behavior, early weaning, weaning methods, and pasture management are also studied at this research unit.

The Paso de la Laguna experimental unit is the premier rice production unit in Uruguay. The extremely flat ground and the extensive system of water irrigation and drainage from its proximity to local rivers makes this an ideal location for this type of research. The research on rice production is thoroughly integrated into animal production systems as well. As with other crops in Uruguay, a rotation of rice with improved pastures is studied along with the impact of animal production systems on crop production and vice versa. As mentioned previously, improved pastures are established by flying on ryegrass seed without any fertilizer. In fact, the only fertilizer used on this land is phosphorous (natural levels are ~1-3 ppm P), which is true of most all land in this area of the country. Extensive interdisciplinary research is done among agronomists, soil specialists, animal scientists, and climatologists.

Maldonado Beef Production. In the Maldonado Department, we visited the Estancia Sierra de los Caracoles as well as the farm of Mauricio Rodriguez. In this area of the country, the soils are not blessed with high quality as they are often shallow and rocky. Nevertheless, production of beef is very similar to other parts of the country where improved pastures with ryerass, clover and lotus make up the bulk of

forage production. Dr. Rodriguez (a veterinarian by training) is also among the most progressive cattlemen in the country. Along with his partners, he is developing a very intensive system of genetic selection using artificial insemination and embryo transfer to develop the absolute best genetics available. He and his partners purchase half interest in the grand champion Hereford bull at the PRADO show in order to collect semen from the bull to extend the ability to use the outstanding genetics. They have even purchased animals cloned from outstanding Angus breeding animals from around the world. In addition Mauricio also manages the Sierra de los Caracoles ranch for the Spanish landowner who live abroad.

Las Brujas. The fourth (of five) INIA research station that was visited is located only a short drive from Montevideo. While a research focuses on horticulture, fruit and vegetable production, and biotechnology, beef production is also a very major part of this experiment station. Located in the heart of dairy production in the southern part of the country, naturally much of the beef research is related to the utilization of Holstein steers in a finishing system. Growth of steers on improved pasture with and without supplementation during the growing phase following weaning along with the use of pasture versus feedlot finishing is the primary focus of this research which is in its infancy. Also a major part of animal research at this station is dairy production with a dairy herd and even facilities to produce and test dairy products like cheese. Additionally, production of sheep, rabbits, and pigs are also tested at Las Brujas.

Like the other INIA research stations who strive to conduct trials and demonstrations that benefit the beef producers in the area, the station at Las Brujas is located in an area where the average farmer is producing beef on less than 100 hectares rather than 1,000 hectares or more. The average farm is between 30 and 50 hectares and the landowners are responsible for about 95% of the labor on the farm. Other than short periods during the year when intensive labor is required, all of the work is done by the family living on the farm. Additionally, because of the small size of the farms, beef production is usually a very small part of the total income, usually accounting for 20-30% of gross receipts. Fruit and vegetable production makes up most of the remaining income for the farm and beef production is usually just a part of a very diverse production system that is used to balance the seasonality of other incomes.

Kiyu Central de Prueba de Toros Hereford. Located 60 km west of Montevideo, Kiyu was established in 1976 through an agreement between the government and the Hereford Breeders and later with involvement from INIA. The sole purpose of this station is the demonstrate the genetic potential of breeding bulls and fattening steers in the Hereford breed. Bulls are transported to Kiyu by breeders after weaning and then the station feeds and manages the bulls using only grass until they reach about 2 years of age and an average 600 kg. Over this period average daily gains, EPD's, and body confirmation are evaluated and bulls receive a score that combines these three traits and the bulls are then ranked prior to a production sale in late September. The average sales price of the bulls is about $2,300/head and this production sale is the start of the season and is considered one of the most important events for the cattle industry and especially for the Hereford breed. In addition to the bulls, this station also buys Hereford steers to fatten using improved pastures to demonstrate the genetic potential of the Hereford breed in a commercial fattening system.

Summary and Overview

The Experience. When I arrived in Montevideo August 19, 2008 I certainly had no idea what kind of experience I was in for. It has simply been outstanding. From Montevideo to Tacuarembo, then Young and Colonia, followed by Canolones, Colonia, then back to Tacuarembo. After that I traveled back to Montevideo, then the Rocha Department, Treinta y Tres, Punta Del Este, Las Brujas, and finally back to Montevideo. These travels in the past 6 weeks have covered more than 2,000 miles or 3,000 km and have allowed me to visit the headquarters for Fulbright, INIA, INAC, FUCREA, and DeLaVe; 8 experimental units (including 4 of the primary INIA experiment stations and their research farms); 13 producer's farms; the PRADO Expo; the Kiyu Hereford bull test; and 3 major meat packing plants. I estimate that I have met with over 300 people in my travels and have planned possible future projects with no fewer than a dozen of them. And this is just the first half of my Fulbright project.

By far and with absolutely no doubt in my mind, the single greatest thing about my experience in Uruguay has been my interaction with INIA. An extremely special thanks goes to Gustavo Brito, Pablo Rovira, and Fabio Montossi. The time that they have taken to show me all of these places and introduce me to so many sectors of the industry has been simply amazing.

Gustavo has taken more than a month of his time to drive me all over the country and

introduce me to these absolutely wonderful people in animal agriculture and Pablo has done a simply amazing job of showing me the eastern half of the country over the last 2 weeks of my stay. Without these people, my stay in Uruguay could not have been anything more than average and they should be commended for their dedication to making this program work and the tremendous dedication that they have for animal agriculture in Uruguay. They are clearly well-respected within the industry in Uruguay and were extremely gracious in every activity that we participated in.

The Country. Despite my best efforts to find information regarding the culture in Uruguay, I found very little to prepare me for my visit to this great little country. At first I was extremely intimidated because of my very limited knowledge of the Spanish language and the fact that many of the daily activities are different than the U.S. Slowly I began to realize that while I struggled to understand the language, almost without exception, the people of Uruguay have been extremely gracious and patient and willing to help and explain to the best of their ability. Never did I ever feel "inadequate" for not being able to better communicate with them. It is from this that I discovered that regardless of the socio-economic status of the person or the situation, the people of Uruguay are very polite, easy-going and willing to do anything for their neighbor. Regardless of the situation, every greeting is accompanied by a tip of the hat or a polite kiss on the cheek and I think that these actions are what best characterizes the people and the country of Uruguay. At first it is difficult to determine the material wealth of the people of Uruguay, because as a general rule even those that do have material wealth, most would never know it. Truthfully, the wealth of this country is in the traditions and generosity of its people, and its culture is the hidden treasure in this small South American country and I, for one, never felt wanting of anything during my stay here.

The Agriculture Industry. As is the case in all countries, the economy of agriculture in Uruguay is susceptible to changes in market conditions as well as climate. The world agricultural market is constantly changing and has seen record prices in some commodities in

the past few years. Grain and fuel prices have soared causing many farmers to adapt to these changes. Unlike many farmers in the U.S. and other countries, farmers in Uruguay are unusually flexible in their production abilities and are capable in changing from a completely beef-based production system to a completely crop-based production system within 1 or 2 years (especially in the western part of Uruguay). Many of the

farmers that we visited have reduced the acreage devoted to beef production and we even observed one operation that was in the process of changing completely to crop production. Many farmers with beef have at least some sort of confined feeding system which may be no more than a fenced pen with water and a feed trough. When market conditions are right, they are able to feed cattle intensively, but are able to take down the fences and remove the feeders at a moments' notice. I only observed one feedlot that had concrete feeders indicating that they were dedicated to confined feeding for the long run.

Many of the largest agricultural businesses in this part of South America are in Argentina or Brazil. As a result, many of the business decisions are based on the markets in these two countries. Farmers in western Uruguay have opportunities to lease their land to Argentine companies who use the land to plant wheat, soybeans, barley, sorghum, or other small grains. These farmers are receiving $160-200/acre ($400-500/ha) for leasing and it is completely risk-free making this a great opportunity for many farmers to convert part or all of their valuable land to a low-risk income, but again can change this from year to year.

To further complicate an extremely complex industry, farmers must deal with a market that uses at least 2 currencies – the Uruguayan peso and the U.S. dollar. Almost all large capital items like cars, farm equipment, land, and animals are sold using the dollar. Additionally, almost all bank loans are made with the U.S. dollar. Many other commodities and daily purchases like food and fuel are made using the peso. Therefore as exchange rates vary, the value of loans and prices of large items may change drastically. In the time that I was in Uruguay, the exchange rate for the peso to the dollar changed from 19:1 to 20:1, representing a change of more than 5% in about a month.

The Forages. As one would expect, grass and other forages are of vital importance to the beef industry in Uruguay. By far, the most predominant energy source of cattle in Uruguay, forages range from land dedicated to natural pasture or improved pasture to land that is rotated from improved pasture to crops to hay and/or silage production. As a rule, the farmers are very good at selecting the production system that maximizes both the use of the land as well as the production of beef. Most improved pastures are composed of ryegrass, white clover, red clover, lotus, and sometimes alfalfa. Phosphorous is added to most pastures as the soils tend to be very deficient (1-3 ppm P), but very few add nitrogen as the price of nitrogen is very expensive. One exception was the Kiyu Hereford Bull Test where sponsors donate many forage treatments as it is an experiment station and the forages there were

exceptional. Certainly research into the economics of applying nitrogen versus the animal gains would be beneficial in the various regions of the country to determine the cost-benefit of this practice.

The Feedlots. While not common in Uruguay, the practice of feeding and/or finishing cattle in a feedlot is becoming much more widely accepted, especially in the South and West. Most are located, as you would expect, near regions where more acreage is devoted to the production of small grains. As with most agriculture in Uruguay, the inputs to a feedlot are kept as low as possible. Even those operations that are dedicated to feeding cattle have facilities that work extremely well, but are low-cost and low-maintenance. Most are constructed from high-tensile, smooth wire with feedbunks constructed of plastic barrels, canvas, or even fed on the ground with dirt mounds or slopes to control run-off and some type of retention to capture the run-off. Corn is not used in the diet as there is no irrigation that would be required to raise corn in this region, so sorghum grain, high-moisture sorghum grain, and sorghum silage is the predominant source of the diet. Additionally, soybean meal, sunflower meal, rice bran and trace minerals make up the balance of the diet. Generally, the diet is about 50% silage and 50% concentrate with average daily gains around 1.3 - 1.5 kg/day (2.9 - 3.3 lb/day). It was determined that if more than 50% concentrate was included in the diet that the cattle became too fat too early for the packing plant, so this proportion of grain produced cattle that gained well without getting too fat.

The Cattle. With more than 80% of beef cattle in Uruguay being Hereford, it is clear that farmers have found a breed that works well here. Other breeds such as Angus, Braford, and Limousin have also become more popular around the country. It seems to me that the one area of beef production in Uruguay that has the most potential is in the area of genetics. Pregnancy rates are consistently around 65% with a few very progressive producers reaching 80% or 90%. Steers generally take between 24 and 36 months to reach the weight required by the packing plant (470 kg or 1,030 lb). Even when nutrition is not limiting, as in feedlots, the diet has to be lowered to the genetic potential of the calf. And the predominant market is for lean beef with a minimum weight and with all growth promotants being illegal in Uruguay, the genetics of the beef are absolutely critical.

Having said this, there are market conditions that currently exist that make some of these improvements difficult to adopt. At many times of the year, the prices paid by packers for old cows may be only about 10% lower than those paid for young steers. This reduces the urgency of cattle producers to make sure that all of the cows are bred since the value of old

cows is relatively high. Other production concerns like dystocia, feed intake, age of puberty, and costs of maintenance make cattle producers very hesitant to make big changes to the genetics of the cattle that they currently have that would result in larger animals that have been selected for growth. Nonetheless, cross-breeding is becoming more common and slowly external genetics are being introduced into cow herds around the country. Still, the tendency is to use genetics from England or Australia and not the U.S., even for Hereford or Angus.

The Meat Processors. I have been overwhelmingly impressed with the meat processors in Uruguay. The level of technology and modern facilities is easily on the same plane as most plants in the U.S. While not able to operate at the same capacity as those in the U.S., all of the basic HACCP, GMP, SSOP, and basic food safety programs would fit easily in anywhere in the U.S. All of the plants that I visited have been undergoing major renovations or improvements to continue to increase the capacity and technology available. Animal welfare is also a major emphasis for every plant that I visited. Each one of the had invited Dr. Temple Grandin (world-renowned animal behavioralist) to visit and evaluate their animal handling facilities and each had made improvements as suggested by Dr. Grandin.

As with other meat industries around the world, many of the packing plants in Uruguay have been bought in part or in whole by other countries, especially Brazil. The one basic problem that most of these packing plants have is the seasonality of beef supply. During the winter months, slaughter numbers are down to 400-600 head per day per plant which is one-third to one-half of their capacity. This, in turn, requires them to request cattle that would normally fall outside of their normal targets for weight, condition, and age, simply to be able to keep the doors open. Herein lies the problem. As mentioned previously, the value of some cattle that would normally be less than market standards for young beef (cows, dairy, etc.) become a commodity with value because the packing plants are operating at less than capacity in an industry that is primarily a high-volume, low margin venture. Therefore market pressure for high-value young beef is below what would be considered normal because of unbalanced supply and demand. Furthermore, additional commercial packing plants are being built and current plants are expanding their current facilities making the supply and demand of beef even further out of balance.

Like other segments of agriculture in Uruguay, the meat packing industry has been extremely flexible and able to meet market demands for beef wherever they exist. Exports make up an extremely high percentage of their production with major markets in the U.S., Europe, Russia, Australia, New Zealand, and they far east. One of the biggest markets currently

for export is to Russia as the demand for beef is very high there and the number of specifications required is much lower than those for the U.S. or Europe. It is very impressive the network of marketing that these packing plants have and will certainly be leading the global

demand for Uruguayan beef. While not as much volume, the domestic market will also continue to play a significant role in the meat industry in Uruguay. The domestic Uruguayan meat market is extremely traditional and is similar to what would have been found in the U.S. 30 years ago. Every town and city in Uruguay has a number of "carnicerias" or butchers located on almost every block of the business district. Here butchers receive carcass halves, quarters, and some boxed and vacuum-packaged meat that will be cut in the store and sold to the public. Most also produce their own chorizo and other processed meats made from the trimmings. While some larger "supermercados" or supermarkets have packaged meat for sale, even these modern markets rely heavily on their butchers to market meat to the public.

The Meat. Dressing percents (the proportion of carcass from the live animal) is very low (52-55%) compared to what is considered normal in the U.S. (62-64%). This is primarily a factor of the lighter weight animals and the lower fat thickness (6 mm of fat versus 12-13 mm of fat). In terms of general quality, the primary concern for most customers of Uruguayan beef is pH. Because most of the beef is from grass-fed or older animals, the lean tends to be rather dark with a higher pH which may lead to microbial problems because of the tendencies of bacteria to grow well in neutral pH. Therefore most of the cuts are tested and must have a pH of less than 5.8 or 6.0, depending on the customer. Beef carcasses are also cut differently in Uruguay than what is customary in the U.S. The primary cut is between the 9th and 10th rib instead of the last two ribs as is customary in the U.S. Because grading the marbling and fat thickness at the 12th rib is customary in the U.S. comparing grading methods between the two countries is difficult as these traits are not the same at these different locations.

Interestingly, the perception of Uruguay as predominantly producing grass-fed beef is correct in the most basic sense, almost without exception, all cattle receive grain during some time in their lives making almost none of the beef marketed in Uruguay eligible for labeling of "Grass-fed" as defined in the U.S. While the beef in Uruguay has much of the flavor normally associated with grass-fed beef, the flavor tends to be variable depending on the cut and condition of the animal from which it was derived. In the simplest terms, Uruguayans eat beef.

In fact, they eat more than twice as much beef per capita than Americans. The cuts of beef consumed in Uruguay differ greatly from those commonly found in the U.S. Americans consume primarily steaks from the rib and loin along with ground beef for hamburgers. In Uruguay, the most common beef products found are Asado (beef ribs – grilled, probably the most popular), vacio (flank steak), cuadril (sirloin), milanesa (round steak, breaded and fried), entrecot (rib [ancho] or strip loin [bife angosto] steak), chorizo (beef and pork sausage similar to American smoked sausage), and chivito (a steak sandwich with grilled round steak, lettuce, tomato, boiled egg, and mayonnaise).

Without doubt, the beef takes the center stage of every meal. The side items like salad or fries are an afterthought as every meal contains a large helping of beef. Almost all of the beef is cooked over a wood fire on a simple grate with wood coals beneath. A wood fire is kept next to the grill to generate the coals and most of the meat is pre-cooked a small amount ahead of time and finished upon ordering. Many restaurants have the meat served family-style where a large roaster of meat is brought out and set in the middle of the table for everyone to take what they want. Many times this is an assortment of the above listed meat items along with variety meats like sweetbread (the thymus gland), kidneys, hearts, small intestines, large intestines, tripe (stomach), and blood sausage. While Americans seem to value tenderness above other traits, Uruguayans value the flavor above all else as evidenced in the selection of cuts that tend to be higher in fat content. With the asado being the most popular, there is a wide variety of quality in this cut and it can usually be determined before eating by the size and shape of the ribs and the amount and color of fat. A good asado is excellent and with all of the other grilled meats is very simple having no other seasoning or rubs or marinades added to it other than salt at the table.

Overview. The beef industry in Uruguay is an exceptionally flexible and modern business that is certainly a major player in the world beef market. Already employing many technological advances in improved pastures, ultrasound measurements, and food safety, more advances are available to farmers and processors in Uruguay to improve profitability in all sectors of the industry. A significant amount of research in meat production and quality is needed to bring these advances to Uruguayan producers to meet their needs and fit into their

current production systems with consideration being given to not only global market demands, but also local production constraints. Current research programs in beef production and processing at Auburn University in the U.S. and INIA in Uruguay are complementary with each having strengths that tend to be challenges to the other. I envision a long-term partnership between Auburn University and the scientists at INIA to advance the production of beef not only in Uruguay, but also in the southeastern U.S.

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