Environmental Studies Practicum:

Maple Syrup Production at St. Johns University

A look at the history and sustainability of the process

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I. INTRODUCTION

There are many signs that we associate with spring time in Minnesota. The first robin we see, the first thunderstorm of the year, and the rising rivers are all signs that Midwesterners are about to emerge from the blanket of winter. One sure sign of winter that many may not see is the tapping of maple trees to make maple syrup. The history of this springtime ritual is one that is deep in history and tradition. Right here at St. Johns university in fact, the monks have been involved in this practice and have developed quite a tradition of their own. The final product is one that can nicely complement a morning stack of pancakes, or a midnight treat of ice cream. Whatever you do with your pure maple syrup, it is clear that Aunt Jamima will never taste the same.

I personally had the great opportunity to participate in this springtime tradition here at St. Johns. I got to observe and help out with everything associated with this process, from tapping the tree, to collecting the sap, cooking the syrup, and bottling it up for shipment to the breakfast table. I was also fortunate enough to be a part of the first annual maple syrup day at St. Johns. The sight of horse teams making their way through the sugarbush and the taste of pure maple syrup is something that I will never forget.

II. HISTORY OF MAPLE SYRUP/SUGAR PRODUCTION IN NORTH AMERICA

The Native Americans were the first to discover maple syrup. Although there are several legends about how exactly they did so, and they have most likely been modified over time, it is popular belief that the discovery was accidental.

> One popular legend involves a Native American chief who supposedly hurled his tomahawk (probably in disgust) at a tree. The tree happened to be a maple, and sap began to flow. The clear liquid that dropped from the wound was collected in a container that happened to be on the ground below. His wife, believing the liquid was water, used it to cook venison. Following cooking, both the meat and the sweet liquid that remained were found to be delicious. Retracing how this occurred revealed that sweet sap from the maple trees was the only difference. The process was repeated and the rest is now history (Koelling et al. Ch. 2).

While it is impossible to say if this is fact or fiction, the bottom line is that by wounding a maple tree in the late winter/early spring produced a liquid that could be processed into many useful products. The early settlers and colonists of North America lived basically a subsistence life centered on agricultural activities. Where there were maple trees available, the sap was collected in the spring and boiled down to make syrup, or boiled all the way to make maple sugar. Most of these early pioneers looked forward to this activity, and it was largely a social affair. Also, one of the main reasons that this activity was carried out on farms was because it came at a time of the year when there wasn't a

whole lot to do. The peak maple sap runs occurred between the winter wood gathering, and the spring planting season.

As with most other things, technological changes have found their way into the methods used to gather and process maple sap. The North Americans would cut a gash into the tree and then the sap would flow from a twig or piece of bark into a birch bark or other container on the ground. They would then take the sap from several of these containers and put it into a larger container which was often a hollowed log. "The sugar in the sap was concentrated by heating stones in a nearby fire and then placing the hot stones in the sap. The heat from the stones resulted in some evaporation and sugar concentration" (Koelling et al. Ch. 2). Another method used was dependent on the temperature as are most things involving syrup making. They would allow the sap to freeze, and because the water would freeze first, what was left was a more concentrated sugar solution.

When the settlers first started to collect the sap of the maple tree, they used basically the same destructive method as the Native Americans. However, over time they began to use an auger to make a small tap hole which caused less permanent damage to the tree. The damage that could be done by the gashing methos is seen in this quote from a settler's son talking about his fathers sugar orchard.

> "The man that commenced on and cleared up the farm used to tap with an ax; he would cut some 4 or 5 boxes or gashes, one above the other, and then strike in his ax below these gashes and put in a spout as wide as the bit of his ax. The

> consequence was that in three or four years his sugar trees would be gone" (Nearing, 51).

The initial spouts were made by pushing the pith out of sections of sumac or elder branches (Koelling et al. Ch. 2). Eventually the metal spout replaced the wooden ones, and had the advantage of serving two purposes. Not only did it allow for the sap to flow out of the tree, but it provided a place for which to hang the bucket or other collecting container from. Eventually a 7/16" brace and bit replaced the auger as the tapping tool of choice, and these are still used today on some of the smaller operations. Larger operations use gasoline powered drills which look basically like a chainsaw with a drill bit.

In addition, it should be said that maple sugar was almost a necessity to residents of the early colonies. In the 1800's imported white cane sugar had tariffs on it, and therefore the common people supplied their own form of sweetener in the form of sugar that they made by boiling down the sap from their maple trees. "The tariff was taken off some of the sugar eventually, and in the 1880's cane and maple sugar were running an even race on price. Around 1885, cane sugar began to undersell maple; since then maple sugar has become a high priced form of sweetening for all but those who could make it for themselves"(Nearing, 64). In 1890 a tariff act, called the McKinley Bill, was put into law in the hopes of stimulating the production of native sugar. The deal was that a bounty of two cents a pound would be paid to the producer of sugars of high quality, and one and three quarters a pound for less quality sugar. However, the regulation didn't pan out for maple sugar producers as it was just too much of a hassle for government. "They

claim that it has been ten times more bother and work to distribute $35,000 bounty among the 1,607 producers in Vermont…Than in distributing $7,000,000 among a few large planters in Louisanna" (Nearing, 65). As a result, cane began to far outshine maple as far as sugar production goes. Also, following the civil war, transportation made cane sugar easier and cheaper to obtain. As many non-farm people switched to cane sugar, farmers began to produce and market maple syrup. Hence maple syrup began to be a specialty product (Koelling et al. Ch. 2).

More recent technological improvements basically involve the collecting of the sap. For a while before WWII a metal tubing system was used in some parts. The idea was that metal tubes could be attached to the taps and then direct all of the sap in a given area to one central location. "However, because it was prone to leaks, difficult to clean, and required strict attention to grade when installed, it did not gain general acceptance" (Koelling, Ch. 2). New methods use plastic tubing to gather sap from hundreds or thousands of trees to one or several central locations. Some of these operations also use vacuum pumps or reverse osmosis systems which "help" the sap on its way. The basic advantage of these systems is that there is little labor involved in the collecting of the sap. Basically the taps and tubes are set up at the beginning of the season, and taken out at the end.

For those operations not using this tubing, changes have come about in the bucket collecting method as well. It has evolved from birch bark containers to wooden buckets, to metal buckets with lids which help keep out rain water and other possible contaminants to the syrup. Before the advent of plastic tubing, most operations began using plastic

bags to collect their sap. These bags were nice because you could see from a distance how much syrup was in the bag whereas you could not with metal buckets. Also, they required much less space to store in the off season. On the same token, there are problems with the bags, basically involving their susceptibility to squirrels, deer, and mice.

As can be imagined, sap collection has come along ways in terms of how it is transported from the tree to the cooker. Initially the sap was taken from the trees to the cooker by hand basically using several large buckets on a large yoke device. Eventually horses and oxen were given the task of transporting the sap by using a wooden sled on top of which a large wooden tub was mounted. Eventually tractors were incorporated to pull large tankers or tubs. In the 1950's the tubing systems were being experimented with. By the 1960's they were used widely as were certain varieties of vacuum pumps (Koelling et al. Ch. 2).

However it is done, once the sap is collected at a central location it must be boiled so that there is a higher concentration of sugar, and the finished product can be called syrup or sugar. The settlers used large kettles or cauldrons placed over a wood fire to boil their sap down. As the concentration progressed more sap was added, or it was ladled into another kettle. This resulted in syrup that was very strong flavored and dark. In the mid 1800's the flat bottomed pan for boiling sap was invented. This was mounted on an arch of some sort, usually made of brick and was better than previous methods because it greatly increased the surface area to which the flames were exposed. By 1860 the evaporator was invented. These evaporators had sectional dividers and basically

allowed the sap to be put in on one end, and the fire was built underneath the pans on the other end. What this allowed was for the sap to be gradually cooked as it got closer to the fire. It was a continuous process with the raw sap coming in at one end, and the finished syrup being drawn out at the other end (Koelling et al. Ch. 2). Basically the evaporator cut down on boiling time and produced a better quality product. One of the first evaporators to be patented and used in the maple industry was the Cooks Sugar Evaporator which was patented on June 22, 1858 (Koelling et al. Ch. 2). The next improvement to the evaporator was the flue pan, which basically has seen little modifications to the present day. "From the flue pan, partially concentrated sap is directed into the flat finishing pan, provided with dividers to maintain sap circulation as it increases in density" (Koelling et al. Ch. 2).

III. HISTORY OF MAPLE SYRUP PRODUCTION AT SAINT JOHNS UNIVERSITY

In fact, a flue pan system is exactly what can be found at the Saint John's sugar shack today. Saint John's got into the maple syruping business in 1942. Contrary to what we may want to think, they didn't exactly do it for fun. WWII was in full force and one of the largely rationed items was sugar. With ships and other means of transportation tied up in the war effort, cane sugar was in short supply and was rationed. Demand for maple syrup as a sweetener increased. To prevent profiteering, the government froze the price of a gallon of syrup at $3.39. So the St. John's monastery, realizing that they had a nice batch of sugar maples on their beautiful property, decided to tap the trees and attempt to make their own maple syrup. They started off just tapping 150 trees, and used the candle shop as the boiling location. While there were clearly some kinks to work out, when the monks tasted pure maple syrup on their pancakes it's safe to say that it was decided to make the syrup operation commonplace at SJU, and a building was built in September of 1942 to be used for the evaporation of maple sap into syrup(St. Johns Quarterly, April 1985). Henry David Thoreau took note of the transcendental qualities of sugaring in this early journal entry: "Had a dispute with father about the use of my making this sugar. ... He said it took me from my studies. I said I made it my study and felt as if I had been to a university."

The original "sugar shack" was located where the baseball diamond is out by the rugby field. The shack was block at ground level and then wood framed completely. However, apparently a beer party gone bad resulted in the shack being burnt almost

completely to the ground. The story, as told to me by Brother Walter goes something like this; In February of 1970 some college students decided to have a kegger in the shack. Since it was cold out they built a fire in the finishing stove. The stove then was a brick base with a 2 x 3 cast iron pan on top of it for boiling the sap. When they are boiling sap in the pan there is a chimney pipe that is attached to the stove. However, because it wasn't syrup season the pipe was removed and the sparks from the fire lit up the wood wall behind the stove and the shack caught on fire. One of the monks was coming back to campus around 2 A.M. and reported the fire. He also said that he saw several kids walking along the road back to campus as he came in. By the time the fire department could put out the blaze all that was standing was the front wall. A keg was found in the ashes, and to this day no one has come forward about who the culprit was.

Therefore the shack that you see out there today was built using volunteer workers and leftover block. The rafters were left over lumber and the room was used tin from an old shed. The tractor used to pull the tanker around collecting syrup was purchased for the garden and grounds in 1966 and has been used for syrup every spring that they have cooked. The monastery bought a used evaporator in 1970. Eventually they decided that it would be easier if the door was on the other side of the shack. So Brother Walter entrusted a small army of football players and they took the evaporator out whole, turned it around, and put it back into the shack in the position where you currently see it. In addition, Brother Walter built the addition onto the shack in1996 so that wood could be stored close to the stove, and also, because of the steps, it would be easier to load the wood into the stove. The addition was also built with used material, except for some mortar for the blocks and cement for the floor. The stove was

re-bricked at the same time using fire brick from the power house and the cement to put them together. The actual tapping supplies also come largely from right here. The spiles, which are the actual tap that go into the tree, have been around for at least twenty years. The covers for the buckets have also been around for some time, and many of them survived the fire of the old shack. The buckets that you see hanging from the trees in the sugarbush are given to the syrup operation from the dining service after they have used the food products that come in them. The plan is to keep collecting these buckets until they have enough to put out about 1000 taps. In the past, heavy duty plastic bags have been used, however there was a problem with squirrels. Apparently the squirrels would bite through the bags just to get a taste of the sap inside, and then move on to the next bag. Several years it was so bad that I read about certain members of the monastic community standing post with a firearm in order to protect the fragile bags.

Also, over the years the monastery has been practicing forest management to turn the area by the shack, commonly referred to as the "sugarbush," into mostly all sugar maples. If you walk through the area you can see the oaks and boxelders that have fallen prey to Brother Walters chain saw. Much of this wood is used as fuel for the cooker, and it too is collected, split, and stacked by volunteers. What this has done is provide the remaining sugar maples with the room that they need to grow and become healthy, sap producing trees. Also, it doesn't hurt that it makes tree identification a lot easier for those who have to tap the trees. Tree identification can get a little tricky in the winter when there aren't any leaves to go on.

The sugar maple and the black maple are the trees of choice because they produce the highest sugar concentration in their sap and also because of the late date at which they

begin growth in the spring. The black maple occupies a much smaller range than the sugar maple however, although they do live in parts of southern Minnesota and Southern and Western Wisconsin. Some other trees that you could tap for syrup include silver maples, red maples, boxelders, and even birch trees. The problem with these trees is that the sugar concentration in their sap is not nearly that of the sugar maple. This in turn means that less cooking of the sap is needed with sugar maples in order to come up with the finished syrup. So with sugar maples, on average, it takes forty gallons of sap to cook down into one gallon of pure maple syrup. On the other hand, if you tap a silver maple, or boxelder, it takes something like eighty gallons to cook down to the same one gallon of syrup. The finished maple syrup will have a sugar content of somewhere around 66%. There are varying grades and colors of maple syrup. The lighter syrups have a more delicate flavor, while the darker syrup isn't quite as pleasant to the taste buds. Francis Schellinger, an Avon man who makes syrup to sell to family and friends put it like this in a 2000 St. Cloud Times article. "The best is the lightest with the most delicate flavor." Francis used to cook his syrup in a galvanized bucket before he obtained a flat pan. He says of the syrup that he made in his bucket, "It was so black you could have tarred a roof with it" (Pike, 1).

While they started out tapping only 150 trees, over the years, Saint Johns has put out as many as 3700 taps. Something that must be noted here is that you can put more than one tap on a tree. The general rule of thumb is 10-15 inch circumference can get one tap, 15-20 can get 2, 20-25 can get 3, and 25-30 can get four. However, there is a new school of thought on this subject. In recent times maple trees across the country have faced stresses from things like gypsy moths, pollution, and weather. "As a result,

tapping guidelines have become more conservative, with one commonly recommended guideline suggesting 12 inches as the smallest tree to tap, and no more than 1 or 2 taps in any tree" (Buzzell, Ch. 6). This year Saint Johns currently has only about 600 taps out. The monastery tries to get out and cook up some syrup about every two years, although they have done back to back years, and they have gone as long as six years without cooking. They do this instead of cooking every year mainly due to the immense time and effort involved in the whole process. One example of the hard work involved in the syruping process can be seen in an excerpt from a log for maple syrup season 1978.

> We had another good run today. Started collecting at 1:30 P.M…Cheri and I hauled sap in till 7:00 P.M. Walt and Mike started the cooker at 1:30 and finished cooking some sap that was left over from previous run. Mike and Clem cooked from 8:00 P.M. till 1:00 A.M. Walt and I got a couple hours sleep and went out to cook at 1:30 A.M. We cooked till everything was in, finishing around 9:30 in the morning.

Apparently they tried to give some of the syrup to the students at the refectory, but Brother Walter claims that the students didn't like it because it tasted so different from what they were used to. So the only way that you can get your hands on some of the SJU syrup is to be a member of the monastery, receive some as a gift, or volunteer to help in the syrup making process. I believe that they used to sell some of the syrup locally as I found income numbers in some old documents. However this excerpt from the 1990 journal probably means the end of selling syrup for Saint Johns. "Rumors about the big sale…little support from community members. Should just use syrup for the house. Sell any?"

IV. THE SCIENCE BEHIND SYRUP MAKING

There is a very good reason why syrup making is a tradition carried out in the spring. And that reason basically involves the physiology of the maple tree. It should be noted that the maple sap production by maple trees is a natural physiological phenomenon, whereas the flow and collection of sap occurs as a result of wounding the tree and gathering the sap that flows in response to the wounding (Buzzell, Ch. 6). Sap flow occurs basically anytime during the trees dormant season when temperatures fluctuate above and below the freezing point. The ideal sap flow temperature is to have it be freezing at night, and around 40 degrees during the day. The general rule of thumb for this area is that the maple syrup season will be something like March 15th through April 15th. Clearly this year has been anything but normal however with strong sap flows not occurring until the end of March, and they began picking up some of the taps as early as April 16th. In addition, another large producer in the area actually gathered sap in January and February when had some warm spells. The complete physiological process of sap flow is a very complex biological process that is still not completely understood. However, there are several aspects that are understood. Basically, the fluctuations in air temperature that were mentioned above cause maples to develop strong positive sap pressure which is well above atmospheric pressure.

The current theory says that when the temperature falls below freezing negative pressure or suction is caused in the sapwood as a result of sap freezing, carbon dioxide dissolving in cooled sap, and some gas contraction during cooling (Buzzell, Ch. 6). This negative pressure causes water to move from the ground into the tree which increases the sap volume. When the temperature then rises above freezing and the frozen sap thaws,

forces which include pressure from released gases, caused by the presence of sugar and other substances dissolved in the sap, as well as previous gas compression and gravity act on the sap and create a positive pressure (Buzzell, Ch. 6). This pressure apparently can get as high as 40 pounds per square inch or more in an untapped tree. The whole process is then repeated if the temperature falls below freezing again. The sugar which is found in the sap of these trees is a product of photosynthesis during the previous growing season.

The sugar concentration in the sap of individual trees varies depending on a variety of factors. Some of these include: genetics, the quality of the site where the tree grows, tree health, environmental conditions during the previous growing season as well as during the tapping season (Buzzell, Ch. 6). On average the sugar concentration in sap can be expected to be somewhere around 2%. A study done by Steve Saupe and his 1994 Biology 334 class found the average sugar content of Saint Johns sap to be 2.5%. The study also found no correlation between tree diameter and sap content and no correlation between nearest neighboring tree and sap content. They did however find that bark color and sap content were correlated. Trees with darker bark color had an average sucrose content of 2.6% while lighter barked trees had an average of 2.35%. Professor Saupe is currently conducting an ongoing study of several trees in the sugar bush which they have recorded data from year after year.

Something else of importance is the concerns associated with microorganisms contaminating the sap. This is of special concern when it gets warm out and there is uncooked sap sitting in a holding tank. If left too long the sap could spoil and be of no use in making syrup. Also, contamination at the tap hole is a problem. For many years,

paraformaldehyde pills were put into the tap holes with the belief that they would prolong and increase sap yield and improve sap quality by retarding the growth of microorganisms (Buzzell, Ch. 6). In fact records indicate that Saint Johns used these pills as recent as 1985. However, “A number of studies have suggested that using paraformaldehyde pellets will significantly alter sapwood compartmentalization (tree defense mechanism), and hence the ability of trees to resist the establishment of decay-causing fungi” (Buzzell, Ch. 6). Therefore they are not a registered pesticide, and are not being manufactured or sold in the U.S. or Canada.

V. ENVIRONMENTAL CONCERNS

One of the great things about maple syrup production at St. Johns is how environmentally friendly it is. As far as tap holes go, one might think that continuous tapping of an individual tree could harm it. Tap holes in a healthy tree will heal completely in 1-3 years depending on conditions. So it is not harmful to the tree to tap it year after year. There are some guidelines that one must follow however. These are laid out nicely in a tapping manual put out by the abbey in 1996. "One should also spot the old tap marks, the last few will still be visible. One should stay at least 4 inches on the horizon and 6 inches on the vertical away from the old hole. Usually the wood right in the old hole is dead wood and not sap producing." In addition all of the wood used in the cooker at St. Johns is harvested using sound forest management practices, and incidentally it takes about a cord of wood to cook 20-25 gallons of finished syrup. The only possible environmental harm that the operation could have would be erosion associated with operating the tractor and tanker on the sugarbush trails. If done correctly even large scale syrup operations impose basically no impact on the environment. However, care must be taken when using pesticides or preservatives as a part of a syrup operation.

VI. COST/BENEFIT ANALYSIS OF MAPLE SYRUP PRODUCTION AT SAINT JOHNS

In looking at the financial aspects of producing maple syrup at St. Johns, it is difficult to do a complete analysis due the sustainability of the system. However, by estimating man hours for the operation, I do believe that a rough cost/benefit analysis can be completed. The analysis will focus on the syrup season for spring of 2002. Estimates are derived from both St. Johns maple syrup operation as well as information from the Wildwood Ranch which is another small scale syrup producer in the area. For cooking the sap down to finished syrup I will use an estimate of 10 man hours per fifteen gallons of finished syrup. The man hours for collecting the sap to make ten gallons of syrup is estimated at 12. Set up and take down time for any given year is estimated at 64 total man hours. This includes tapping the trees which accounts for about 30 hours, and then getting the shack ready to roll. As far as cutting wood goes, approximately four cord was used this year in the cooker. It is estimated, from personal experience, that it would take about 40 man hours to cut, split, and stack that amount of wood. The total amount of syrup made this year at St. Johns was 117 gallons. This brings our total man hours to 322.4. Wage estimates are taken from the Minnesota Department of Economic Security based on employment data for the year of 2000 under the title of "Farmworkers and Laborers, Crop, Nursery, and Greenhouse." As there is no data for the St. Cloud area, I will use the average hourly wage for the state of Minnesota, which is $9.91. 322.4 multiplied by $9.91 brings us to a total labor cost of $3194.98. In addition, Brother Walter tells me that additional miscellaneous expenses amount to about $100 a year.

This includes things like bottles, labels, gas, etc. So our final cost of the operation come sin at $3294.98.

Now we must look at the possible revenue that could be generated by 117 gallons of pure St. Johns Syrup. Something important to point out here is that it is much more profitable to sell syrup in smaller containers. The folks at Wildwood Ranch tell me that they get about $35-$40 dollars for a whole gallon of syrup. If they sell it by quarts they wind up getting about $44 dollars per gallon. And if they sell it in little 50mL maple leaf shaped glass bottles they can get around $225 a gallon. I am going to assume that St. Johns theoretically would sell their syrup in gallons and quarts and therefore get, on average $40 per gallon of syrup. This year they produced 117 gallons which means they produced roughly $4,680 dollars worth of syrup. This could provide them with net profit of $1385.02. Obviously this financial analysis doesn't take into account things like amortization/depreciation of fixed assets, and it is based on very rough estimates. But in any case, it provides a little insight into just how costly a syrup operation is to run.

VII. CONCLUSION

I think that the most important thing to realize about the syrup production at St. Johns is that it is not done for the money, it is done out of tradition, and interaction with the environment. I think that Brother Walter put it best when he said, "The time that is spent through out the operation is much like any farming operation. If one is to do true accounting as a company would, one would find no sense in doing it. It is done for the love and exercise not to mention the good eating of the pure syrup, which was made here, by us, for us. Much like a person grows their own garden."

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