Agriculture is a major industry in Nepal, providing jobs for over 70% of the population and contributing to 38% of the country's GDP (Pariyar, n.d). Subsistence farming is practiced by most poor to middle class farmers which requires quick returns and only focuses on short term goals, not long term to increase agricultural development (Pariyar, n.d). A study conducted on small farms in Nepal consisting of goats, sheep, buffalo and cattle showed that the production levels of meat and milk were lower than potential levels for those animals. The contributing factor to the low production rates was found to be the nutrition of feed they were consuming, consisting of low digestible forages (Redding et al, 2012). Considering this, to increase production of livestock, better quality feed must be present in livestock diets and this could be prepared with the use of the Econo Roller Mill from Apollo Machines and Products Ltd. For the purpose of this paper, the Econo Roller Mill will be discussed in detail.

Product Information:

Apollo Machines and Products Ltd. is located in Saskatoon, Saskatchewan, Canada where it currently operates and specializes in agriculture manufacturing and processing equipment (Apollo Machines, 2000). Apollo Machines and Products Ltd. can be found on the Internet at www.apollomachinesandproducts.com where a full list of agricultural equipment can be found. Of their many feed-processing units manufactured by Apollo Machines, the Econo Roller Mill should be exported to Nepal to improve quality of feed for animals. The price of the mill is determined by options chosen, for example the size of the motor or diameter of rollers, although the cost of a basic unit is approximately $2425.00 CND. A basic unit consists of rolls 6 inches in width and 8 inches in diameter, one and a half Horsepower motor which requires 110/220 volts, and it

comes with magnets (to catch and prevent metal pieces in feed), motor mount and a stand (Handford, Pers. Comm., 2014). Many features of the Econo Roller mill make this machine attractive to small-scale farmers. The mill is relatively low maintenance and does not require the use of tools, has instant release rolls that allow debris to fall through without having to push it through, offset rollers that allow continuous feeding and prevent grain from sitting on top of rollers, as well as a heavy duty frame and steel shafts (Handford, Pers. Comm., 2014).

How it works:

Grain processing begins once it is placed into the hopper of the Econo Roller mill where two grooved rollers are turning in opposite directions. The grain then descends through the rollers, becoming crushed while passing through. The finished product produced is uniform in size with few dust and small particles present, which is ideal for feeding to livestock such as cattle (Government of Saskatchewan, 2014). There are different settings on the roller mill, which can allow the operator to produce a variety of grain sizes, for example flour can be produced from wheat and other grains when passed through the mill a few times with the adjustment of rollers (Handford, Pers. Comm., 2014). The spoilage of rolled grains is reduced since there is no moisture driven off the grain during processing, as there would be if the grains were heated for other processing (Reuscher, n.d).

Efficiency of machinery is very important to ensure that the inputs required do not out weight the final product, as well the quality and particle size of the feed must be as desired (Reuscher, n.d). There are multiple methods of processing feed; rolling is recommended and can be done with the Econo Roller Mill. It produces crushed and

uniform feed with minimal dust and fine or over sized particles (Nutrition and Management, 2000). Rolling can also be done with the addition of water, called tempering, or can be done after the addition of steam, called steam rolling (Mathison, 1985). In comparison, a machine called a Hammer Mill can be used to process feed which works by operating hammers inside the mill that strike the grain repeatedly until the size of the particle is small enough to fall through screen openings (Nutrition and Management, 2000). Fine particles are often produced, which can lead to acidosis and respiratory problems for the animal during the process of digestion (Mathison, 2008). In Table 1.0 the Hammer Mill and the roller mill are compared and contrasted based on type of feed produced as well as other traits.

Table 1.0- Comparison Between Hammer Mills and Roller Mills

Hammer Mill	Roller Mill
• Rotating hammers that strike material until particle size is small enough to fit through screen A • Used to produce finer grinds, commonly for pelleting or mash feed applications B • Requires high amounts of power A • Variable include screen area/horsepower ratio, screen size, hammer pattern and position, uniform feed distribution B	• Uniform feed A • Little dust and fine particles produced A • Crush grains between rollers turning in opposite directions A • Lower power requirements A • Rollers can be re grooved A • Typically more expensive B • Grain isn't over processed A

Table 1.0- Comparison of two grain processing methods, hammer mill and roller mill. Information obtained from: A- Government of Saskatchewan, 2014 and B- from Reuscher n.d

Benefits:

Surrounding the outside of a grain seed is a protective layer called a hull, which is a barrier to the digestive enzymes and microorganisms in the stomach required to break down the starch in the seed (Mathison, 2008). Starch is the main nutrient in grains and in order for an increase in animal production optimal starch utilization is necessary

(Theurer, 1985). Processing grain is a method used to increase the utilization of feed by making starch more accessible to the animal during digestion (Theurer, 1985). As a result of starch being more accessible, the rate of digestion in the rumen of an animal is slowed down, utilizing the nutrients in the grain (Mathison, 2008).

A study done by Theurer (1985), investigated the effects on different methods of processing grains on performance and effectiveness of feed utilization, finding that feed conversion is in fact improved by 91%. This study also looks into the effectiveness of processing of corn and the digestibility of the grain, showing that feed conversion of the whole kernel and dry rolled kernel had relatively the same conversion average, although starch utilization was improved (Theurer, 1985). The rumen is the major site of starch digestion and from the experiments results they show that increasing the degree of ruminal microbial breakdown of starch is beneficial to the animal for both starch utilization and efficiency of feed utilization. Processing of grains make more area of the grain susceptible to breakdown of starch, therefore increasing the extent of microbial breakdown in the rumen (Theurer. 1985).

In research carried out by Mathison (1996) unprocessed barely had a 16% decrease in the digestibility of the grain and 37% decrease of starch digestion. As a result, rates of gain in cattle were reduced by 5- 50% and the feed required for gains increased by 15% to 100% (Mathison, 1996). Further research is required to explain why bloating and incidences of acidosis are common in cattle fed whole grain, but during this study these were common findings when fed high grain diets (Mathison, 1996).

The effect of processing depends on the type of grain seed. As shown in Table 2.0, corn was observed to have no economical benefit of processing in a study done by

Mathison (1996) but from research by Ferraretto et al. (2013) starch digestibility was observed to improve when particle size of corn was reduced. Oats had no significant results on grain and starch digestibility, as compared to wheat, barely and sorghum where an improvement of digestibility was observed. The Econo Roller Mill produces quality rolled grain in ideal particle size for all livestock, minimal dust particles and would be an perfect product for small-scale farms (Handford, Pers. Comm., 2014).

Figure 2.0- Type of Grain and Effect of Processing

Grain Type	**Effect of Processing**
Wheat [B]	-Starch digestibility 83% when whole, 99% when rolled -54- 68% digestibility when whole
Corn [B]	-Not economically justified to process -Rolling does increase surface area for bacterial attachment or enzyme degradation [C]
Barely [B]	-Whole barely 16% lower digestibility than when processed
Sorghum [A]	-Not easily digested by cattle -Rolling significantly improves digestibility of starch and energy
Oats [A]	-61% digestibility and 69% dry rolled -No benefit to processing

Table 2.0- Data and information obtained from: A- Campling, 1991 and B- Mathison, 1996 and C- Ferraretto, 2013

Exporting Benefits:

Exporting goods has many benefits to Canada including the opportunity for the country to sell their goods and import foreign goods and to stimulate the economy. One of five jobs in Canada is related to exports and such activity produces 60% of the annual economic activity (DFAIT, 2013). By exporting the Econo Roller Mill to other countries, it would benefit not only a Canadian business, but also the country. Apollo is a small Canadian company providing approximately 15 Canadian's jobs and if an increase in

demand of products appeared then it could provide an increase of jobs in the manufacturing and distributing sector of the company (Industry Canada, 2013). Other job opportunities could arise if the Econo Roller mill was exported to developing countries to encourage agricultural development because farmers need to be educated about the machine in order to use it properly. Experts could educate farmers on how to use the machine safely and properly. Benefits to Canada include economic growth from the purchasing of a Canadian product and alternatively, creating a relationship with another country. Trade is an important factor in Canadian economy and exporting the Econo Roller Mill would provide the company and the country with benefits.

Nepal Farming:

Nepal is a landlocked country located in South Asia. It is bordered by China and India as well by the Himalaya, extending from the highest peak in the world called Sagarmatha in Nepal (Pariyar, n.d). The population of the country is approximately 30 million and is expected to continue to grow as it had a growth rate of 2.3% between the years 1991 and 2001(FAO). With an area of 14.7 million hectares, Nepal lies along the slopes of mountains, providing very hilly regions with elevations ranging from 66m to 8848m above sea level.

The country can be divided into regions such as the plains/Terai, hills, and mountains resulting in different methods of farming from region to region as the climate changes with the elevation (Redding et al, 2012). In mountain regions, a transhumance method consists of herds moving seasonally around fixed areas depending on the availability of grazing for the livestock (Redding et al. 2012). Availability of grazing varies drastically depending on the season; in winter minimal fodder is available because

of snow coverage and in April-May animals are expending more energy then they are acquiring which leads to weight lost and hardship (Pariyar, n.d). Lactating and growing animals require an increase of energy; therefore a concentrate is often provided. Soils in the mountain areas are often less fertile and prolong time to maturity, allowing only one crop to be produced annually. Farmers in this area usually have little access to electricity, roads or communication systems (Pariyar, n.d). Isolated areas will likely have to wait longer for electricity to be accessible, although National Association of Community Electricity Users Nepal (NACEUN) has been working to provide the nation with electricity (Rana, 2012). Rual areas that have access to electricity have shown positive results in agriculture, education and other areas (Rana, 2012). The Econo Roller mill would probably not be of a benefit to mountain farmers because in order for the mill to operate electricity is required. Although, it would be a benefit to properly utilize the grain produced since a 5-gallon pail of grain will produce 7.5 gallons on feed, minimizing the input of feed and potentially feeding more concentrated to livestock (Apollo).

An alternative method of farming practiced in Nepal's hill region is sedentary. In this method livestock spend half their day grazing around the villages and then return home each night to be fed crop by-products and occasionally grain (Redding et al. 2012). In the lower belt, winter wheat, rice potatoes and vegetables are common crops as compared to the upper belt where corn, millet, mustard and soybeans are some of the common crops (Pariyar, n.d). There is often competition between each species of livestock in this region because of the high animal and human population in the area, as well land is commonly cultivated resulting in less pasture (Pariyar, n.d). This area would be a ideal for the use of the Econo Roller mill because of the large population of farmers

that could buy the machine together. The cost of the machine would be too expensive for the average farmer to purchase, but by farmers sharing the roller mill, the cost would be lowered and each farm would benefit from the processed feed.

In the Terai regions there is access to a market, allowing agricultural production to provide for 47% of the agriculture GDP of the country. Animals are typically stall-fed forages and crop by-products; as well during the dry seasons animals may also graze on pasture and during the wet season they are fed a combination of rice straw and wheat roughage (Pariyar, n.d). Some upper class farmers are able to afford machinery to replace the task of animal labor allowing production to be much more efficient (Pariyar, n.d). This would be a good opportunity for the Econo Roller mill to improve quality of feed because of the accessibility farms have to a market allowing them to buy grains to process and/or sell their processed grains. As well, there are farmers in the upper class who are purchasing machinery to better their farm, and the Econo Roller mill could be used to increase productivity of livestock with rolled grains.

Nepal farms typically consist of ruminants such as goats that are used for meat and milk, cattle that are used for milk and labor and buffalo that are used for milk and meat (Redding et al. 2012). Other livestock such as sheep, pigs, chickens and ducks are also found on many farms for meat and fiber. Combinations of these animals are kept on farms to provide the farmer and his family with a variety of food products and labor purposes. When livestock consume grains and forages that are high in fibre

During a study of multiple small farms in the low-mid altitude region of Nepal, farmers pointed out that disease was one of the major issues, followed by malnourishment and market access for problems of raising livestock (Redding et al.

2012). Nationwide, about 66% of people that are obtaining a living through agriculture are in poverty, potentially from the decrease of the average farm size from 1.1 hectares in 1995 to 0.7 hectares in 2010 resulting in a lower income (IRIN, 2013).

Agriculture Issues:

Many problems are associated with agriculture and food production in Nepal. Since 1990, the country has been in a food deficit from the low production levels and imports not keeping pace with the rapidly growing population (NAFSCIP, 2010). In order to increase productivity, inputs such as quality feed, health services and technologies are important to be able to supply food for the increasing population (NAFSCIP, 2010). Improved nutrition can significantly increase low production levels possibly caused from poor immune responses and overall health status (Devendra and Leng, 2011). The Econo Roller Mill would be an ideal product for farmers in Nepal because it produces quality rolled feed from any type of grain and it is appropriate for small scale farms like those in Nepal (Apollo, 2000).

Although a poor country, Nepal exports agricultural goods including, vegetable gee, pulses and live animals, as well as ginger, cardamom, and tea. Agricultural imports include cereal grains, vegetables and pulses. Nepal's major trade partner is its neighboring country, India where the border is open between the countries (NAFSCIP, 2010). A potential country that Nepal could import from is Canada, as it has many programs such as the Canadian International Food Security Research Fund (CIFSRF) and International Development and Research Center (IDRC) that encourage trade and research for developing countries to improve agricultural production and food security.

Exporting to Nepal:

Shipping the Econo Roller mill to Nepal could be done by ocean freight from a company called A1 Freight Forwarding out of New Market, Ontario. This company works with international courier companies to provide the best possible rates for customers. When shipping the Econo Roller Mill internationally, the product will be in crates as well they will be placed in shipping containers when on ocean freight. The dimensions of the roller mill are 20 inches wide, 40 inches front to back and 34 inches tall which would allow approximately 20 machines to fit into a large shipping container that is 40 feet x 8 feet x 8 feet 6 inches. The total weight of 20 machines would be approximately 5500 pounds, costing around $3835.66 CDN to ship by ocean freight (A1 Freight Forwarding). This is the price it would cost from Saskatoon, Saskatchewan to New Delhi, India, which from then the products would have to be shipped approximately 1057km most likely by truck which would cost an additional $3465.26-$3830.03 with the possible additional costs of duties and taxes (World Freight Rates). The total cost for shipping 20 units to Nepal may seem unattainable for farmers but when put into perspective of distance travelled and quantity of units it is not so unrealistic.

When comparing the Econo Roller mill with products on Alibaba.com, there were many different products similar to the roller mill. Table 3.0 compares some comparable products to the Econo Roller Mill from China and/or India. Some similar companies to Apollo Machines and Products Ltd. in Canada that produce agricultural processing equipment are Brandt Agricultural Products (Regina, SK), Buhler Industries Inc. (Winnipeg, MB), and Master Industries Inc. (Loreburn, SK) and many others (agric.gov.ca).

Table 3.0- Comparing Similar Products

Brand Name	Cost (US $)	Place of Origin	Weight	Voltage Required
DingSheng	$599- $1999	China	40kg	220V
WHIR	$600- $900	China	40kg	220V
JUNLAN	$1050	China	160kg	220V
Hongle	$300- $800	China	50kg	220- 380V

Table 3.0- Products similar to the Econo Roller Mill from Apollo Machines. All Information from www.Alibaba.com

Overall, the Econo Roller mill would benefit Nepalese farmers greatly by producing rolled grains for livestock and increasing starch and grain digestion. Barriers to exporting this product would be price and the requirement of electricity. Nepal is a poor country and most farmers that would benefit from this product may not be able to afford it. If farmers in Nepal were to purchase 20 machines, the cost of each would likely be lower due to the number of machines bought. The owner of Apollo would make the ultimate decision of where and how much of a price break would occur (Handford, Pers. Comm., 2014). Electricity is also an issue because of the limited access to electricity for farmers in rural areas (Rana, 2012). This product is perfect for small-scale farmers, especially in Nepal who need to increase productivity of animals to ensure enough food.

Exporting Econo Roller Mill to Improve Feed Quality in Nepal

Nicole Langdon

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