

Promoting Canadian Agrifood Exports to Nepal: Prepodyne GEN

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**Introduction:**

Agriculture is an essential industry worldwide as people need to have food available in order to survive. In Canada only 2% of the population produces the food that is consumed throughout the country (Statistics Canada, 2008). In developing nations subsistence agriculture where people must produce their own food is more common. In order for people in developing nations to continue to provide for themselves, and ultimately be able to produce a surplus to sell, they must be provided with affordable technologies that can help to increase their yields.


The purpose of this paper is to evaluate the potential of exporting a general antiseptic from Canada to Nepal in order to aid in Nepal's agricultural sector. This report will evaluate the advantages and disadvantages of exporting this product for both nations and then use this information to conclude whether or not this is a viable product. The report will include a description of the product followed by an evaluation of its export potential especially pertaining to Nepal. This product will also be compared to other similar products found around the world. The information provided will then be analyzed to provide recommendations as to whether or not this idea should be pursued in Nepal or other similar nations.

**Section I (Product Information):**

Prepodyne GEN is a general antiseptic solution that was developed for use in the agricultural sector. This product can safely be used for a wide variety of applications including disinfecting surfaces and cleaning wounds to prevent infection. It is a stable solution with a very low toxicity that can be used directly on skin or surfaces. An advantage that has made Prepodyne and similar products popular in the medical industry is its orange colour which is visible upon application but can be removed without staining by rinsing with water. Also, it is completely water soluble so it can be diluted for easy cleanup (M. Petrucci, personal communication, October 13 2015; West Penetone, 2015b).

**History of Prepodyne GEN and like Products:**

Prepodyne GEN is a Canadian product manufactured and shipped out of West Penetone's headquarters in Montreal, Quebec (see contact information figure 1). This product is a solution of polyvinylpyrrolidone (PVP or povidone) and iodine powder (M. Petrucci, personal communication, October 13 2015; West Penetone, 2015b). The antibacterial properties of this



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*Figure 1: Contact information for West Penetone, the Canadian producer of Prepodyne GEN (West Penetone, 2015a)*

solution have been known since the mid-1950's and have been seen in natural home remedies for centuries (Shelanski, 1956). However, Prepodyne GEN is the only povidone-iodine solution manufactured in Canada.

### How Prepodyne GEN Works:

The effectiveness of Prepodyne and other iodine based antiseptics are due to their unique chemical structure. All iodine based disinfectants have one important similarity, the presence of free iodine molecules. These products are made up of triiodide ions and stabilizers or carriers which hold the iodine molecules with bonds that are relatively easy to break (Block, 2001). In Prepodyne GEN the carrier that is utilized is PVP as seen in figure 2. The relationship between the amount of free iodine in the system and the amount of bonded iodine is dependent on the concentration of the solution and determines the effectiveness of the solution as a disinfectant (Block, 2001).

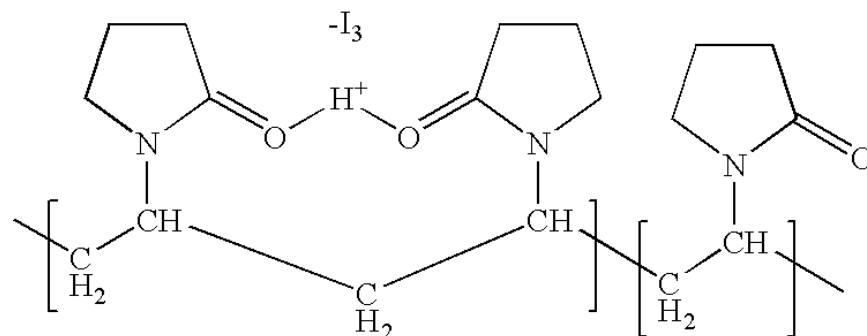


Figure 2: Chemical structure of povidone-iodine, the active ingredient in Prepodyne GEN (Samson, Liang, & Capriotti, 2013)

The free iodine molecules act as a poison and infect the nucleic acids and proteins of the invading bacteria. This kills the bacteria so that they cannot infect the host organism. In order to maximize these disinfecting properties, the solution must contain the optimal concentration of free iodine which is obtained through careful dilutions. If the product's concentration either increased or decreased then the free iodine availability and the disinfecting properties will decrease (Block, 2001).

### **Production and Cost Analysis:**

The costs of production for Prepodyne GEN depends on the method used to make the povidone-iodine complex. There are several different methods in use today. One method involves mixing PVP directly with iodine which requires a long period of mixing followed by a 1 to 3 month resting period in order for the compounds to reach a stable equilibrium. Other methods of preparing the solution require the addition of a polar solvent and then the heating of the mixture. The result is a product that reaches stability within a few days (Sackler et al., 1990). All of the methods used have their advantages and disadvantages which in turn affect the cost.

West Penetone distributes Prepodyne GEN in one of two sizes, either cases of 4 - 4L bottles, or 12 – 1L bottles. The original price per case was estimated at \$172.24 for either bottle size, but has since been reduced to \$115.20 for a case of 4L bottles and \$125.40 for a case of 1L bottles (M. Petrucci, personal communication, October 13 2015).

### **Methods of Use:**

Prepodyne GEN is a versatile product that can be used for a variety of purposes. Prepodyne has been shown to be effective at killing bacteria associated with mastitis in milk producing animals, common bacterial strains that infect open wounds during healing, and the cryptosporidium bacteria that causes diarrhea (Gershenfeld, 1957; Wilson & Margolin, 1999; Yousaf, Muhammed, Bilal & Firyal, 2012). An experiment performed by Gershenfeld in Philadelphia (1957) showed that in a 1:1 solution with the test bacteria the povidone-iodine solution killed the bacteria within 15 seconds. In more recent studies povidone-iodine based scrubs like Prepodyne GEN have been compared to other common antiseptics that are widely used in hospitals. The results as seen in table 1 showed that the povidone-iodine product was

effective at destroying the most diluted sample at all observed time intervals, and tied with Glutaraldehyde after 90 min for the most concentrated *Cryptosporidium* oocysts (Wilson & Margolin, 1999).

Table 1: Performance of povidone-iodine as compared to two other common hospital antiseptics for killing *Cryptosporidium* bacteria on surfaces and tools based on the excystation percentage of bacteria when treated with the disinfectants vs. the control sample.

		Oocysts Dilution					
		1.5x10 <sup>6</sup>		1.5x10 <sup>5</sup>		1.5x10 <sup>4</sup>	
		Treated	Control	Treated	Control	Treated	Control
Povidone-Iodine (10%)	10 min	41 %	88 %	37 %	88 %	17 %	88 %
	90 min	28 %	88 %	25 %	88 %	6 %	88 %
	10 hours	18 %	88 %	5 %	89 %	4 %	88 %
Phenol (10%)	10 min	77 %	88 %	69 %	85 %	59 %	88 %
	90 min	82 %	89 %	79 %	91 %	63 %	88 %
	10 hours	78 %	88 %	74 %	90 %	69 %	88 %
Glutaraldehyde (2.5%)	10 min	51 %	88 %	28 %	86 %	4 %	86 %
	90 min	28 %	89 %	16 %	86 %	6 %	87 %
	10 hours	22 %	86 %	8 %	88 %	-	86 %
% = The most effective treatment for a specific test period and oocysts dilution							
Table compiled by Kineta Cousins with data retrieved from (Wilson, & Margolin, 1999)							

Prepodyne GEN can be applied directly or as a diluted solution. For optimal performance the area to which the solution is being applied should be thoroughly wetted before application to ensure total coverage. Application can either be done directly from the bottle or with a damp rag or sponge (Block, 2001). These methods should be used when cleaning wounds or tools where the ultimate disinfecting effect needs to be achieved. Another method of application involves diluting the product to increase coverage. As previously discussed, dilution of the product will reduce its efficiency but the product is still effective for certain purposes. Dilution would be suitable for application to large areas such as with a topical rash or in handwashing (Block, 2001; West Penetone, 2015b). Diluting the product and placing it in a spray bottle would also be an effective way to disinfect an injury while flushing out debris. With any of the application

methods only a few drops of product are required to kill bacteria and other pathogens (P. Stewart, personal communication, October 16 2015).

**Safety Precautions:**

Prepodyne is a stable compound that is safe for external use. The product does not have any known danger however adequate research has not been performed to prove this. It has been advised that the product should only be used externally. If contact with eyes occurs, the eyes should be flushed with water. If the product is ingested, then a large quantity of water is to be consumed and medical attention should be sought out (West Penetone, 2015).

**Intellectual Property Restrictions:**

There are no specific regulations or patent constraints concerning the formulation of compounds in Prepodyne GEN. The active ingredient povidone-iodine was originally patented in 1955 for use as a disinfectant but is now widely used in a variety of antibacterial products (Shelanski, 1956). Maria Petrucci of West Penetone commented that they possess all the necessary licencing needed in order to export this product (personal communication, October 13 2015).

**Current Market:**

Currently in Canada Prepodyne GEN is sold by Greenhawk Harness and Equestrian, a chain of tack stores. The product is marketed to horse owners and stable operators as an addition to their first aid kits. It is suggested as a go to product for cleaning wounds to prevent infection, as well as a way to treat cuts and rashes that have been infected. Prepodyne GEN retails at \$22.99 for a 1L bottle (Greenhawk Harness and Equestrian, 2013).

**Canadian Benefits:**



The Canadian benefits of exporting Prepodyne GEN will be relatively small. The majority of the inputs for the production of this product are sourced from overseas and the production is highly mechanized (P. Stewart, personal communication, October 16 2015; Kaiho 2008). The production of Prepodyne would not require an increase in labour. In Canada the main benefit will be to the Canadian economy. With more money being generated, West Penetone could help to support new innovative research in the sanitation sector.

The transportation industry in Canada will benefit from the export of Prepodyne. In order to export this product it must be transported to an international seaport from which it can be exported (A1 Freight, 2015a). This will require both an increase in manual labor to move the product and administrative guidance. West Penetone does not currently export this product so a person who is experienced in the logistics and legislation of exporting would be required (M. Petrucci, personal communication, October 13 2015).

With increased production there would also be an increased need for inputs which are sourced from abroad requiring further transportation increases. Currently, 90% of the world's iodine is produced in Chili and Japan either by extraction from natural gas, or through mining caliche deposits (Kaiho, 2008). The purified iodine would then need to be transported to Canada for use in Prepodyne GEN production.

## **Section II (Export Potential to Nepal):**

### **Introduction to Nepal:**

Nepal is a small landlocked country approximately one-seventh the size of Ontario located in South-East Asia between China and India. Nepal is divided up into 3 agro-ecological regions (figure 3): the mountains in the North, hills in the mid-region, and the Terai plains in the South (United Nations Data Retrieval System, 2015). The environmental conditions of the different regions allow different crops and livestock to thrive. Throughout Nepal 3 out of 4 households own livestock (Food and Agriculture Association of the United Nations, 2005). These animals are used for food and for draft purposes. The most common animals are large ruminants consisting of cows and water buffaloes. Other livestock such as chickens, pigs, goats and yaks are also widely kept. The main uses of the cows and the water buffalo is for milk and manure production. Water buffalo are also eaten whereas cows, the national animal of Nepal, are not (Kathmandu University, n.d.).

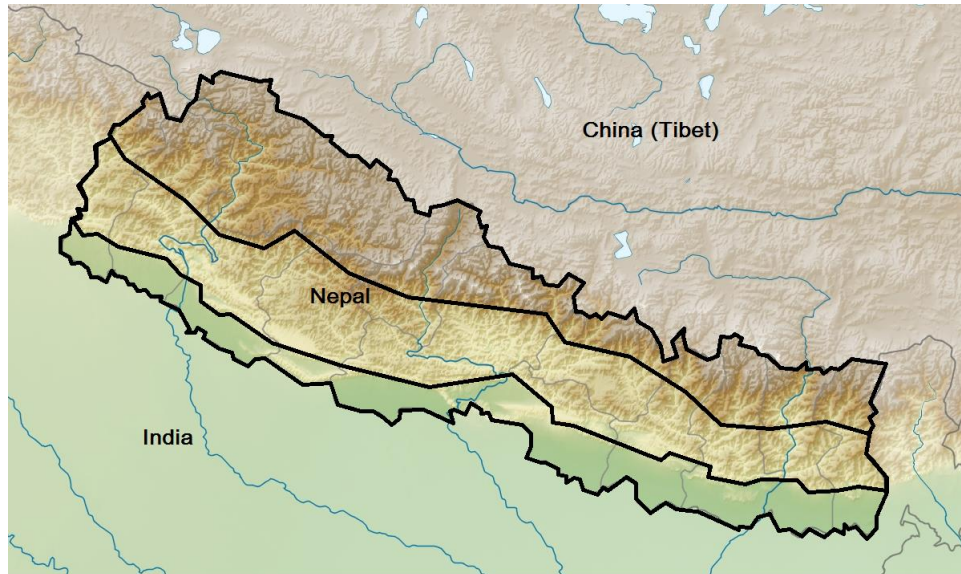


Figure 3: Map of the agro-ecological regions of Nepal (Dedering, n.d.)

### Uses and Benefits for Nepal:

Prepodyne GEN is a versatile product which could help improve sanitation in Nepal's agricultural sector and other sectors. This antibacterial agent can be applied to a variety of surfaces to kill harmful pathogens as well as help treat bacterial infections. Prepodyne and other povidone-iodine based products have been found to be effective at killing cryptosporidium parasites which cause diarrhea, bacteria associated with avian influenza H5N1, bacteria which have been known to cause mastitis, and bacteria which infect open wounds (Gershenfeld, 1957; Ito et al., 2006; Wilson & Margolin, 1999; Yousaf et al., 2012).

In Nepal, cryptosporidium has been found to be among the top 3 causes of diarrhea. This parasite can cause symptoms that last up to 2 weeks and can result in death, in severe cases (Sherchand & Shrestha, 1996). Diarrhea is detrimental to farmers who become unable to work, especially if they are unable to seek medical attention. In a study by Sherchand and Shrestha, 20% of the fecal samples collected in Nepal contained traces of this pathogen (1996). Although

the transmission of cryptosporidium has not been directly linked between livestock and humans, it is prevalent in areas where livestock are kept due to lack of sanitation (Sherchand & Shrestha, 1996). By using Prepodyne GEN to disinfect tools that are used around the farm, and to wash hands before eating, the Nepalese can reduce the spread of the pathogen.

Washing tools with Prepodyne GEN is also an effective way to reduce the spread of infections among livestock. If a farmer found an animal suffering from an infection, they could use Prepodyne GEN to help treat the infection. Common surfaces that the animal has come in contact with could also be treated to reduce the chances of the pathogen spreading. Using Prepodyne has been found to be effective in reducing the spread of H5N1 in meat birds and mastitis in cows (Ito et al., 2006; Yousaf et al., 2012). Mastitis is a major issue in Nepal affecting almost half of the milk producing animals in the country, shown in table 2 (Subedi & Dhakal, 2002). This significantly decreases the yield of the animals which results in the difference between the farmer being able to sell milk for money and hardly having enough milk to feed his own family. A study at the University of Agriculture in Pakistan found that 5 days of treatment with povidone-iodine cured 46.6% of cases of bubaline mastitis in water buffalo (Yousaf et al., 2012). By disinfecting the tools used during milking and disinfecting the animal's teats the Nepalese could decrease the prevalence of mastitis and increase yields.

*Table 2: Prevalence of clinical mastitis in large milking ruminants in a study from Chitwan, Nepal.*

	Cattle	Buffalo
Number of animals tested	250	212
Percent of animals positive for clinical mastitis	56%	44%
Number of quarters tested	620	493
Percent of quarters positive for clinical mastitis	35%	27%
Most common breed to test positive for clinical mastitis	Holstein Friesian cross (65% positive)	Local buffalo (52% positive)
Table made by Kineta Cousins with data retrieved from (Subedi, & Dhakal, 2002)		

The last use of Prepodyne GEN highlighted is as a way to prevent or treat infections of open wounds. The solution can be applied directly to an open wound to kill any pathogens that may infect the wound. This can be done when cleaning and flushing wounds. Using povidone-iodine based products has been shown to initially slow healing, however normal healing rates are reached again within 72 hours (Goldenheim, 1993). It has also been shown to greatly reduce the chances of infection and treat wounds that have become infected (Gershenfeld, 1957). This is similar to Prepodyne's use in treating mastitis. It is important to note that this product can be used for these purposes both on livestock and humans.

The overall benefits of Prepodyne GEN to Nepal are to reduce infections both in livestock and humans which will result in an increase in productivity. By using Prepodyne GEN both as a preventative measure and as a treatment, livestock would become more productive increasing profitability for farmers. If the farmers do not have to spend time and money on unproductive animals then they can use their money to better help themselves and their families.

**Negative Impacts for Nepal:**

The use of Prepodyne GEN or another povidone-iodine based product will not result in any known negative impacts for Nepal. Iodine based scrubs have been widely used in the medical sector for years and only positive benefits have been found to date. Scrubs similar to Prepodyne GEN are used in hospitals to disinfect surfaces and equipment used in surgery and general practice (P. Stewart, personal communication, October 16 2015). This solution and its components are very stable and non-irritant. Due to the stable coat it forms, and its high solubility, PVP is found in a wide variety of products including medication, injections and hair products (Haaf, Sanner, & Straub, 1985). There is no significant concern associated with iodine or iodine based products (Kaiho, 2008). Also, since Prepodyne is a product designed to help

solve an issue in Nepal that is not currently being widely addressed, it will not have a negative economic impact.

**Transportation and Storage:**

According to Maria Petrucci of West Penetone (personal communication, October 13 2015), Prepodyne is a very stable compound and does not fall under any legislation that would restrict its transportation. She also noted that currently the product is shipped by land transport as their company does not possess the necessary licencing to ship commercial goods by air. Since

<b>AIR FREIGHT RATE</b>	<b>3.40 \$ CAD / KG ALL IN</b>
<b>ACTUAL WEIGHT</b>	<b>900.00 KG</b>
<b>VOLUME WEIGHT</b>	<b>375.79 KG</b>
<b>CHARGEABLE WEIGHT</b>	<b>900.00 KG</b>
<b>AIR FREIGHT</b>	<b>3060.00</b>
<b>TERMINAL &amp; SCREENING FEE</b>	<b>225.00</b>
<b>PROCESSING FEE</b>	<b>75.00</b>
<b>SURCHARGES</b>	<b>0.00</b>
<b>TOTAL:</b>	<b>3360.00 \$ CAD</b>

the cost of air freight would amount to \$3,360.00 CAD per pallet (figure 4), and only \$631.21 USD (approximately \$845.00 CAD based on the exchange rate as of November 27, 2015) for land and sea freight (figure 5), land and sea would be the more cost effective method of transportation (A1 Freight, 2015a, 2015b). The route for transportation involves shipping cases of Prepodyne GEN by sea from Montreal, Canada to a commercial seaport in India. From India the product can be loaded into a truck and shipped over land to Nepal’s capital city, Kathmandu, from which it can be distributed to local retailers (A1 Freight, 2015a). The route is also detailed in figure 6.

Figure 4: Shipping quote for one pallet (approximately 864 1L bottles) from Montreal to Kathmandu, Nepal by air (AI Freight, 2015b)

Figure 5: Shipping quote for one pallet (aproximately 864 1L bottles) from Montreal to Kathmandu, Nepal by land and sea (AI Freight, 2015a).



Figure 6: Map of Transport route for Prepoddyne GEN from Canada to Nepal (Outline world maps, 2015).

Another important part of transportation in ensuring that the product is stored in a safe environment throughout the process. West Penetone suggests that Prepoddyne GEN be stored at room temperature. The majority of the product by volume is water. It is important that the product not be exposed to temperatures below 0°C as it would freeze and come out of solution. Since the product is iodine-based it is important not to expose it to heat over 80°C as this could cause the release of potentially harmful gasses (West Penetone, 2015b). Shipping this product as

previously described would not result in the exposure to any of these conditions. Since the average temperature in Nepal ranges from 3-16°C in the North (Climate Data.org, 2015a) to 10-24°C in the South (Climate Data.org, 2015b) storing Prepodyne GEN out of direct sunlight would be adequate.

When importing and exporting goods, countries require that a certain percentage of tax known as a tariff be payed, and that shipping documents must be filed. Prepodyne GEN is an antibacterial scrub and therefore falls under the customs chapter 3401.20.90.10 which is for soaps, washing preparations, and waxes etc (Canada Border Services Agency, 2015). In Canada this section of goods is subject to tariffs of 6.5% where as in Nepal the tariffs are 40% (Canada Border Services Agency, 2015; Government of Nepal Ministry of Finance, 2015). In order to export the product from Canada, the exporter must file an export declaration and pay the corresponding fees 48 hours prior to loading (Canada Border Services Agency, 2014). Similar costs and documentation are also required by the importing nation.

**Cost Analysis to Achieve Profitability:**

Prepodyne GEN is high cost product for the Nepalese but the potential benefits outweigh the price. The most cost effective way to provide the people of Nepal with this product would be to sell the 4L bottles and then allow the people to distribute the product amongst themselves. As seen in tables 3 and 4, the cost per liter of Prepodyne including shipping and tariffs is \$4.77 CAD cheaper if the product is sold in the 4L bottles as opposed to 1L bottles. The cost of shipping documentation would also need to be added to the total price but would be minimal if an entire pallet (216 – 4L bottles) was exported. Assuming that the retailer would then increase the price to allow for a minimum of a 20% margin, the cost of one 4L bottle would be \$55.32 CAD. In Nepal the gross national income per capita was \$657.00 USD (approximately \$878.80 CAD) in



2013 which was a significant increase from \$327.40 USD (approximately \$437.88 CAD) in 2005 (United Nations Data Retrieval System, 2015). Since the income of individual farmers is likely lower than the national average it would be important to promote the sharing and distribution of Prepodyne GEN within a community in order to make it more affordable.

Table 3: Estimated cost of Prepodyne GEN in 1L bottles shipped from Canada to Nepal

	Percentage	Bottle (1 L)	Case (12 Bottles)	Pallet (864 Bottles)
Unit Cost (M. Petrucci, personal communication, October 27 2015)		\$ 10.45	\$ 125.40	\$ 9028.80
Tariffs: Canadian (Canada Border Services Agency, 2015)	6.5%	\$ 0.68	\$ 8.15	\$ 586.87
Tariffs: Nepalese (Government of Nepal Ministry of Finance, 2015)	40%	\$ 4.18	\$ 50.16	\$ 3611.52
Transportation (A1 Freight, 2015a)		\$ 0.98	\$ 11.73	\$ 844.21
Total*		\$ 16.29	\$ 195.44	\$ 14071.40
*Cost of necessary export documentation not included				

Table 4: Estimated cost of Prepodyne GEN in 4L bottles shipped from Canada to Nepal

	Percentage	(Per L)	Bottle (4 L)	Case (4 Bottles)	Pallet (216 Bottles)
Unit Cost (M. Petrucci, personal communication, October 27 2015)		\$ 7.20	\$ 28.80	\$ 115.20	\$ 6220.80
Tariffs: Canadian (Canada Border Services Agency, 2015)	6.5%	\$ 0.47	\$ 1.87	\$ 7.49	\$ 404.35
Tariffs: Nepalese (Government of Nepal Ministry of Finance, 2015)	40%	\$ 2.88	\$ 11.52	\$ 46.08	\$ 2488.32
Transportation (A1 Freight, 2015a)		\$ 0.73	\$ 2.92	\$ 11.69	\$ 844.21
Total*		\$ 11.52	\$ 46.10	\$ 184.40	\$ 9957.68
*Cost of necessary export documentation not included					

### Marketing strategy:

Marketing Prepodyne GEN effectively in Nepal is important to ensure that the Nepalese people will see the potential benefits and consider purchasing it even with its high cost. An effective way to market this product would be through the use of picture books and word of

mouth. Picture books are important in conveying these ideas as the majority of the Nepalese people are illiterate (United Nations Data Retrieval System, 2015). These picture books could then be distributed to communities both as an advertisement and a user manual to show the many applications of Prepodyne. Once the people of Nepal see the benefits of this product they will then be able share the knowledge with their neighbours.

In order to establish a market for Prepodyne GEN it is important to start with a small test market. One way to establish this market would be to give out 200mL samples to farmers throughout a variety of villages. If 4 - 4L bottles were exported initially for this purpose it would allow for 80 samples to be distributed at a loss of under \$200 CAD to the importer (estimated from table 4). This cost would be recoverable through future sales. Since only a few drops of the product are necessary for application, the initial farmer could even sell part of his sample. Once the Nepalese farmers become familiar with using this product and its benefits they can then look at buying a bottle for their community to share.

In Nepal there are more than 2 million households that own cattle and many more owning other types of livestock (Food and Agriculture Association of the United Nations, 2005). If only one percent of these people were interested in buying Prepodyne GEN that would be over 20,000 potential customers. Assuming that the average customer would be interested in buying 200mL of the product, which would cost them approximately \$2.80 CAD, this would result in the sale of 1000 - 4L bottles or about 4.5 pallets.

### **Global Competition:**

Throughout the world there are numerous povidone-iodine products similar to Prepodyne GEN for sale under a variety of brands. These disinfecting agents come in many forms. The active ingredient is a 10% solution of povidone-iodine in ointments, creams and solution or a

99% composition in powders. These products are often distributed under the brand name Betadine. This wide array of products range in price and in quantity. Povidone-iodine powder costs \$10-30 USD/Kg from China and can be bought in containers as small as 100g up to bags weighing several kilograms. The solutions cost approximately \$10-20 USD/L and are available in bottles ranging in size from 200mL to 4L (Alibaba, 2015; HUAFU Chemical, 2013). For the purpose of exporting a povidone-iodine product to Nepal, using a Chinese company's product would likely be more economical.

### **Recommendations:**

In order to move forward with this idea, there are still some items that need to be addressed. These items include the establishment of a system for sharing the product, quantifying additional shipping and distribution costs, and the researching of environmental concerns associated with the product's use. The unit cost of \$2.80 CAD for 200mL of product is economical for many Nepalese farmers but a system needs to be in place to subdivide the product into these smaller containers. A Canadian company could export reusable plastic bottles that the product could be placed in. Since only a small quantity of Prepoddyne is needed for application, the bottles could be outfitted with a lid that only allows for a small flow. To ensure that this product remains at an affordable price for the consumer, the distribution costs would also have to be addressed. The projected costs for transportation that were provided did not include distribution outside of Kathmandu. As the Nepalese would likely be applying the product in a venue without waste removal, environmental impacts due to the leaching of the used product into the ground would also have to be assessed.

### **Conclusions:**

In conclusion, Prepodyne GEN and other povidone-iodine based disinfectants would be an effective way to help farmers increase productivity. In many developing nations like Nepal, sanitation is a major issue leading to economic losses. A versatile and affordable product like Prepodyne will be instrumental in helping subsistent farmers increase their yields. This would lead to other benefits such as a surplus of products that could be sold. The farmers could then use any money generated to help improve other sections of their farm, or pay to send girls to school.

**Reference:**

A1 Freight. (October 15, 2015a). *Ocean freight lcl quote*. Retrieved from: <http://www.a1freightforwarding.com/quote/booking.php?quoteID=147087&CargoType=Commercial%20cargo>

A1 Freight. (November 27, 2015b). *Air freight quote*. Retrieved from: <http://www.a1freightforwarding.com/quote/booking.php?quoteID=154443&CargoType=Commercial%20cargo>

Alibaba. (2015). Povidone Iodine. Retrieved from: [http://www.alibaba.com/trade/search?fsb=y&IndexArea=product\\_en&CatId=&SearchText=povidone+iodine](http://www.alibaba.com/trade/search?fsb=y&IndexArea=product_en&CatId=&SearchText=povidone+iodine)

Block, S. (Eds.) (2001). *Disinfection, sterilization and preservation* (5<sup>th</sup> ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Canada Boarder Services Agency. (2015). *Chapter by chapter customs tariffs T2015-2* [Data file]. Retrieved from: <http://www.cbsa-asfc.gc.ca/trade-commerce/tariff-tarif/2015/html/tblmod-2-eng.html>

Canada Border Services Agency. (2014). *Step-by-step guide to exporting commercial goods from Canada*. Retrieved from: <http://www.cbsa-asfc.gc.ca/export/guide-eng.html>

- Climate Data.org (2015a) *Simikot* [data file]. Retrieved from: <http://en.climate-data.org/location/799258/>
- Climate Data.org (2015b) *Kathmandu* [data file]. Retrieved from: <http://en.climate-data.org/location/1137/>
- Dedering, W. (n.d.) [graphic illustration map of Nepal] *Nepal*. Retrieved from: [https://de.wikipedia.org/wiki/Benutzer:Uwe\\_Dedering#/media/File:Nepal\\_relief\\_location\\_map.jpg](https://de.wikipedia.org/wiki/Benutzer:Uwe_Dedering#/media/File:Nepal_relief_location_map.jpg)
- Food and Agriculture Association of the United Nations. (2005). *Livestock sector brief*. Retrieved from: [http://www.fao.org/search/en/?cx=018170620143701104933%3Aqq82jsfba7w&q=livestock+nepal&cof=FORID%3A9&siteurl=www.fao.org%2Fag%2Fportal%2Findex\\_en%2Fen%2F&ref=&ss=8785j8336569j17&x=0&y=0](http://www.fao.org/search/en/?cx=018170620143701104933%3Aqq82jsfba7w&q=livestock+nepal&cof=FORID%3A9&siteurl=www.fao.org%2Fag%2Fportal%2Findex_en%2Fen%2F&ref=&ss=8785j8336569j17&x=0&y=0)
- Gershenfeld, L. (1957). *Povidone-iodine as a topical antiseptic*. *American Journal of Surgery*, 99, 938-939. doi: 10.1016/0002-9610(57)90086-7
- Goldenheim, P. (1993). *An appraisal of povidone-iodine and wound healing*. *Postgrad Medical Journal*, 69. Retrieved from: <http://www.ncbi.nlm.nih.gov/pubmed/8290466>
- Government of Nepal Ministry of Finance. (2015). *Custom tariffs 2015/2016* [Data file]. Retrieved from: <http://www.customs.gov.np/en/tariff.html>
- Greenhawk Harness and Equestrian. (2013). *Prepodyne General 1L*. Retrieved from: <http://greenhawk.com/wdItemDesc.asp?strilhID=web&strmdNumber=MEO8779&stricSKU=MEO8779>
- Haaf, F., Sanner, A., & Straub, F. (1985). *Polymers of n-vinylpyrrolidone: synthesis, characterization and uses*. *Polymer Journal*, 17, 143-152. doi: 10.1295/polymj.17.143
- HUAFU Chemical. (2013). *Analysis of the domestic production of polyvinylpyrrolidone*. Retrieved from: <http://www.polyvinylpyrrolidone.com.cn/news-2.html>
- Ito, H., Ito, T., Hikida, M., Yashiro, J., Otsuka, A., Kida, H., & Otsuki, K. (2006). *Outbreak of highly pathogenic avian influenza in Japan and anti-influenza virus activity of povidone-iodine products*. *Dermatology*, 212, 115-118. doi: 10.1159/000089210
- Kaiho, T. (2008). *Industrial production and applications of iodine*. Retrieved from: [http://ign.org/newsletter/idd\\_nl\\_feb08\\_iodine\\_production.pdf](http://ign.org/newsletter/idd_nl_feb08_iodine_production.pdf)
- Kathmandu University. (n.d.). *Livestock farming*. Retrieved from: <http://sasecrtn.ku.edu.np/index.php/en/resources/usefulinfo/how-to-grow-harvest-food-cash-crops/livestock-farming>

Outline World Maps. (2015). [graphic illustration of world map with country borders] *Political world map*. Retrieved from: <http://www.outline-world-map.com/political-world-maps>

Sackler, M., Miller, R., Pinter, E., Rackur, H., Sackler, R.R., Sackler, R.S., & Halpern, A. (1990). *United States patent no. US4954351*. Luxembourg: United States Patent Office.

Samson, C.M., Liang, B., & Capriotti, J.A. (2013). [graphical illustration structure of povidone-iodine] *United States patent no. US8562963 B2*. United States Patent Office.

Shelanski, H. (1956). *United States patent no. US2739922*. Philadelphia, United States: United States Patent Office.

Sherchand, J., & Shrestha, M. (1996). *Prevalence of cryptosporidium infection and diarrhea in Nepal*. *Journal of Diarrheal Disease Research*, 14. Retrieved from: [http://www.jstor.org/stable/23498441?seq=1#page\\_scan\\_tab\\_contents](http://www.jstor.org/stable/23498441?seq=1#page_scan_tab_contents)

Statistics Canada. (2008). *Farm population and total population by rural and urban population, by province, 2001 and 2006 census of agriculture and census of population* [data file]. Retrieved from: <http://www.statcan.gc.ca/tables-tableaux/sum-som/101/cst01/agrc42a-eng.htm>

Subedi, K., & Dhakal, I.P. (2002). *Clinical mastitis in different breeds of cattle and buffaloes at Chitwan Nepal*. *Journal of the Institute of Agriculture and Animal Science*, 23. Retrieved from: <http://www.nepjol.info/index.php/JIAAS/article/view/744>

United Nations Data Retrieval System. (2015). *Nepal*. [data file]. Retrieved from: <http://data.un.org/CountryProfile.aspx?crName=Nepal>

West Penetone. (2015a). [graphic illustration of contact information] *Contact us*. Retrieved from: <http://westpenetone.com/en/contact-us/>

West Penetone. (2015b). *MSDS: Prepodyne GEN MSDS EN*. Montreal, QC

Wilson, J., & Margolin, A. (1999). *The efficacy of three common hospital liquid germicides to inactivate cryptosporidium parvum oocysts*. *Hospital Infection*, 42(3), 231-237. doi: 10.1053/jhin.1999.0553

Yousaf, M., Muhammed, G., Bilal, M., & Firyal, S. (2012). *Evaluation of non-antibiotics alone and in combination with cephadrine in the cure rates of clinical bubaline mastitis*. *Journal of Animal and Plant Sciences*, 22. Retrieved from: <http://www.cabdirect.org.subzero.lib.uoguelph.ca/search.html;jsessionid=F54F89387EDF9D54D582FA99CC09C4FA?it=any&q2=1018-7081&q1=Evaluation+of+non-antibiotics+alone+and+in+combination+with+cephadrine+in+the+cure+rates+in+clinical+bubaline+mastitis.+&la=any&occurring1=title&rowId=1&rowId=2&show=all&options1=AND&options2=AND&occurring2=sn>