

Protect-It®, an insecticide to protect Nepal's stored grains

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Part I: Product Information

A product that has the potential to better Nepal's agricultural sector as well as the Canadian economy is a powdered insecticide to help decrease the amount of pest infestation in stored grains. This specific insecticide is very efficient, cost effective, non toxic, and has many benefits that makes this product the better choice when compared to pesticides (Hedley Technologies, 2014a). By reducing the pest infestation in stored grains, Nepalese farmers can increase yield and the overall quality of their grains, bringing in more profit and excess product for their families.

Details about the product

Protect-It® is a product that consists of diatomaceous earth and silica gel (Hedley Technologies, 2014a). Protect-It® absorbs the waxy layer from the exterior of an insect, causing desiccation, a physical method of protection against insect infestation which does not require chemicals (Hedley Technologies, 2014a). A research study done at the Cereal Research Centre, Agriculture and Agri-Food Canada, in Winnipeg, Manitoba, states that inert dusts are effective as they have the ability to damage the cuticle of an insect, causing death by desiccation (Ebeling W, 1971). As insects maneuver themselves around grain, the silicon-dioxide-based dusts absorb the cuticle waxes of the insect (Ebeling W, 1971). Insects are unable to survive when they have lost about 60% of their water or 30% of their body weight, therefore, the lower the humidity, the higher the efficacy of pesticides containing silica (Ebeling W, 1971). Various insects have different levels of sensitivity to inert dusts and the type of grain being treated also affects efficacy of the product (Ebeling W, 1971).

Table 1: The lethal dose for 50% and 90% of the population (LD50 and LD90) of various stored- product insects in wheat at 10% moisture content treated with Protect-It diatomaceous earth after 7 days.

Source: Post- harvest insect control with inert dusts. (Fields & Korunic, 2002).

<http://home.cc.umanitoba.ca/~fieldspg/fields/korunic-2002.pdf>

Insect	LD50 (ppm) (90% CI)	LD90 (ppm) (90% CI)
<i>Cryptolestes ferrugineus</i>	52 (45-61)	96 (89-112)
<i>Oryzaephilus surinamensis</i>	50 (24- 72)	158 (136-185)
<i>Sitophilus granarius</i>	204 (188-221)	373 (347-406)
<i>Sitophilus oryzae</i>	260 (242-281)	436 (393-496)
<i>Tribolium castaneum</i>	325 (303-347)	421 (397-449)
<i>Rhyzopertha dominica</i>	340 (313-367)	596 (560-637)

Protect-It® can be used in a variety of places, inside and around containers, equipment, and places where any products are processed, stored, or transported (Hedley Technologies, 2014b). This product protects grains from a variety of insects such as weevils, beetles, mites, and larvae. (Hedley Technologies, 2014b). A few benefits of Protect-It® include that there is no applicator certification necessary, it is unnecessary to remove the product from the grain before processing, there is no re-entry waiting period after application, no degrading or dissipating so long as the grain is in storage, protection against infestation of the most common stored grain insects, and the use of Protect-It® does not affect milling, malting or baking quality (Hedley Technologies,

2014a). In addition, livestock can consume grain that has been treated with Protect-It® as it is not considered hazardous when ingested. (Hedley Technologies, 2014c). This is very important to farmers to ensure that their livestock stays healthy and is not affected by the use of Protect-It®. This product can be easily applied by anyone, almost anywhere, in amounts based on the type and amount of grain and pest being treated (Hedley Technologies, 2014b). The amount of product required for various pests and stored grains is shown in the table below.

Table 2: The amount of Protect-It® necessary for treating different pests in different stored grains.

Source: Protect-It®- For insect control in stored grain, warehouses, and processing facilities.

Product label, 2014. http://www.hedleytech.com/CN_PI_5kg_label_Feb12.pdf

Commodity	Rate of Protect-It per metric ton (g/tonne)	
	Rusty grain beetle	Other listed insects
Wheat	100	500
Barley	150	500
Oats, Buckwheat, Peas Rye, Flax, Soybeans	500	500
Feed grains, Seed, Corn, Sorghum	1000	1000

Similar Canadian Products

After researching, it has been assumed that no other Canadian companies produce a product that is similar to Protect-It®. There are many diatomaceous earth based insecticides but mainly small scale products for home use. For example, the product “Ant and crawling insect killer”, is a 7oz bottle that can be bought from a local superstore such as Walmart, and used around the

house, indoors and outdoors (Safer® brand, 2105). Protect-It® seems to be the only current Canadian product designed for large scale agricultural uses such as use in stored grains.

Canadian Product Companies

The Canadian company that would be the best producer of a powdered insecticide such as Protect-It®, is Hedley Technologies Ltd. The corporate headquarters are located in Toronto Ontario (Hedley Technologies, 2014a). Hedley develops and markets insecticides with the intention to minimize risk to human health, public safety, and increase the value of agricultural production (Hedley Technologies, 2014a). The first contact made with Hedley was by email with Taylor Murphy. Through communication with Taylor, it was understood that the manufacturing process of Protect-It® involves quarrying the diatomaceous earth, blending it according to the ingredients list, and packaging it in either 5 kg boxes or 10 kg bags (T. Murphy, personal email communication, October 20, 2015). It was also explained that the diatomaceous earth is freshwater, sourced from quarries in the Americas (T. Murphy, personal email communication, October 20, 2015). Taylor explained that Hedley does not ship directly to end users, but to crop input suppliers, farm supply wholesalers, and cooperatives (T. Murphy, personal email communication, October 20, 2015). After doing some research, a company called Woodrill Ltd was discovered, a local farm supply located in Guelph Ontario (Woodrill, 2015). After speaking on the phone with an employee named Laura Bottenham, it was determined that the cost of a 5kg case of product is \$62.25 (L. Bottenham, personal phone communication, October 17, 2015). As mentioned above, the amount of product needed for stored grain varies. Further pricing with information about transportation and shipping will be addressed in detail in a later section. Taylor from Hedley proclaimed that Protect-It® is advantageous when compared to other

diatomaceous earth products because less of it is needed (T. Murphy, personal email communication, October 20, 2015). It works faster and more effectively due to its unique formulation (T. Murphy, personal email communication, November 24, 2015). For reasons of trade secrecy, Hedley does not disclose any sourcing, manufacturing, or packaging sites (T. Murphy, personal email communication, November 24, 2015). The contact information for Hedley Technologies Ltd and Woodrill Ltd is listed below:

Hedley Technologies Ltd.

520-170 Attwell Drive

Toronto, ON

M9W 5Z5

Tel: (905) 206-0013

Toll Free: 1-888-476-4473

Fax: 905-206-1413

Email: info@hedleytech.comWebsite: <http://hedleytech.com>**Woodrill Ltd.**

7861 Hwy #7 East

Guelph, ON

N1H 6H8

Tel: (519) 821-1018

Toll Free: 1-800-461-1018

Fax: 519-821-5198

Website: <http://woodrill.com>**Benefits to Canada**

As mentioned above, the diatomaceous earth that the product is composed of is sourced from quarries in the Americas, but the finished product itself was tested and approved in Hedley's Winnipeg laboratory 20 years ago and continues to be produced and sold in Canada (Hedley

Technologies, 2014d). By exporting Protect-It® from Canada to Nepal, Hedley Technologies will most likely hire more employees to meet the new product demand. The exportation will support the Canadian economy, and if the Nepalese people are satisfied with this product, it is likely that the trading between Nepal and Canada will increase. Also, with marketing opportunities in Nepal and other potential countries, more Canadian companies may begin producing other variations of this product which could benefit Canadian farmers and all other farmers who use a diatomaceous earth insecticide in their stored grains. Additionally, the exportation of Protect-It® to Nepal would have a positive impact on the trucking, rail and ship transport as it would need to be transported via truck or train before it could be loaded onto a cargo ship for exportation (T. Murphy, personal email communication, November 24, 2015).

Part II: Critical analysis of potential benefits to Nepal

Introduction to Nepal

Nepal is a nation located between China and India. Approximately 28,109 people call Nepal home (Government of Canada, 2015). As a whole, Nepal encompasses about 147,181km² (Government of Canada, 2015), and is divided into three major ecological zones (figure 1) known as the mountain, hill, and terai regions (Sharma, 2015).

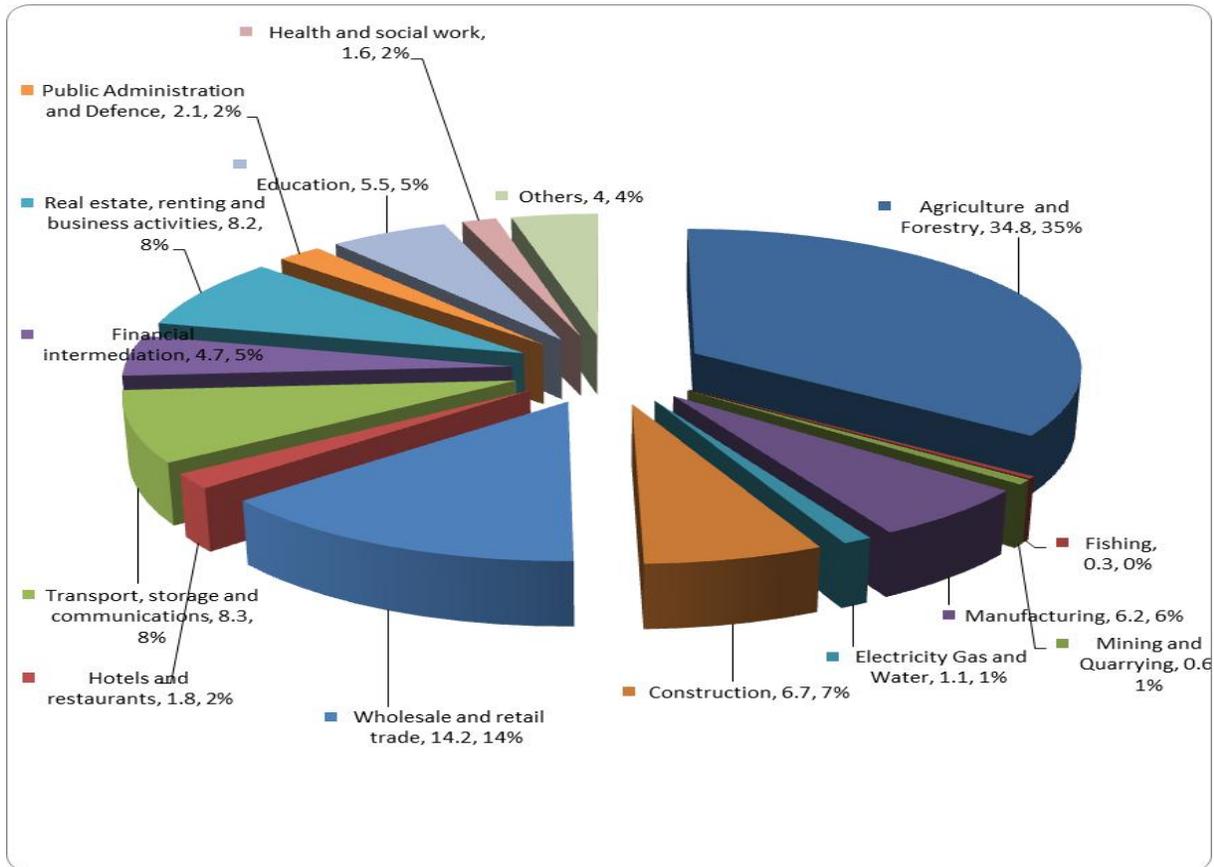
Figure 1: The ecological zones and development regions of Nepal.



(Muzzini, 2013).

Nepal is among the poorest and least developed countries in the world, with about one-quarter of its population living below the poverty line (Central Intelligence Agency, 2014a). As illustrated in figure 2, agriculture contributes the most to the economy, providing income for more than 70% of the population and accounting for just over one-third of GDP (Central Intelligence Agency, 2014a).

Figure 2: Percentage contribution to GDP by different sectors in Nepal.



(Khanal, 2015).

Canada established diplomatic relations with Nepal in 1965 and have since shared a longstanding relationship (Government of Canada, 2013). During the period 2008-2013, two-way trade ranged from \$15 million to \$23 million per annum (Government of Canada, 2013). As shown in table 2, in 2014 Canadian exports to Nepal totaled approximately \$11 million and Canadian imports from Nepal totaled \$13 million (Government of Canada, 2015). Table 3 shows the trade relationship between Canada and Nepal over the past few years.

Table 3: Bilateral Product trade (Canada – Nepal).

Source: Government of Canada- Fact Sheet- Nepal. http://www.canadainternational.gc.ca/india-inde/bilateral_relations_bilaterales/fs_nepal_fd.aspx?lang=eng

Year	Exports	Imports
2010	\$5,496,537	\$15,376,553
2011	\$6,338,701	\$15,737,207
2012	\$6,557,819	\$12,293,247
2013	\$10,296,214	\$12,184,691
2014	\$11,056,336	\$13,038,786

By examining a chart of different countries GDP- per capita in 2015, Canada is listed as the 29th highest, with a GDP of \$45,000, whereas Nepal is listed 199th on the chart with a GDP of \$2,400 (Central Intelligence Agency, 2014b). Because Nepal's GDP is very small in comparison to Canada's, it is important that all of the products being exported from Canada to Nepal are cost effective.

Crops in Nepal

The major crops grown in Nepal include rice, maize, and millet (Sharma, 2015). Over the past 25 years, the area, production, and yield of maize has somewhat improved in the Terai region but yields have decreased by approximately 17% (Sharma, 2015). This indicates that improvement in agricultural technology is still needed (Sharma, 2015). Insect pests are proven to be one of the

main causes of storage losses in different commodities under subtropical environmental conditions (Latif et al., 1991). In addition, one fifth of the world's total crop production is destroyed annually by herbivorous insects (FAO, 2010). Extended storage of grains for more than three months makes the commodity more susceptible to insect attacks (Wakil & Schmitt, 2014). Not only do insects deteriorate grain, but they causes severe quantitative as well as qualitative grain losses (Ahmedani et al., 2011). Nepalese farmers are greatly affected by pests, especially in the Terai region (Sharma, 2015). This would be the main region that would have a demand for an insecticide such as Protect-It®. This is because the majority of crops sold throughout Nepal are grown and farmed from the Terai region (Sharma, 2015). In addition, the land area of Terai is very flat and is most suitable for growing crops (Sharma, 2015). The climate in the Terai is ideal for pests and therefore, farmers in this region would have a greater need to use insecticide on their crops than the other regions of Nepal (Sharma, 2015). In the Terai region, maize is developing into a commercial crop for processing into corn oil, glucose, animal food, and breakfast cereal. Over the next 20 years, the demand for maize is expected to increase by 4% per year due to an increased demand for food in the hills and in the Terai regions of Nepal (Sharma, 2015). This means it is important that changes are made to increase the yield per Nepalese farmer. Protect-It® is affordable enough for the average farmer in the Terai region. As long as the farmer can get to the market, close to where most products are imported and sold, they can purchase Protect-It® and be able to make profit due to the benefits of the product to make up for the cost of actually purchasing the product. Prices of Protect-It® are discussed in better detail later in this report.

By exporting Protect-It® to Nepal, the pest infestation in stored grains will decrease, causing the crop yield to increase. This is important as some of the crops listed in the table below such as maize, are not only a source of income, but act as a staple food which are eaten routinely and make up for a large and important portion of a standard diet (Sharma, 2015). The area, production and productivity of major crops during 1998-1999 are shown in Table 4.

Table 4: Area, Production and Yield 1998/99 (Nepal).

Source: Statistical Information on Nepalese Agriculture 1998/99, Agriculture-Statistics Division, Nepal. <http://www.fao.org/docrep/003/x6906e/x6906e09.htm>

	Crops	Area (ha)	Production (MT)	Yield (kg/ha)
1	Paddy	1514210	3709770	2450
2	Maize	802290	1345910	1678
3	Millet	263950	291370	1104
4	Wheat	640802	1086470	1695
5	Barley	31843	31798	999
6	Oilseeds	190429	119731	629

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7	Potato	118043	1091218	9244
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8	Sugar cane	53894	1971646	36584
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9	Pulses	308008	228840	743
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Transportation

Another personal communication by email with Taylor Murphy from Hedley Technologies explained that Protect-It® is not very dense, so a 5kg box is larger than expected (T. Murphy, personal email communication, November 24, 2015). For transportation from Canada to Nepal, a plane would not be cost effective (T. Murphy, personal email communication, November 24, 2015). Other countries that currently import Protect-It®, import by truck in the Americas and by cargo ship container overseas (T. Murphy, personal email communication, November 24, 2015). The cost per box for shipping would be lowest if a full shipping container was being shipped (T. Murphy, personal email communication, November 24, 2015). A 20-foot container holds 10 pallets of Protect-It®, each pallet containing 63 x 5kg boxes of Protect-It® (T. Murphy, personal email communication, November 24, 2015). It was also discovered that shipping to Nepal would involve land or rail transport to a North American port, then cargo ship to a south Asian port, then transport over land to Nepal (T. Murphy, personal email communication, November 24, 2015). Taylor estimated that the cost of shipping a 20-foot container to be

between \$2500.00 and \$3000.00, plus about \$1000.00 for insurance and perhaps \$300.00 more for export documentation (T. Murphy, personal email communication, November 24, 2015). This works out to about \$6.82 per box in shipping. The cost per box would be less if a 40-foot container was to be shipped instead of a 20-foot container (T. Murphy, personal email communication, November 24, 2015).

Issues which require further improvement

Nepalese people who may be hurt by this product are those who sell pesticides or other forms of insecticides. Although other insecticides may be cheaper and more easily accessible, Protect-It is a healthier alternative for animals, humans and the environment (Hedley Technologies, 2014a). Pesticide use in agriculture has a significant negative impact on farmers' health (Ajayi, 2000). Pesticide pollution not only affects human health, but also affects multiple other environmental factors such as soil, surface and ground water, crop growth and production, and other flowering plants that are important to livelihood (Pimentel, 2005). If there is competition in Nepal with other insecticide products, some individuals may be hurt financially by the importation of Protect-It®. The benefits of importing Protect-It®, such as increased yield and income, will make up for the loss of the few salesmen in Nepal, as it will have a great and positive impact for individual farmers as well as families, companies, and the economy.

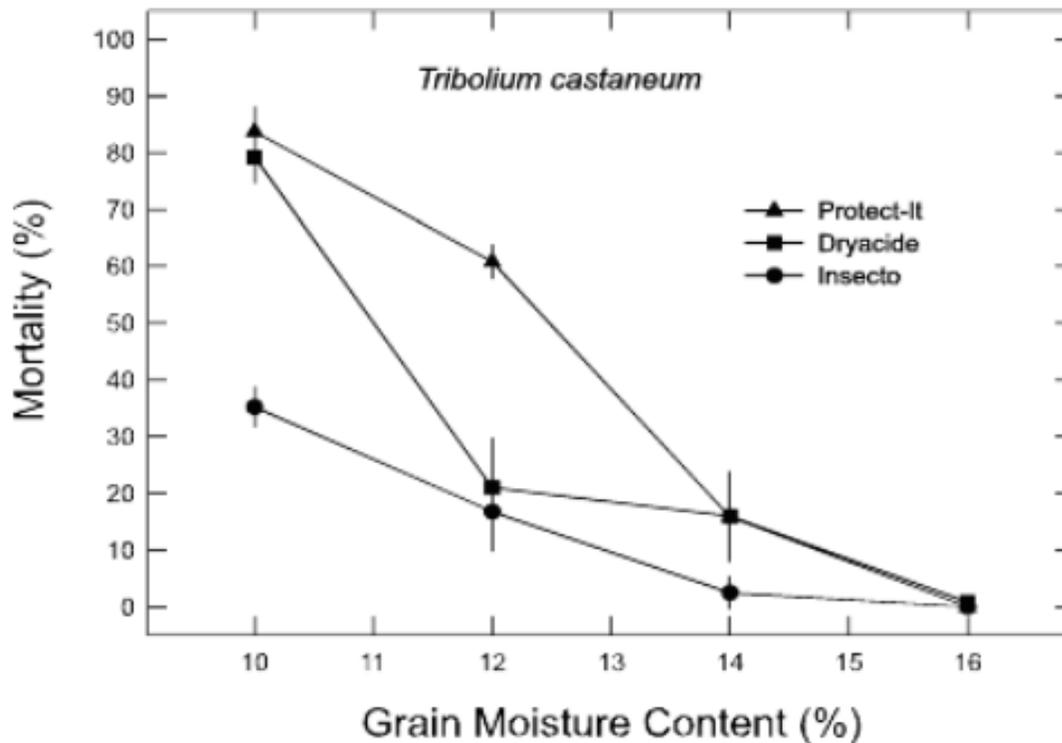
One of the main issues with Protect-It® and diatomaceous earth based insecticides is that the application of product reduces grain bulk density. For a sufficient level of efficacy, the available diatomaceous earth formulations should be applied at doses between 400 and 1000 ppm (Fields and Korunic, 2000). Many researchers feel that there is a need for using new types of diatomaceous earth, which would be effective at lower dose rates (Arthur, 2003). Some newer

diatomaceous earth formulations, combined with low doses of insecticides, have already been evaluated and have displayed promising results (Athanassiou et al., 2006). Protect-It® has been found to affect test weight of wheat and barley when treating stored grain (Hedley Technologies, 2014b). A laboratory evaluation of diatomaceous earth deposits was done, and according to the results, bulk density of grain was reduced significantly by spraying the diatomaceous earth product in comparison to dusting it (Athanassiou et al., 2010). Before adopting the method of spray application of product on grain commodities, further evaluation is necessary in terms of effectiveness, application apparatus and the impact on physical properties of grain (Athanassiou et al., 2010).

Comparative products from other nations

There are many diatomaceous earth based pesticides produced from different nations all over the world. The location of the world the diatomaceous earth is mined from, has an effect on the efficacy of insecticide (Athanassiou et al., 2010). For example, diatomaceous earth from several parts of the world was screened, and it was discovered that local diatomaceous earth from the former Yugoslavia was very effective, and could successfully be used against stored-grain pests (Athanassiou et al., 2010). This means that some products will be much more effective than others. A study was conducted to determine the effectiveness of diatomaceous earth when in contact with insects at different moisture levels. This study also compared 3 different diatomaceous earth insecticides, Protect-It®, Dryacide, and Insecto (Figure 3).

Figure 3: The mortality of *Tribolium castaneum* held on wheat for 14 days at 30 degrees C treated with three diatomaceous earths at 300ppm.



Source: Post-harvest insect control with inert dusts. (Fields & Korunic, 2002).

<http://home.cc.umanitoba.ca/~fieldspg/fields/korunic-2002.pdf>

As seen in Figure 3, it is quite clear that Protect-It® caused for the highest mortality rate, making it the most effective insecticide when compared to Dryacide and Insecto. Regardless of the moisture level, Protect-It® remained the most effective over the 14-day period (Figure 3). A few products that are similar to Protect-It which are produced in different nations of the world are compared in table 5.

Table 5: A comparison between different diatomaceous earth based insecticides.

Product	Place of origin	Price	Other notes
Protect-It®	Toronto, Canada	Approximately US \$6000 /Metric Ton	Form: Dust or slurry. Composed of: Silicon Dioxide 74% (present as 100% Diatomaceous Earth) Silica Aerogel 10%. Packaging: 5kg boxes, 10kg bags. Purpose: pest control
Dryacide®	St. Paul, Minnesota, USA	Approximately US \$3173/ Metric Ton (US \$1.44 / lb)	Form: Dust formulation or slurry. Composed of: Silicon dioxide, diatomaceous earth

			<p>90%.</p> <p>Other ingredients</p> <p>10%</p> <p>Amount needed: 1-3 pounds per 1,000 square feet.</p> <p>Packaging: 50-pound bags.</p> <p>Purpose: pest control</p>
Insecto®	Costa Mesa, California, USA	<p>Approximately</p> <p>US \$3967 /</p> <p>Metric Ton</p> <p>(US \$1.80/ lb)</p>	<p>Form: dust</p> <p>Composed of: Silicon Dioxide, from diatomaceous earth</p> <p>90.0%. Organic.</p> <p>10% inert ingredients.</p> <p>Amount needed: Approximately one</p>

			<p>pound per 1,000 square feet.</p> <p>Purpose: pest control</p>
DElite	Jilin, China (Mainland)	US \$300 - 600 / Metric Ton	<p>Min order quantity: 10 Metric Tons</p> <p>Description: White powder, organic, biological and harmless insecticide.</p> <p>Contains: diatomaceous earth.</p> <p>Purity: 87%.</p> <p>Purpose: pest control</p>
Diatomaceous Earth INS	Rajasthan, India	US \$250 - 800 / Metric Ton	<p>Form: Powder.</p> <p>Description: Biological pesticide.</p> <p>Contains: diatomaceous earth.</p> <p>Purity: 100%.</p>

			Amorphous silica >98%. Purpose: pest control
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Sources: **Protect- It®**- Hedley Technologies Ltd. (Canadian technologies, 2014).

http://www.hedleytech.com/canadian_customers.htm

(T. Murphy, personal email communication, November 24, 2015).

Dryacide®- Winfield. (Dryacide, 2015).

<http://www.winfield.com/Farmer/Products/ProductCategory/ProductDetail/ECMD2-0058536>

Insecto®- (Insecto, 2013). <http://www.insecto.com/msds.html>

DElite- Alibaba. 100% Green Pest Controller Food Grade Diatomaceous Earth For Natural Pesticides, Insecticide/Agriculture. http://www.alibaba.com/product-detail/100-Green-Pest-Controller-Food-Grade_60009020666.html?spm=a2700.7724838.30.2.UCBax4

Diatomaceous Earth INS- Alibaba. Diatomaceous Earth for Insecticide.

http://www.alibaba.com/product-detail/Diatomaceous-Earth-for-Insecticide_50001938441.html?spm=a2700.7724838.30.2.zSjLZS

By researching the different companies that supply insecticides that are similar to Protect-It, it was determined that all products listed above are produced for the same purpose, the control of insects in stored grains (Table 5). All of the products contain a combination of diatomaceous earth and silica, can be used on the common grain pests and all work to exterminate the pests by

desiccation (Table 5). The major differences between the different products are the place of origin, the price, and the amount of product needed to treat grain (Table 5).

Summary

To conclude, if Nepal were to import a diatomaceous earth based insecticide such as Protect-It®, Nepalese farmers would be able to treat their harvested grains in a non toxic and efficient way (Hedley Technologies, 2014a). In addition, diatomaceous earth insecticides are considered among the most promising alternatives to the use of traditional pesticides in stored grain (Kabir, 2013). Pest infestation in Nepal would decrease and the quality and quantity of grain would increase. This would result in a greater financial intake for the Nepalese farmers. Protect-It® is proven to be an effective and impressive product but in comparison to other diatomaceous earth based insecticides, is more expensive (Table 5). In addition, the transportation from Canada to Nepal is much further than some other countries which export similar products, although, further research would have to be done to determine if other products are as effective as Protect-It®. There is potential to export Protect-It® even with it being as costly as it is. In Canada, there is a company that works in conjunction with the government called Export Development Canada (EDC), which offers a variety of financing solutions for exporting products to other countries (Export Development Canada, n.d). This is done to help Canadian companies sell beyond Canada's borders. It is recommended that Hedley Technologies contact EDC to see if there are financing solutions to help with the exportation of their product. Protect-It® would help Nepal deal with some of their main and current agricultural issues. If importing Protect-It® is feasible, it should certainly be considered as a potential export product from Canada to Nepal.

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