Assessment of the Export potential of Canadian Allosperse Technology for Pesticides to Nepal

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This report will explore the potential advantages and disadvantages of exporting a new pesticide product developed in Canada to Nepal for use in the agriculture sector of the country.
This report contains two sections. First, the product will be explored in detail starting with the clarification of pesticides and their use in general, exploring the technology and manufacturing perspective, costs of using this product, competitive products and the benefits of use in the Canadian agriculture sector.
The second section of the report will explore the potential benefits of exporting this product for the development of the agriculture sector in Nepal, specifically exploring the potential benefits to Nepal, transportation logistics, financial benefits, possible negative environmental impacts and a summary of recommendations.

Part 1: Product information: Allosperse technology in pesticides

1. General Explanation of Pesticides and Pests

The term pesticide includes a wide range of different materials including insecticides, fungicides, herbicides, rodenticides, molluscicides, nematicides, plant growth regulators and others. (Aktar, Sengupta, Chowdhury, 2009). This report will explore three (3) categories of pesticides used today commercially: fungicides which deal with fungal diseases, insecticides which deal with insect pests and herbicides which deal with weeds that compete with crops for nutrients. Pesticides provide benefits to crop production through increased yield by decreasing pest damage on crops (Godfray et al., 2010).

2. Allosperse technology in pesticides

The products that I considered to potentially export to Nepal are pesticides that contain a new technology called Allosperse. This is a dependable, dispersal technology in fungicides, herbicides and insecticides for use by farmers to spread on their fields.

Allosperse was developed by a Toronto based company called Vive Crop Productions. This product is currently the only one of its kind in the agriculture sector. Allosperse is a technology that works with fungicide, herbicide and insecticides that are applied to crops to provide benefits of helping the pesticides get deeper into the plant and going specifically to the target problem area and providing better mixing technology in the spraying tank.

3. Description of how the product was developed and how it works

The Allosperse technology was originally developed in the chemistry department of the University of Toronto in 2006 by a team working with Prof. M. Cynthia Goh. After receiving private funding, the company, Vive Crop Productions was launched to continue its work in the private sector.

This product works by dissolving negatively charged polymers in water. These like charges repel causing the polymers to spread out into the solution. Once this occurs positively charged ions are added to the mix. These ions neutralize the charge around the polymers, causing the polymers to collapse around the ions and create a kind of nano cage — the Allosperse (Vive crop production, 2015). The nano cage surrounds the pesticide's main ingredients and allows them to be dispersed evenly in water. This is done through a hydrophilic exterior and hydrophilic interior. This causes the pesticides to be strongly attracted to each other while also having an attraction to the leaves (Hamilton, 2012). This decreases the loss of pesticides as a result of lack of attraction between the plant and the pesticides. This attraction occurs because the outside of the cages like water and this allows the particles to freely and evenly disperse within the water. Once sprayed on crops, the water droplets evaporate and the active ingredient remains to be dispersed from the particles that are left behind onto the pant. (Hamilton, 2012) This means

farmers don't need to overspray fungicide, herbicide and insecticides in order to achieve their positive effects which as a result is more environmentally friendly due to less runoff materials and reduced cost from decreased amounts of spraying.

4. Machinery Required and Cost

The Allosperse pesticides have only two main requirements and related costs to use. These are the distributor (or sprayer) in order to disperse the chemicals and the second is the pesticides that contain the Allosperse technology. The cost of the sprayer varies as there are many types of sprayers used worldwide today for the spreading of pesticides. The types of pesticide dispersal technology can be seen in (Tables 1, 2 and 3).

Table 1: Ground sprayers for liquid

Type of Sprayer	**Description of spraying Technology**
Air blast Sprayers	Have a nozzle placed in a very high speed air stream produced by a fan. The air stream propels the very fine spray droplets to the target.
Boom Sprayers	Have multiple nozzles spaced over the length of the boom
Hand-held Sprayers	Are light weight and hand operated. They contain a long metal extension that ends in an adjustable nozzle. A hose attaches the 'wand' to a small portable tank or larger, stationary one
Backpack Sprayer	Have a spray tank that fits comfortably on the back like a knapsack. The applicator pumps the sprayer handle to build up pressure in the tank and applies the product through a small hose / single nozzle assembly

Information within Table collected from (Health Canada, 2006)

Table 2: Types of applicators for solid formulations

Type of applicator	**Description of technology**
Granular Spreader	Broadcasts pesticide granules over an entire field surface or

	in bands that correspond to crop rows. Application equipment may use gravity or a positive metering mechanism to regulate the flow of granules
Dust Applicators	Equipment used to apply products as a dust range from simple shaking devices to power dusters.

Information collected from (Health Canada, 2006)

Table 3: Other types of application

Types of applicators	**Description**
Aerial sprayers	Fixed wing aircraft and helicopters may be used for applying pesticides either as a solid or liquid
Fumigation equipment	A fumigant is a pest control product that, at a specific temperature and pressure. Can exist in the gaseous state in sufficient quantities to be lethal to a pest organism
Foggers	Outdoor foggers or space sprayers can be mounted on a truck or aircraft and used to form a cloud of small droplets that are suspended in air. There are two types- thermal foggers and cold foggers.
Chemigation	Chemigation is the application of chemicals, such as pesticides and fertilizers, to crops through an irrigation system by mixing them with the irrigation water.

Information collected from (Health Canada, 2006)

Canadian farmers use a combination of the various applicators outlined in Tables 1, 2 and 3 above to disperse pesticides on crops. Although a large variety of applicators are possible for use in developing countries, because of the physical terrain and the small farm size many of these applicators are not cost effective. As a result 'backpack' sprayers are the most widely used small-

scale sprayers in developing nations. (Meijden, 1998). A 'backpack' sprayer costs around 1,688 Indian rupees or 33 dollars Canadian as purchased from Flipchart (an Indian online vendor).This purchase would typically be a onetime purchase for a farmer and they would use it for multiple years if properly cared for or it may be purchased by multiple farming families and shared. This would be an affordable purchase based on a general average income of approximately $1,000 Canadian per year (8179.87 Nepalese Rupee) for a farmer in Nepal.

The second purchase that is needed for use of this technology is the purchase of pesticides. This purchase can range in price. Currently, Vive Crop Productions has three types of pesticides available for purchase but after emailing the producer I was unable to get the price of any of the products. Although a specific price was not provided, for the purpose of this report, an estimated cost based on available pesticide costs was used.

5. Canadian benefits of this product

There are a variety of benefits of the use of this product in Canada, from the environmental benefits, reduced costs of pesticides and increased yield for farmers.

First, they improve the Canadian farming economy by reducing farmers' costs of pesticides. Additionally, benefits include increased food yields "With the use of fertilizer and the use AZteroid a type of Allosperse, the corn yield for 2015 went from a field that was untreated at 180.7 bushels per acres to 218.2 bushels per acres with the use of Allosperse and fertilizer" (Vive Crop production Inc, 2015)

Second, by minimizing the use of pesticides that in turn helps reduce pesticide related run off. This run off factor alone has a major impact on both Canadian and United States waterways. "It was found that one of the top three leading causes of impairment in rivers and lakes was agriculture in the United State (Environmental Protection Agency, 2009). If we are able to keep our current water supply cleaner, it helps prevent an increase of algae growth in our water systems. Algae can destroy a water system by blocking the light that is needed by plants, and destroys the underwater environment and kills fish. llo

The Allosperse technology provides a healthier way to apply pesticides onto farmer's field without compromising human health. "They're all approved by the U.S. Environmental Protection Agency" says Thomas. "The end result is that the nasty solvents are gone." (Hamilton, 2016)

Through the continued and wider use of this technology in Canada we will be able to help decrease environmental damage from pesticides while saving money for farmers through decreased pesticide use but maintaining or increasing crop yields.

6. Evaluation of regional and global competition

Allosperse pesticide product group is the only technology of its kind but other companies have additives for insecticides and fungicides that can achieve similar although less effective results. These different additives are compared together with the Allosperse technology developed by Vive crop in Tables 4 and 5.

Table 4: Insecticides:

Product name	Producing company	Price	Provided benefits
Bifender (is mixed with liquid fertilizer)	Vive crop protection	Not provided	• Control soil-dwelling and surface insect pests • Protect roots from insect feeding • Improve emergence and seedling vigor • Get seedlings off to a healthy, fast start by establish a large, vigorous root system • Prolong blooming • Improve heat and cold tolerance

BREAK-THRU®S 233 - Organo modified Trisiloxane	EVONIK industries	Depended on distributor	• Excellent adhesion and retention, • suited for enhancing the biological performance of (semi) systemic products
Force® CS (can only be applied to corn crops)	Syngenta	Dependent on distributor	• soil-applied corn insecticide that offers high-level control of corn rootworm and other early-season insects

Information within table collected from:
(Evonik Industries, 2016)
(Syngenta Canada Inc, 2016)
(Vive Crop production Inc, 2015)

Table 5: Fungicides

Product name	Producing company	Price	Provided benefit
AZteroid is mixed with a liquid fertilizer	Vive crop productions	Not provided	• Controls soil-borne and seedling disease • Increases seedling growth • Increases nourishment to grain and flower • Get seedlings off to a healthy, fast start by establish a large, vigorous root system • Prolong blooming • Improve heat and cold tolerance
Abound Flowable Fungicide	Syngenta	209.95 Canadian	• Highly-effective systemic activity

		or 10,631.34 Indian rupee for a 1 gallon can as purchased from Keystone pest solutions LLC.	provides excellent disease protection • Stops disease before it starts – even during periods of rapid growth – because of movement into new tissue • Broad-spectrum disease control that protects crops from all four major fungi classes • Effective at low use rates • Rapid uptake into the plant
Quash® Fungicide	Valent	Dependent on the distributor	• Broad spectrum performance • Preventive protection for when diseases strike • Helps deliver on optimal yields and crop quality

All information within Tables collected from:

(Syngenta United States Inc, 2016)

(Vive Crop production Inc, 2015)

(Valent Canada, 2015)

(Keystone Pest Solutions LLC. 2016)

7. Evaluation of the Marketing opportunity in Nepal

Given the small farm size and small amount of Allosperse technology and product that would be required for each individual farmer, it would be best to market Allosperse through a government agency - either directly through the Nepal government or through an agency such as the Project for Agricultural Commercialization and Trade World Bank (PACT). These organizations should

be able to communicate the benefits to a large population of farmers or within a town or a series of towns.

It would be best if the product were made available through distribution centers containing different types of fungicide, herbicide and insecticides that contain the Allosperse technology. Through these distribution centers the products could be stored and dispersed to the farmers in a fair and controlled way and include required training. This would allow farmers to have equal access to these products along with a central location for them to purchase from.

Along with this the government could hire a series of trucks in order to further help spread these pesticides to farmers or the farmers could come to the location in order to purchase amounts that they need for their farm. A possible location for the central distribution centre is in the town of Birendranagar. This town is located very close to the farming region of Surkhet Valley, a major region for farming within Nepal. Many of the farms in this valley are located along the highway allowing farmers easy accesses to these products.

8. Vive Crops Production Personal and Contact information

For more information on the technology of Allosperse contact Vive Crops Production.

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Part 2 Export potential of Allosperse, a fungicide, herbicide and insecticide dispersal technology for use within Nepalese agriculture.

Introduction - Agriculture within Nepal:

The second part this report will be exploring the potential impacts that the importation of Allosperse could have on the economy and agriculture industry within Nepal.

Nepal is a landlocked country that lies between India and the region of China. There are 3 regions in Nepal - the Terai region, the hill region and the mountain region. Most of the farming within Nepal is done within the Terai region. Nepal as a country is severely underdeveloped with nearly 33.7% of its GDP being based on the agriculture industry (The World Bank, 2014). Compared to Canada which has only 6.6% of its gross domestic product (GDP) based on agriculture (Government of Canada, 2016).

Under development in Nepal results in a lack of modern day technology. Farmers in Nepal do not have access to modern farming equipment (e.g., farm machinery and irrigations systems). As a result of this underdevelopment Nepal has major food security concerns within their nation. In Nepal, approximately 5 million people are undernourished and forty-one percent (41%) of children under five years old have stunted growth (World food program (WFP), 20015).

One of the greatest plagues that face the agriculture industry worldwide is pests. It is estimated that Nepal loses around 35% of its crop due to pests and storage (Palikhe, 2002). One of the greatest defences in the fight against pests was the introduction of pesticides. In India after the introduction of pesticides, high yield varieties of seeds and advanced irrigation technology, a significant increase in grain production yields was seen- annual food grain yields increased from 50 million tons to 198 million tons over a period of 47 years (Employment Information: Indian Labour Statistics, 1994).

Nepalese farmers have been working to increase yields and have increased their use of pesticides (Diagram 1)

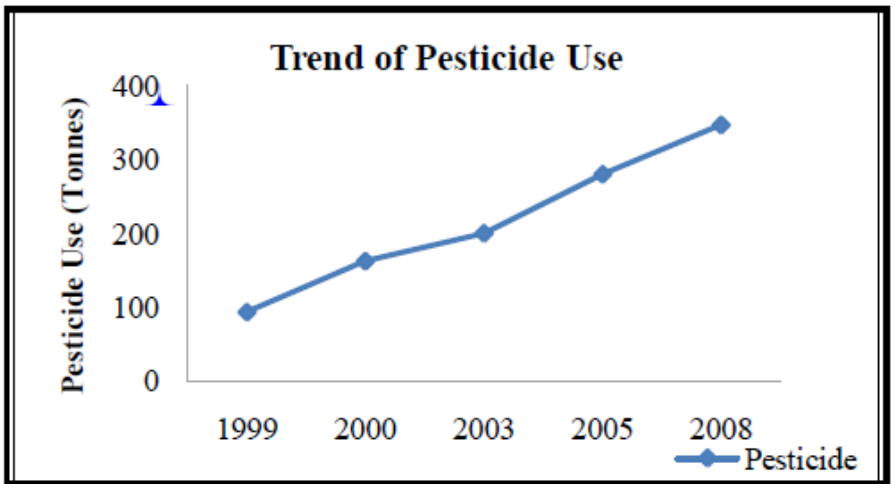


Diagram 1: Trends of pesticide use within Nepal (in tonnes) retrieved from (Giri, 2010)

While use of pesticides can be beneficial and results in increased crop yields, they do have negative impacts. One problem with the use of pesticides today is that they agglomerate (i.e., clump together and cause uneven distribution on fields). This results in farmers over spraying to ensure proper coverage. As a result of this over spraying pesticide run off can occur.

Pesticides are useful and should continue to be used in Nepal. The introduction of Allosperse will reduce agglomeration, resulting in even distribution of pesticides in fields, lower amount of pesticide use and increase yields due to increased pesticide effectiveness.

Needs and benefits to Importing Nation (e.g local women)

There are many benefits to the Nepalese people from the introduction of Allosperse technology into the agriculture sector. The two main benefits from use of this product within Nepal are the benefits to local women and children relating to income, time and education, and the second benefit is increased yield size.

In Nepal many tasks connected with food production are left to women '72.8% of economically active (age 10 and over) women are engaged in agricultural work compared to men's 60.2% (Food and Agriculture Organization of the United Nations UN Complex, 2010). As a result of this, women prepare the fields to be planted and are left to weed the fields.

With the introduction of the Allosperse technology, women would be able to save time and money. This technology reduces the amount of pesticides required, reducing costs and would

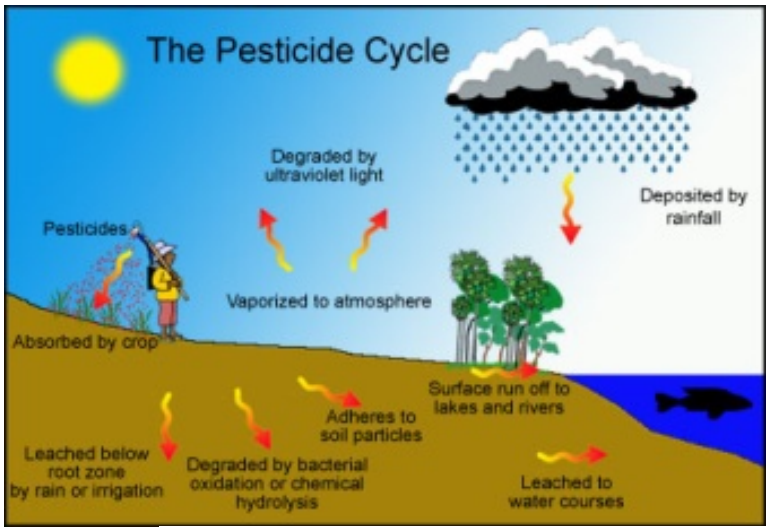
result in larger crop yields because of increase pesticide effectiveness. The end result would be a larger income for farm families. Often times young children are taken away from their schooling to assist with weeding tasks. Using an effective pesticide with Allosperse technology would reduce manual labour required and allow children to attend their schooling.

Environmental Benefits to Nepal:

There are environmental benefits from the introduction of Allosperse to Nepal (e.g. combat climate change and prevention of soil erosion on hillsides). Reduced use of pesticides would be beneficial to the Nepal farmers because they would be able to reduce costs while still protecting their plants. The total economic costs of pesticide use for farmers amounted to 15% of agricultural cash income (Atreya.et al ,2012). The increase in farmer income would provide more spending money available for purchasing clothes, food and housing. There are also environmental benefits that come from the decrease in pesticide runoff. This helps save water sources, decreases algae growth and improves the water environment.

Allosperse technology has been shown to increase product yield based on test results in Canada. This benefit would be expected in Nepal since Nepal and Canada have a very similar climate. This product is viable in the cold climate of Canada making it also possible to be used in the mountain regions of Nepal to increase crop yields.

(Diagram 2) Impacts pesticides can have on the environment retrieved from (Commons Abundance network, 2016



Transportation logistics: Mapping of Exportation from Canada

There are two potential pathways that could be used to export Allosperse from Canada to Kathmandu, Nepal (see tables 6 and 7). Kathmandu was chosen as a potential distribution point because it is close to the farming region of the Surkhet Valley. This valley is located within the

Terai region of Nepal and is one of the major farming regio
is also located nearby along the Ratna Rajmarg highway. Tra
be easy as it is along the highway and many of the farms are

Table 6 is a potential transport routes the pesticides could take to get Nepal

Table 6: Potential transportation route

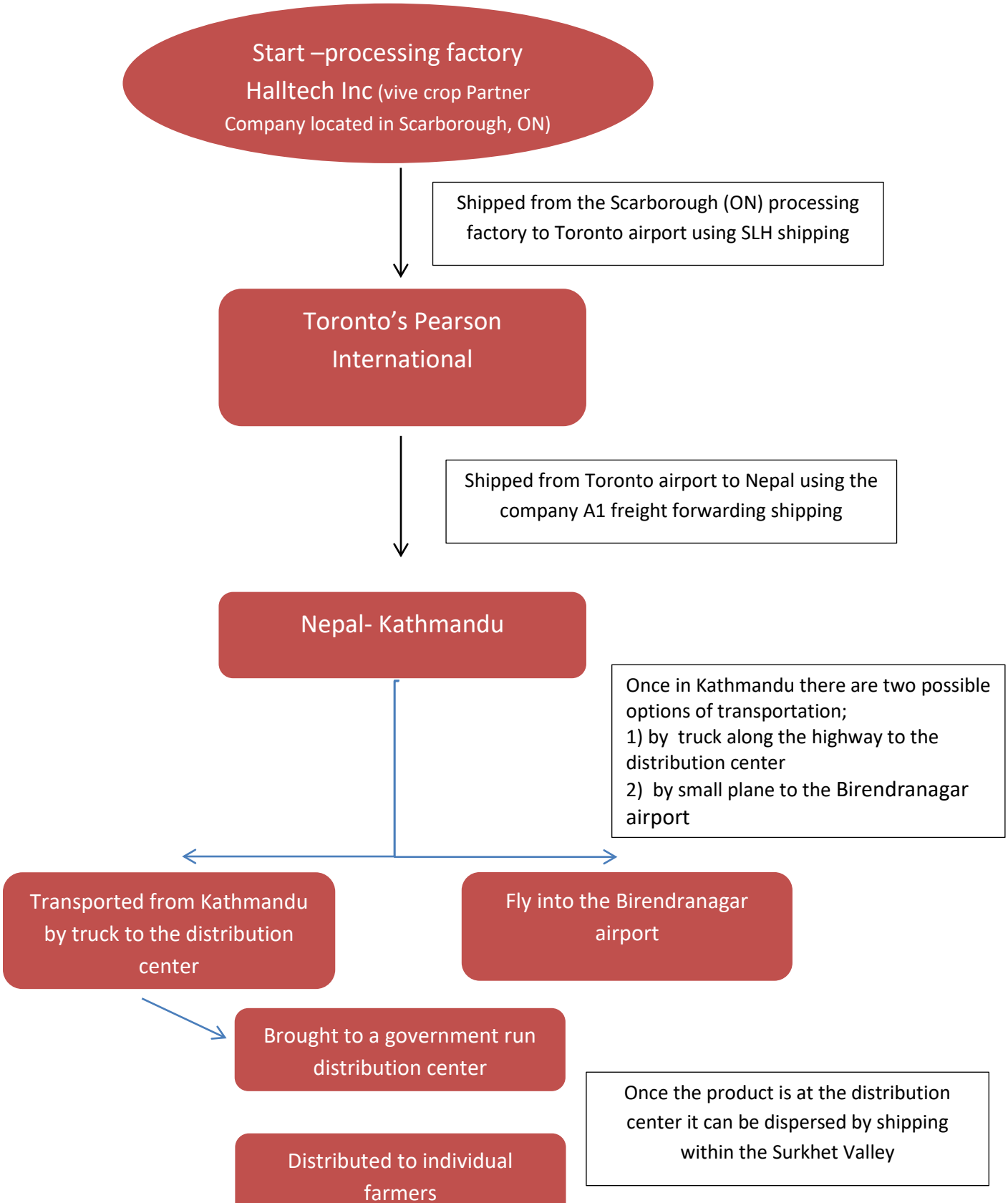
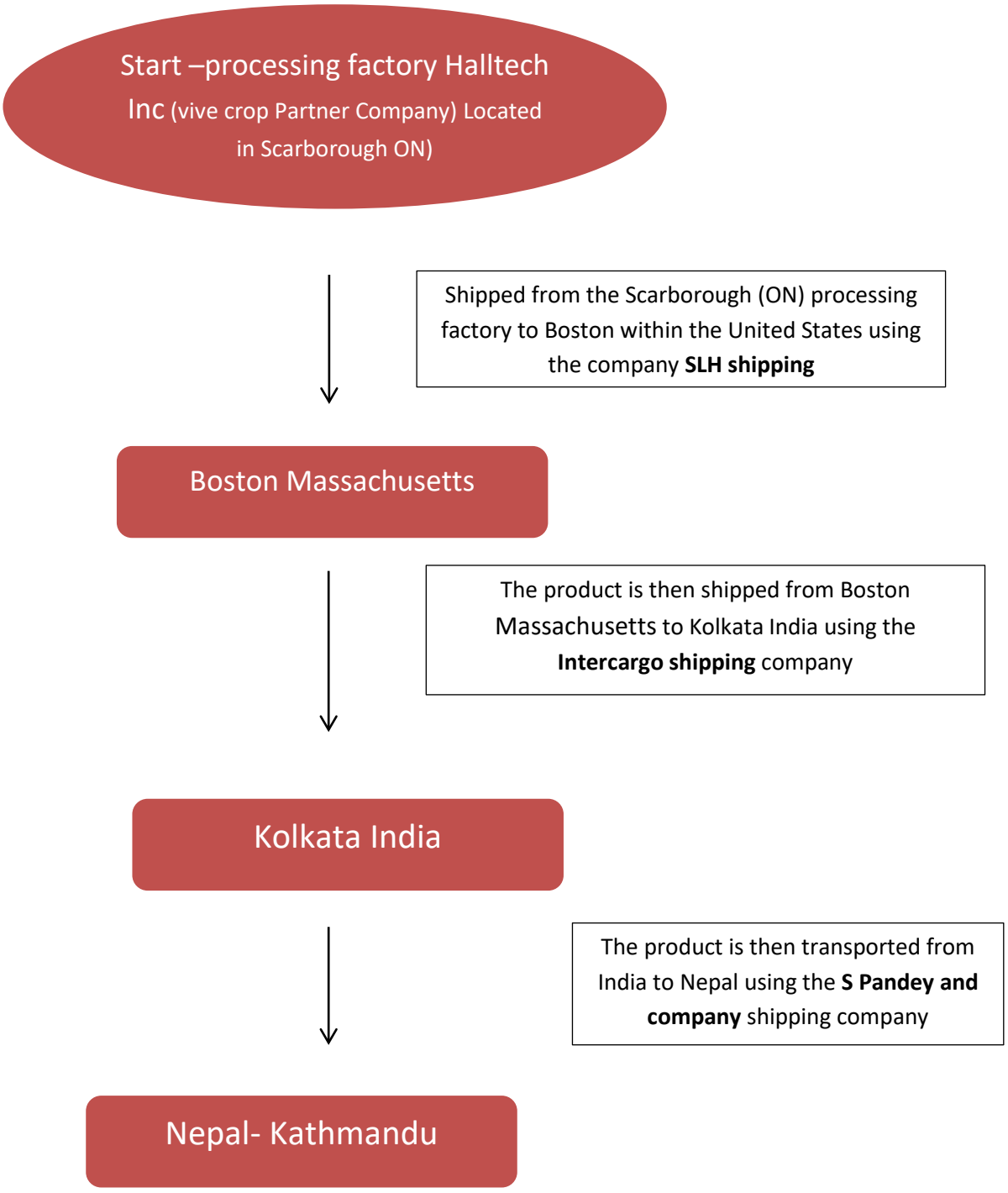
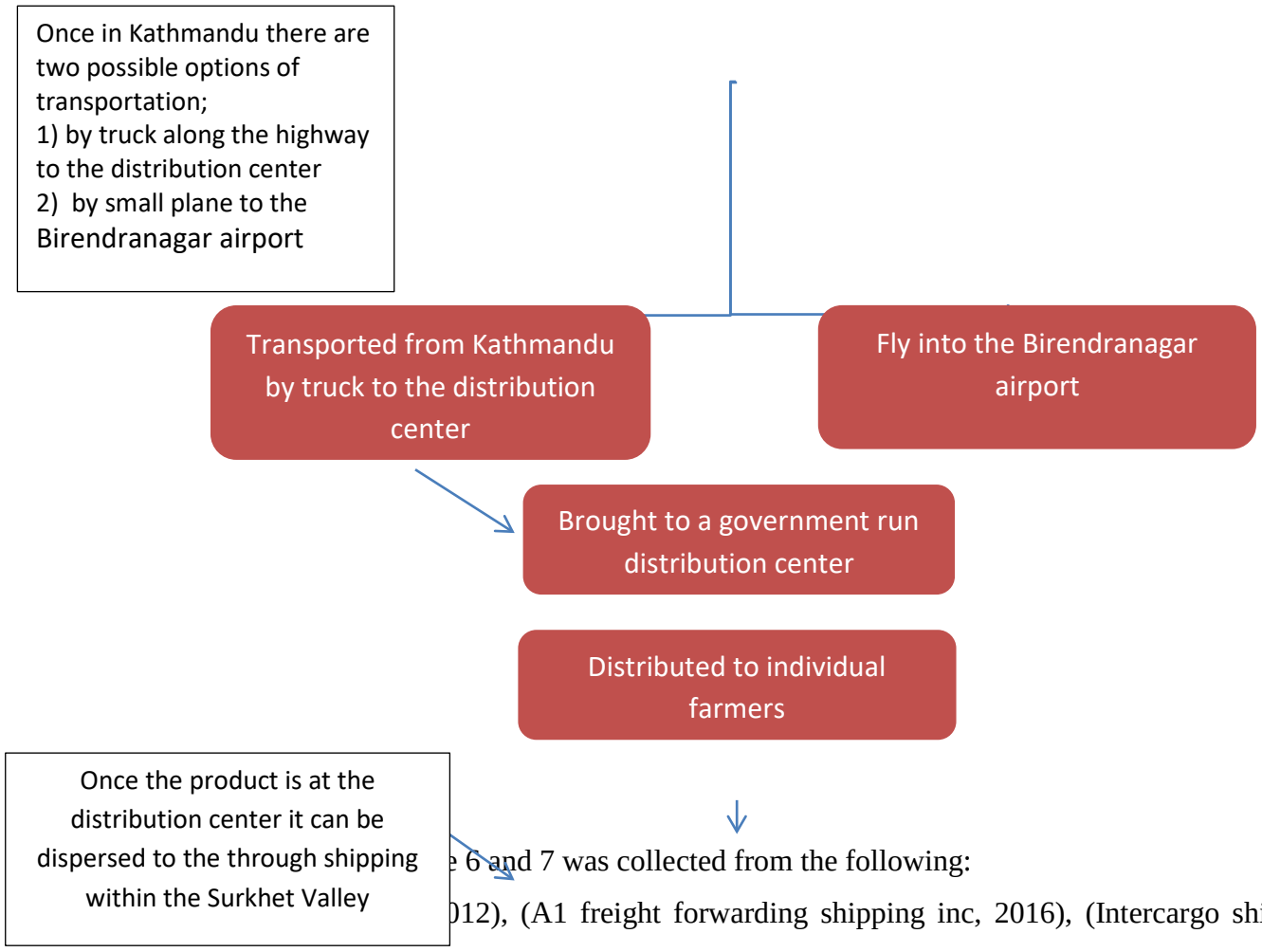


Table 7 is a potential transport routes the pesticides could take to get Nepal

Table 7: Alternative transportation route





e 6 and 7 was collected from the following:

012), (A1 freight forwarding shipping inc, 2016), (Intercargo shipping, 2016) and (S Pandey and company shipping company,2016)

Financial Analysis

Table 8 below documents a financial analysis of the cost and benefit of the use of Allosperse technology in the product Azteroid on a corn crop located in Nepal. The data used in the analysis are estimated values based on information available online (see references). Note that the price for Azteroid is an estimated value (based on typically herbicide cost estimates) because no pricing information was available from Vive.

Item	Units	Unit of measure
Crop Yield		
Corn price	200	$CAD/ metric ton
Expected yield increase (corn)	9.15	Percentage
Average farm size	0.94	Hectare
Average yield (corn) - No Allospere	2.22	Metric ton/hectare
Financial benefit		
Average farm size	0.94	Hectare
Corn yield per farm	2.09	Metric ton
Crop value (No Azteroid)	417.36	$CAD
Corn yield with fert Azteriod	2.28	Metric ton
Crop value with Azteriod	455.55	$CAD
Increase revenue (with Azteriod)	38.19	$CAD
Recommended fertilizer amt (7.6 fl oz/acre)	0.119	gallons/farm
Azteroid container size	1	gallon
Price	50.00	$CAD per 1 gallon
Plus shipping	94.00	
Total	144.00	Gallon
Cost for 1 farmer	17.14	
Benefit for 1 farmer	21.05	$CAD per farm

Table 8: Financial Analysis

Table 8 is a cost summary of the potential costs and earnings of a single yield of corn using the Allospere technology within a Nepalese farm.

The information from table 8 was collected from the following:
(Vive Crop production Inc, 2015)
(index mundi, 2016)
(United States Department of Agriculture (USDA), 2016) and
(Canada post, 2016)

The estimated benefit of the use of Allosperse technology in the product Azteroid for a typical farmer in Nepal is approximately $21 per crop.

The sizes of farms within Nepal are very small (0.94 hectare) and as a result of this it would it would not be possible for a single farmer to be able to purchase this product on their own because they would need much less than one gallon. As a result of this they would need to purchase this through a community effort or through an initiative like the Project for Agricultural Commercialization and Trade (PACT) which is an association of the World Bank.

Potential Negative Impacts

The introduction of Allosperse to Nepal has many positive benefits to the Nepalese agricultural system, however, there are possible negative impacts also (e.g., the unintended impact to the current environment within Nepal and the impact from human pesticide exposure).Although Allosperse technology in products such as AZteroid, Fenstro and Bifender are in use in the United States, the long term impact of this technology on the environment is unknown at this time.

The second impact that could come from the introduction of this within Nepal is an increased amount of use of and exposure to pesticides by farmers. Because of the expected increase in crop yields, there may be a wide scale increase of the use of pesticides within the different regions of Nepal. This could have a negative impact if farmers are not properly trained in the use of pesticides.

There must be proper education regarding the use of Allosperse, including proper application rates, proper handling and safety procedures. A lack of education of safety information and lack of training could result in a very large impact to the environment and to community health. Improper human exposure to pesticides can cause harmful effects (e.g., acute, delayed, and allergic effects (University of Kentucky, 2014) resulting in negative short and long term impact to the health of farmers.

Possible solutions

Although the issues stated above could have an impact on the society within Nepal, there are improvements that could be implemented along with the Allosperse technology in order to stop these events before they even occur. The first solution would be to provide proper training. This would help with the prevention of unintended impacts to the environment as farmers would be made aware of the impacts on the environment this can have if not used properly. Similarly this education in use of the product and spreading of pesticides could reduce the incidence of negative health impacts that are related to pesticide use.

In addition to training, safety procedures could be developed by the Nepalese government in the event of a spill. This could allow for proper cleanup of spilled chemicals preventing unintended consequences.

Conclusion: A Critical summary and recommendations

Allosperse technology could provide some limited benefits to agriculture in Nepal but I would not recommend this product would be good export to Nepal. The average crop yield in Nepal is significantly lower than in other developed nations (e.g., corn yield in Nepal 2.22 metric ton/hectare vs 10.88 metric ton/ hectare in U.S (United States department of Agriculture (USDA), 2016). The number of farms in Nepal that currently use insecticides, herbicides and fungicides is still low compared to use rates in more developed countries but it is increasing. Expansion in the proper use of pesticides could provide a positive benefit to Nepalese farmers. Given the typical small farm size, the incremental benefits that would be expected due to the use of Allosperse would not likely be justifiable.

Although currently this product is unrealistic for importation to Nepal if further work is put into the wider continued use of pesticides on farms within Nepal and the cost of pesticides with the Allosperse technology was comparable to costs for other pesticides, exportation of Allosperse technology may be beneficial in the future.

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