

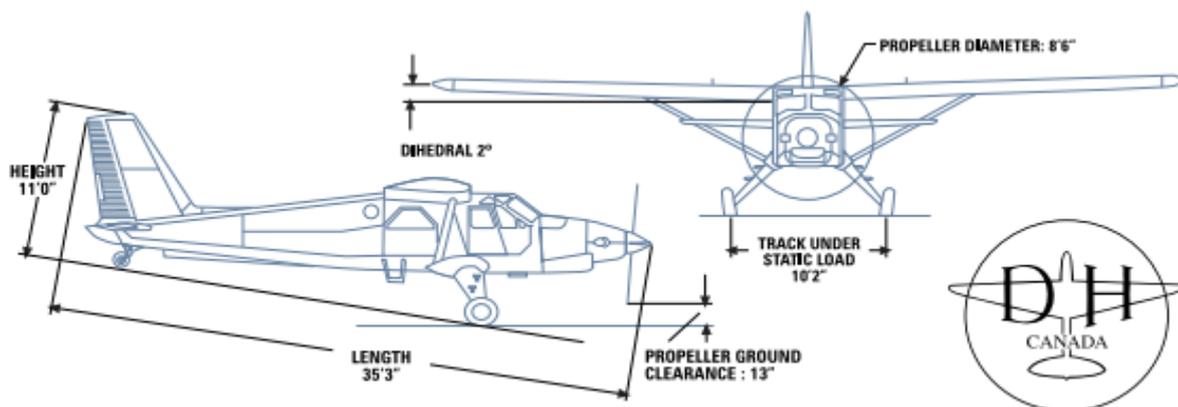
Export to Nepal: Viking (DHC-2T) Turbo Beaver

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Product Information

Product

The proposed product for export to Nepal is the Viking (DHC-2T) Turbo Beaver. A Canadian produced eight seat STOL aircraft (Viking Air Ltd.). The product would be shipped to Nepal with the purpose of being used as an agricultural aircraft for the purpose of spraying crops with pesticides, fungicides and herbicides to help hill farmers improve their yields. The product itself has a gross weight of 2720 kilograms, with a wingspan of 48 feet, length of 35



NOTE: Dimensions are approximate only and may vary depending on aircraft configuration and loading conditions.

feet, and a height of 15 feet.

(Viking air ltd.)

The aircraft has an effective range of 972 kilometers, on a 704 liter tank at 227 km/hr. The plane is capable of STOL(Short takeoff and landing), requiring only 312 meters of runway space for takeoffs and landing. The plane does not need a surfaced runway for takeoffs or landings, just a strip of relatively flat area. The plane is not an agricultural aircraft by factory design, but supports a simple modification to allow it to spray crops (Viking Air Ltd.)

Viking Air

_____ Viking air is a Canadian Company based in North Saanich, British Columbia. They founded in 1970 for sales modification and repair, they currently employ more than 435 people. Their main production focus is the Twin Otter aircraft, but they also manufacture the DHC-2T. In 1983 the company received the spares manufacturing and distribution contract from de Havilland, and in 2006 bought the type certificates from Bombardier for most the de Havilland aircraft. The current CEO is David Curtis. (Viking Air Ltd.)

Cost

_____ Viking air could not be reached for a price estimate, however second hand sources value the plane at around 1,000,000\$ CAD. The company website lists the contact for sales inquiry as VP. Dominique Spragg (dom.spragg@vikingair.com). The cost to fly the aircraft is approximately 240\$ for a 185 kilometer route based off calculator used for the Twin Otter, factored for the Turbo Beaver's weight difference, and the minimum wage of Nepal (Labor Act) and the fuel prices of Nepal ("Nepal Fuel prices," n.d.)

The appeal of this plane over an inexpensive kit plane would be mainly safety features, and reliability, however since it's prohibitively expensive to ship a fully built plane, it would have to be sent as parts to be constructed in Nepal. Smaller and perhaps more light planes could be seen as an attractive, inexpensive replacement.

	DHC-2T	Tapanee Levitation 2	Super-Cyclone	Nordic VII
Cost	Aprox 1 Million	35,000\$*	50,000\$	35,000*
Weight	1,316 kg	1,276 kg	816 kg	283 kg

Company	Viking Aviation	Tapanee Aviation	St-Just Aviation	Norman Aviation
Effective Distance	972	875 km	1,852 km	563 km
Load	1404	464 kg	772 kg	197 kg

* indicates the engine is not included

Load must include the weight of the pilot, seats and instruments

If Nepal desired to import kit planes from Canada, a company would have to be contracted to design and enter production of the plane. Companies that create kit planes will do one production run before moving onto a new cycle. It's likely a company in China or India could produce and design a kit plane for far less than what Canada could offer due to the cheaper cost of labor in those countries.

Job Growth

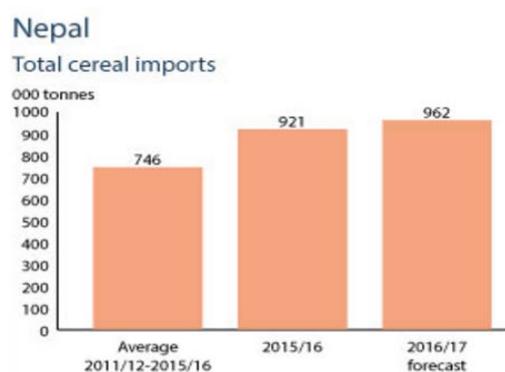
The production of the plane would provide both economic growth, and an increase in jobs. No exact figure could be found for the number of employees on the production side of Viking Air. In mid 2015 Viking air laid off 116 employees, mostly in its main North Saanich facility, mostly in in production with 74 employees being let go. This mass layoff was due to decreasing sales, and customers backing out of current sales. A contract with the Nepalese for exportation would allow Viking air to increase its workforce with guaranteed sales. Selling 50 planes to Nepal would require them to double production, and allow Viking air to set the groundwork for future potential contracts in the area of aerial application. (Duffy A.). If Viking Air was able to fill at least those vacant layoff spots, for a very conservative low income cutoff, it would directly add 3,238,488\$ per year to the economy (CCPA). With such a large contract, and workers likely making more than the bare minimum it wouldn't be surprising to see that number double. In addition to direct job growth, Viking Air may choose to directly source metal and materials from Canadian companies further adding the the economic growth of Canada. No data could be found for where Viking Air sources their

material, but a contract between Nepal, Canada and Viking Air may include a clause that they must source a reasonable amount of build materials locally.

Export Potential

Nepal

Nepal is a small country bordered by China and India, with a population of 31 million people. The country is split up into 3 distinct regions; terai, hill, and mountain region. The terai region is the most agriculturally successful region in Nepal (Savada & Harris, 1993). Only 20% of the land in Nepal is suitable for agricultural use, so it must be used as efficiently and effectively as possible. 83% of Nepal's population is



Notes: Total cereal includes rice in milled terms. Split year refers to individual crop marketing years.
Source: FAO/GIEWS Country Cereal Balance Sheets

Nepal
Cereal production

	2011-2015 average	2015	2016 forecast	change 2016/2015
	000 tonnes			percent
Rice (paddy)	4 742	4 299	4 840	13
Maize	2 167	2 230	2 250	1
Wheat	1 805	1 571	1 400	-11
Others	342	336	345	3
Total	9 056	8 436	8 835	5

Note: percentage change calculated from unrounded data.
Source: FAO/GIEWS Country Cereal Balance Sheets

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ulting in a high dependency on agriculture for economic growth. Over half of the Nepalese people are literate (57%) with a heavy skew towards male literacy (71% vs 47%). It's national budget is \$3.9 billion USD, and imports \$6.3 billion USD(The World Factbook: NEPAL. (n.d.)). Covered under this is the import of 921 000 tonnes of cereal crops, due to Nepal's food deficit (FAO nd.). This number is about equal to the total production capacity of Nepal. These numbers may be skewed due to the aftereffects of the Nepal earthquakes that occurred April 2015. Nepal's GDP per capita is on the lower end of the spectrum, at \$1500 USD. Agriculture in Nepal is directly responsible for the livelihood of 75% of the population, in addition to feeding everyone.

Chemical Literacy in Nepal

Nepal's current chemical usage is primary applied through the use of tractor when possible, and backpack sprayers when not. Though, the vast majority of nepalese farmers are not able to use the technology due to; not having knowledge of it, inability to transport the product, or prohibitive cost. Currently less than 8% of the population involved with intense agricultural development were found to be trained in integrated pest management (IPM) (Atreya K.). Most do understand the dangers of pesticides, and when given a choice between the health costs, and intensifying production using the chemical choose to forgo the spray to minimize the cost. A third of health care expenditure goes towards farmers afflicted with conditions stemming from the use of pesticides and fungicides, 144 Nepalese Rupees per individual. (Atreya K.). In addition, most Nepalese have not adopted the use of PPE (personal protective equipment) in regards to chemical spraying(Atreya K.). Currently most of the chemicals used are sourced from India, who also lacks the safety track record you might expect from a first world nation. The majority of chemicals outlawed or heavily regulated in Canada and the United States (Atreya K.), it would be best if the farmers did not need to interact with the chemicals given the poor education and safety options offered to them

Challenges of Spraying

For hill region farmers transportation is one of the largest factors in the application of chemicals to crops. Moving the agents needed for fungal and pests require a great deal of infrastructure which is just not present, especially considering the earthquake of 2015, April. This completely restricts tractors from most of these areas. Tractors are also poorly suited from Nepal's primary cereal crop, paddy rice. Because paddies take advantage of water for natural pest and fungal resistance tractors are unable to easily access the plants to spray them. (FAO nd.)

Spraying with an Aerial Applicator

By using an aerial applicator like the Viking DHC-2T Turbo Beaver, you can eliminate the need for farmers to interact with the chemical on the first degree. In addition, with an aerial applicator extremely rural areas can be reached for spraying. This also solves the problem of how to spray the paddy rice that a tractor cannot reach. The Viking DHC-2T Turbo Beaver is capable of the low level flights needed to spray the low lying crops. An aerial applicator would also perform reasonably in the hill region, however it's possible that an area with especially defined elevation differences could result in an uneven spray of chemicals, with some being dispersed too finely.

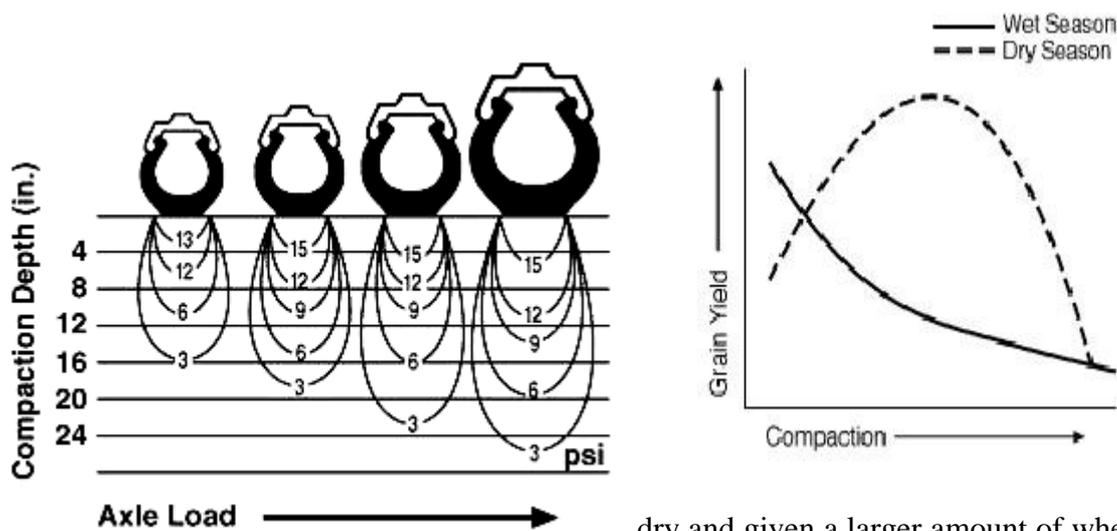
With a tradition applicator of chemicals like a tractor, a farmer could lose up to 5% of their yields from trampling alone, and requires farmed to spread the rows of their crop farther apart to make room for the tractor to run through (Hanna S. et al.). Data for foot trampling was unavailable, but the assumption can be made it's not significant. The use of an Aerial applicator eliminates both of these negative impacts of tractor based chemical application.

Soil compaction is another negative consequence of tractor based application. Soil compaction can cause a direct decrease in crop yields, and negatively affect the nutrition of

harvested crops (Soil compaction: Causes, effects and control. (n.d.)). With aerial application, by avoiding soil compaction corn yields, a staple cereal crop of nepal can be increased by an

additional 7.5%. Wheat conditions will

improve



dry and given a larger amount of wheel traffic,

Nepal however is not a dry region, and experiences a large amount of precipitation (FAO nd.). Wheat in a system with more moisture was found to result in higher yields with less wheel traffic. In addition, in soil with higher compaction wheat was found to be less abundant in protein, from 13.6% presence in non-compacted soil to 12.7% in compacted soil. Under high compaction potatoes were also found to have yields reduced up to 35%. Surface soil compaction can increase runoff, this allows for an increased amount of soil and water losses.

(Soil compaction: Causes, effects and control. (n.d.)). All of these issue can be avoided by use of the Viking DHC-2T Turbo Beaver.

Marketing

_____ With the GDP of Nepal so low (CIA nd.) it's unlikely any single person, village, or agricultural business would be able to afford the Viking DHC-2T Turbo Beaver price point of ~1,000,000\$. This would have to be a government purchase for the benefit of farmers, and their citizens. Since formation of the fifth 5 year plan in 1975 - 1980, the government has

shifted focus heavily to agricultural advancement for the purpose of economic growth(Savada, A. M). It would not be out of the picture that the government would pick up this import because of the focus on agricultural intensification. With this in mind market costs could be suppressed greatly with only one buyer in mind. Nepal already has programs in place to assist farmers as well, in that they will guarantee a price for the rice produced by their farmers. This shows that the government does care about the wellbeing of their agricultural workers, so they may take this extra step to help them.

Shipping

_____The most effective way to get the Viking DHC-2T Turbo Beaver to Nepal is through commercial air freight. The high cost of the plane makes some shipping routes prohibitively dangerous. When shipping by sea, you take the, albeit small risk of losing the shipping container. However it must then be trucked through India, and then up the mountain into Nepal. The most concerning part of this route is the long chain of custody, many things could go wrong or be lost. Therefore, ideally the freight is sent by air, unassembled directly to Kathmandu. This would likely cost anywhere from 3000\$-15000\$ USD depending on how efficiently the parts can be packed (Freight Shipping (n.d.))(Alibaba nd.). The plane would leave the production facility in North Saanich to be delivered at the Vancouver airport by an in house cargo truck. From there the unassembled parts will be shipped directly to Kathmandu where they will be assembled and shipped to the airfield the Nepalese government wants to house them.

Benefit to Importer

Nepal can benefit in non agricultural areas with the importation of the Viking DHC-2T Turbo Beaver. By importing a large number of unassembled aircraft, job opening will be available for educated workers, to help combat Nepal's brain drain (CIA nd). This will be temporary position, as the planes will not be imported forever, however if the imports are

spaced out correctly, some, or all of the workers could be kept on for repair and maintenance of the planes. Nepal will also need to train, and hire more pilots, at least one for each imported plane. As a government position, most or all of the money paid to these employees will find it's way back into the economy to spur GDP growth in Nepal(Sturm, J. et al). The agricultural benefits are increased yields, lower soil compaction, improved farmer safety and wellbeing, and improved nutrition in harvest crops.

Competition

_____ China and India both have aerospace manufactures, and have easier access to Nepal for trade. In addition both have much cheaper labour(CIA np.). Canada would be hard pressed to undercut either country if they decided they wanted to move into the market. China's state owned aerospace company Hongdu Aviation Industry Group has 20,000 employees and could easily copy or redesign a plane Canada chose to export for much less. Hongdu Aviation Industry Group could also sell a plane of their own making to Nepal. To avoid a situation like this a contract should be written up with Nepal with a clause to prevent competition. The matter of ethics behind such a clause may not be in Canada's best interest.

The DHC-2T Turbo Beaver also has competition from other types of aircraft. A UAV or unmanned drone used as an aerial applicator would be cheaper, safer, and allow the farmers who enter into the program to have more autonomy over their harvests. The Yamaha R-MAX is one such device, already widely used in Japan and South Korea in hilly areas where tractor spraying is not feasible and aerial application by plane is too dangerous. This type of Aerial application is also ideal for a system that has a higher number of small land size farms like Nepal. Not all the farms in an area are going to plant the same crop, so spraying them individually is the only way to ensure maximum yield increases. With an aerial applicator like the DHC-2T Turbo Beaver this is not efficient.

Possible Concerns

_____ Currently, there is no way for the farmers to inform the government that their crops need chemical assistance. So a system would need to be implemented that allowed the farmers to communicate with the government, or the branch that would be applying chemicals to the farm timely.

The issue of farmer education is also a problem. It may be difficult for a farmer to tell the difference between two afflictions to his crops without proper training. Farmers would also have to be taught how to use the communication system. Cell phone use in Nepal is quite high though so this could be circumvented by connecting farmers to the domestic network. This could be an opportunity to improve education in Nepal, but likely the additional cost of startup would deter the government from buying in. Farmers may also be slow to adopt the technology. It's possible that those in the agricultural sector will be adamant about maintaining the way they have done things up until now (Savada A. et al).

Viking air might not be seen as a reliable brand in Nepal. Tera Air, a domestic aviation service in Nepal has had two accidents with Viking's Twin Otter model. One was a fatal accident that killed all 22 people on board, another was a hatch malfunction that occurred 5 minutes after take off. (News B. nd). While the company's fleet is entirely de Havilland, and Viking Air built planes, it could be enough to turn public opinion away from the import, which has reliability and safety as a main selling point compared to the cheaper option, to a cheaper alternative from a competing country.

While there is currently no information about Nepalese Aerospace manufacturers, this import could stifle the industry. By becoming reliant on another country for an import, it's possible Nepal will never develop or research this technology past the maintenance and upkeep.

Future Research

Before exporting a plane of such cost and investment to Nepal, a study should

be done on plane performance in hilly areas, as this would be the most affected area if the export is a success. By being able to improve the yield outputs of such a difficult to maintain area, the export program will gain a considerable amount of traction.

A domestic telecommunications infrastructure system would benefit this type of program. As well as future Nepal programs that involve rural citizens.

Some unknowns that this proposal does not take into consideration are the types of pesticides and fungicides used, and whether they will be compatible with aerial application, research would need to be done in this area, or Nepal could source their chemicals from Canada as well. Because of the nature of Aerial application they would not be able to fly during a storm, so a study into the crossover between storm season, and when crops need to be sprayed for particular pest or fungus should be investigated.

A pilot program would be beneficial to Nepal. To have a few villages and communities attached to one or two planes in a rural airfield to test the effectiveness of aerial application. By starting with a small scale case study Nepal can make a more informed decision if the DHC-2T Turbo Beaver is a worthwhile investment. It could also lay the groundwork for a slow roll out of the plane across the nation.

Recommendation

The Viking DHC-2T Turbo Beaver, primarily due to it's cost, and excessive fuel consumption would not be an effective export to the country of Nepal. The time it would take to see economic returns on the expenditure would be much too long. With cheaper alternatives like kit planes available, the government, and any company interested in offering aerial application would be better off going that route, or even designing their own product to market domestically. An additional alternative would be a UAV applicator, or any sort of unmanned drone. By adopting these technology you remove the issue of communication and allow farmers to operate independently, and prevent any large scale plane based accident

from occurring. Canada would also be challenged to compete in these areas against India and China who have much cheaper labour for manufacturing, however a success in this area will allow Canada to market to other developing nations en masse who have similar needs to Nepal. In conclusion, the export of Viking DHC-2T Turbo Beaver is not recommended, but the research into similar fields of aerial application for the export to developing nations could prove beneficial.

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