Company Background

Montana Pure Protein offers Montana grown pulse crop ingredients and solutions to help satisfy consumer market demands for sustainable, flexible, nutritious and clean labeled products. Montana Pure Protein offers protein concentrate, starch flour and fiber, extrusion products, therefore enabling consumers to increase the intake of plant-based protein.

Project Title

Life cycle analysis (LCA) of Lentil Texturized vegetable protein (TVP) developed using Montana Pure Protein (MPP) lentil protein and starch concentrate.

Project Background

Textured or Texturized vegetable protein (TVP), also known as textured soy protein (TSP), soy meat, or soya chunks is a defatted soy flour product, a by-product of extracting soybean oil. It is often used as a meat analogue or meat extender. It is quick to cook, with protein content comparable to certain meats.

Texturized Vegetable Protein (TVP) is currently made using soy protein concentrate which is obtained from soy by extrusion. Soy cultivation in recent years has been associated with deforestation and pollution in the Amazon region. Lentil protein concentrate has been proven to be a viable substitute for soy protein concentrate. Determining the life cycle of lentils in making TVP would measure its effect on the environment and possibly reduce the burden on the Amazon Forest from the use of soy.

Extrusion

During extrusion, raw materials are forced to flow under controlled conditions along the length of the extruder barrel and through a shaped opening at a defined throughput. During extrusion the product is cooked and mixed by three separate energy sources: mechanical energy (shear caused by the screw elements), thermal energy that comes from the heating system, and self-heating due to the melt viscosity in the barrel. As the rheological behavior of the dough in the barrel greatly affects finished product quality, it is very important to control temperatures and process times to optimize food quality and heat transfer.

Extrusion causes a change in the structure of the soy protein which results in a fibrous, spongy matrix, similar in texture to meat.

Lentils farming in Montana

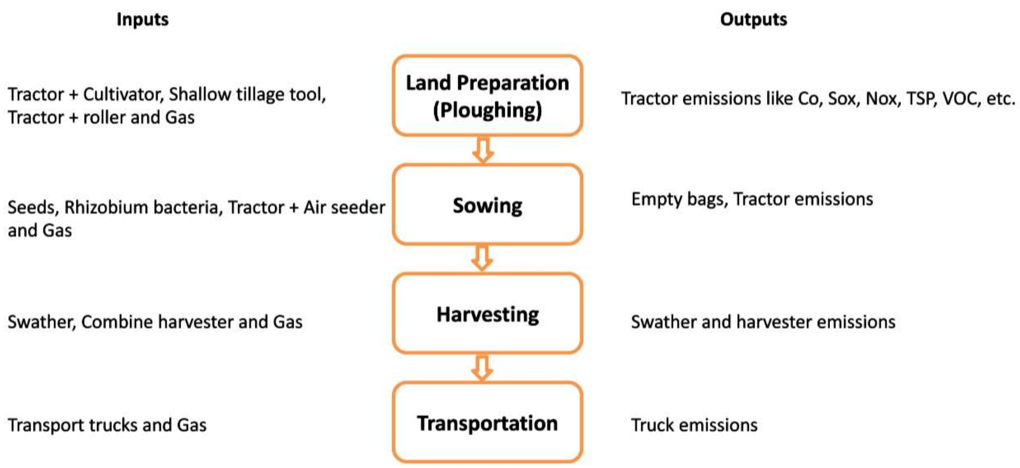
Montana is the largest producer of lentils in the United States, and accounts for more than 38% of lentils grown in the nation. Because lentils are a legume, like peas, beans, and alfalfa, they add nitrogen to the soil, improving soil health and reducing the need for nitrogen-based fertilizers.

For lentils cultivation the ploughing of soil is carried out by cultivator and tillage is done by shallow tillage tool and later soil is flattened with roller to breaking up the large lumps. Sowing of seeds with Rhizobium bacteria is carried out by air seeder equipment. No irrigation required for lentils farming and it only depends on late winter snow fall and rain fall i.e., around 9-16 inches. Lentil crop cutting is carried out by swather and later is subjected to dry for 7-10 days, after drying; harvesting is done out by combine harvester. For conventional farming the lentils yields around 1400 lb per acre and for organic farming is around 900 lb per acre.

Life Cycle Assessment (LCA)

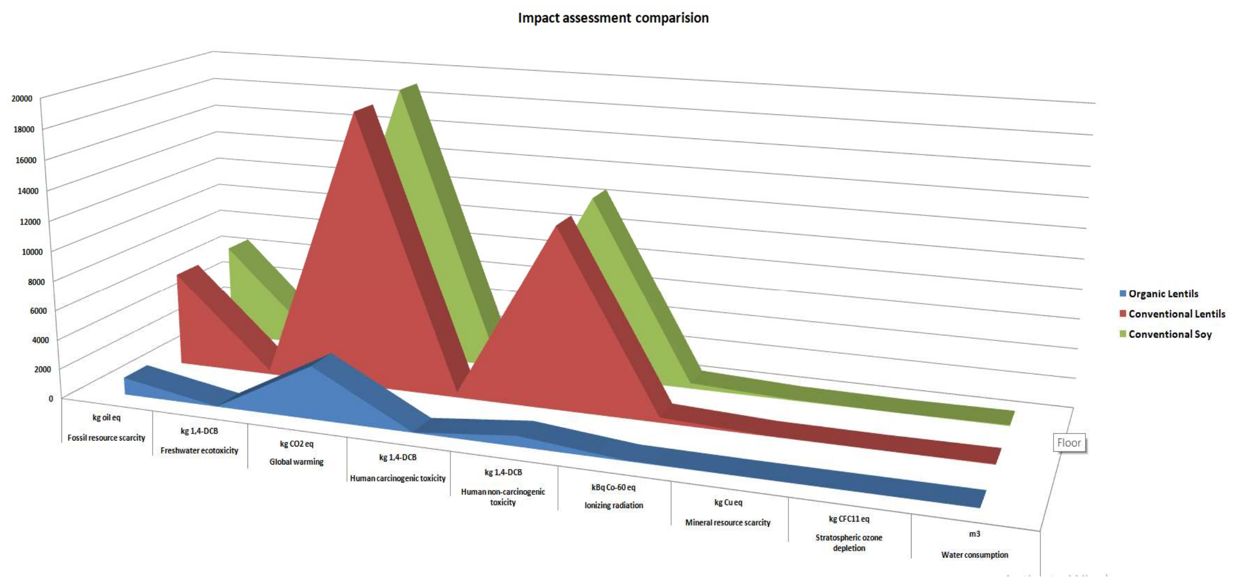
Life Cycle Assessment is a technique that allows identifying the overall environmental effects of the life cycle of a product or process, by evaluating the potential environmental impacts of a system through detailed study of the inputs of energy and mass in the production life cycle, including transportation. OpenLCA software is used for LCA with a database of AGRIBALYSE and ReCiPe 2016 Midpoint (H) is used as impact assessment method.

System Boundaries



Impact Assessment Comparison

As per system boundaries, LCA is performed for organic farming of lentils, conventional lentils farming and conventional soy farming. The impact assessment results such as GHG emissions as Global Warming Potential (GWP), ozone depletion, water consumption etc., are compared.



Conclusion

- The LCA study indicates organic lentil farming is more sustainable and less impact on environment.

S. No	Farming Type	Global Warming Potential (GWP) (kg co2eq per acre)	Stratospheric ozone depletion (kg CFC11 eq)	Water Consumption(m3)
1	Organic Lentils	3561.24	0.0040	6.10
2	Conventional Lentils	18672.59	0.0091	47.54
3	Conventional Soy	18963.04	0.0092	66.80

- Soy farming is driving towards deforestation in Amazon region and greater impact on environment.
- Organic farming of lentil will save 27528 gallons of water per acre and per crop cycle than conventional farming.

- Replacing of soy protein concentrate in Texturized Vegetable Protein with lentil protein concentrate is feasible.

Recommendation	Annual Reduction per crop (basis:50 hectare)	Annual Savings	Status
Organic Lentil farming (Ground water)	3401084 gallons of water	$4000	Recommended
Organic Lentil farming (Surface water)	3401084 gallons of water	$5100	Recommended

Intern: Ravi Kumar Pirati

Chemical Engineering, Montana State University.