WOOD FIBRE USE IN BC AGRICULTURE: SUPPLY - DEMAND ASSESSMENT AND ANALYSIS

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Final Report

Prepared by Allen Dobb B.S., M.S., P. Ag. and

James Hackett B.S.F, M.Sc., RPF

For the Ministry of Agriculture, Food and Fisheries

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Alex Kulchar – BC Cattlemen's Association
Joe Heemskerk – BC Association of Cattle Feeders
Phil Owen – BC Dairy Association
Dale Krahn – BC Chicken Growers Association
Christine Koch – BC Pork Association
Reg Ens – BC Agriculture Council
Mike Wallis –BC Cranberry Growers Association
Hedy Dyck – BC Landscape Nursery Association
Brent Barclay (Executive Sponsor) – Director of Regional Services, Ministry of Agriculture
Clayton Botkin – Industry Specialist – Poultry & Regulated Markets, Ministry of Agriculture
Karen Tabe – Regional Agrologist – Central Interior, Ministry of Agriculture, Food and Fisheries
Katie Galliazzo – Industry Advisor – Livestock, Ministry of Agriculture, Food and Fisheries
Amanda Fouty – Director Pricing and Tenures, South Area – Ministry of Forests, Lands, Natural Resource Operations and Rural Development

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Limitations

The findings, analysis and recommendations rely on the methods and assumptions described in the report and were developed with the diligence and standard of care required by the professional designations of the authors. The conditions on which the analysis and recommendations are based are dynamic and therefore the contents of the report should be re-evaluated and amended as required, prior to any reliance upon the information presented herein.

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Executive Summary

Over the last 10-15 years agriculture producers in BC have faced reduced availability and increased prices for residual wood fibre used in their operations. One of the primary and critical uses of whitewood (Spruce, Pine, Fir – SPF) sawdust and shavings (SDS) is for livestock bedding and poultry litter. Wood fibre is also used as a beneficial mulch in blueberry production, and as a component in soil mixes and growing mediums used by the greenhouse and nursery sectors. A sector wide shortage, precipitated by the shutdown of lumber mills during the first stage of the COVID-19 pandemic, led the Ministry of Agriculture, Food and Fisheries (AFF) to initiate this assessment of agriculture sector demand for residual wood fibre. With significant structural changes taking place in the forest industry, there was an identified need to explore the overall fibre supply, potential alternatives to wood fibre use in the various sectors, and the economic effects on agriculture operations.

The specific objectives of the agriculture wood fibre use assessment were to:

1. Identify total provincial, regional, and sector-specific residual wood fibre demand for agriculture; and estimate provincial and regional residual wood fibre supply. Variables should include, but not be limited to volume, type of fiber, supply sources, reliability of supply, timing of availability, regional differences, and trade-offs agriculture has had to make.
2. Delineate product characteristics used or required by the different agriculture sectors.
3. Identify wood fibre alternatives used by agriculture industries.
4. Identify supply gaps and critical needs, including any important regional differences that future work should consider.
5. Identify competition from secondary users of fibre products (e.g., bio energy, pellet industry)
6. Develop an economic evaluation of current costs for individual sectors, agriculture's ability to pay, impact to agriculture if cost is too high or supply is unavailable, maximum willingness to pay (WTP).
7. Provide recommendations to the province and the agriculture sector to address information gaps and issues.

The fibre unit (FU) is equivalent to 200 cu. ft. and is the most common form of measure for wood fibre trade in the agriculture sector. Since the residue outputs from raw log volume are reported in m^3 (solid wood), expansion factors were applied to the solid wood equivalents to get closer to the actual volume of the different residues produced. Actual (2018-20) and predicted (2021-26) wood fibre supply (SDS and hog fuel) was estimated using the BC Fibre Model (the "Model"). The surplus or deficit indicated by the model is the difference between residue supply and forest industry demand. Information on current supply conditions was also gathered through interviews with forest industry company managers. Agriculture demand for wood fibre was estimated by developing typical demand scenarios for each of the agriculture sectors included in the assessment from information obtained through interviews with survey participants.

The Model output suggests Forest industry demand for SDS has been relatively constant for the period, estimated at 3.1 million FUs per year. A provincial surplus of 628,753 FUs in 2018, turned into a deficit of -417,617 FUs in 2019. The SDS deficit increases in 2020, to -461,091 FUs. By 2022, a small surplus is forecast for the rest of the period. Under the Model assumptions, there are chronic deficits (actual and forecast) for the Central Interior, Cariboo, and Thompson-Okanagan regions, where competition for SDS from the co-generation, pulp and especially the pellet industries is high. SDS is preferred by these facilities, because dehydration and manufacturing costs are lower for this material compared to other types of fibre. The Model results for hog fuel show that BC is in a deficit position for the entire 2018-2026 period under the model assumptions. The provincial deficit was -1,550,427 FUs in 2018 and increased to -1,949,631 in 2020. The forecast deficit is in the range of -1,821,673 to -1,852,235 FUs for the 2021-2026 period. Major hog fuel deficits exist in all the Model regions except W. Prince Rupert and Kootenay.

BC forest product company fibre managers generally agree with the trends predicted by the Model, that supplies will continue to be constrained for both sawdust, shavings and hog fuel and competitive conditions will continue to intensify. This is despite recent market conditions, where record prices for dimension lumber and panels were observed, with mills running at two-shift or more capacity, resulted in a glut of residual fibre. These same managers opined that a year ago, in Spring, 2020, "conditions were just the opposite". Residual fibre was in short supply at that time.

Current Central Interior prices for shavings and sawdust range between $40-$50/ODT ($32-$40/FU) and $30-$40/ODT ($24-$32/FU) respectively. Prices are considerably lower in the Kootenays at where there is an identified surplus, with one mill reporting a price of $20/ODT ($16/FU). Hog fuel prices in the Central Interior are significantly lower than SDS, ranging between $10-$20/ODT ($8-$17/FU).

Total provincial demand for SDS from agriculture is estimated at 412,421 FUs/year. The largest combined demand is in the Lower Mainland at 268,255 FUs/year or 68% of the provincial total. The Thompson-Okanagan has the next highest demand at 67,397 FUs/year (16.3%), followed by Vancouver Island at 39,249 FUs (9.5%). The largest demand comes from the dairy sector at 139,408 FUs/year, followed by equine at 116,735 FUs/year. The poultry and blueberry sectors have nearly identical demand at 61,991 and 61,717 FUs/year respectively. The beef sector has the lowest demand overall, with the combined demand of the feeder and cow-calf subsectors estimated at 32,570 FUs/year.

The provincial average price paid by producer participants is close to $70/FU delivered. The lowest price in the survey ($23/FU), was recorded In the Kootenay region where there is an indicated SDS surplus, whereas the highest prices were recorded from the dairy sector in the lower mainland at $100-115/FU. Hog fuel uses in agriculture are primarily in the greenhouse and nursery, equine sectors. Both uses are difficult to estimate. Although Information on the total greenhouse and nursery sector demand was sought by surveying primary suppliers in the Lower Mainland, Thompson-Okanagan, and on Vancouver Island. Only one supplier reported information, so this area of agriculture demand was not estimated for the assessment.

There are important regional distinctions as it relates to agriculture demand of SDS. The aggregate demand from agriculture on the coast is 307, 504 FUs/year (Lower Mainland and Vancouver Island regions combined). What sets this region apart is that no specific forest industry demand for SDS has been identified by the Model. Agriculture is the main consumer of the SDS supply, which amounted to an estimated 411,109 FUs in 2018. In the Thompson-Okanagan region agriculture has much lower SDS

requirements, but still a sizeable critical demand of 67,397 FUs/year. Total supply for the region is predicted to stabilize at around 425,000 FUs. However, forest industry demand, almost exclusively from the pellet industry amounts to 487,776 FUs. This puts agriculture at a significant disadvantage in capturing part of the supply because of the dispersed unaggregated nature of this demand. In the Central Interior, the SDS supply is substantially larger than any other region, hovering close to 1M FUs. However, projected industrial demand is close to 1.6M FUs. Agriculture demand hardly registers in the balance with estimated demand at around 16,000 FUs. The Kootenay region is the only agriculture region in the province where there is an identified SDS surplus.

The prices recorded in this assessment indicate that agriculture consumers of SDS are paying competitive prices in all areas of the province. Several participants reported 100% price increases in the last two years. More critical for some has been the decrease in fibre supply as well as the inability to secure fibre on a consistent basis. In other situations, substitution with a type of fibre that is less preferred has accompanied the price increases. SDS is currently a critical input on most dairy and poultry operations in the province. Use can be reduced slightly, but a certain amount of bedding or litter is required in any given system in these two sectors. In the short term at least, this demand appears to be inelastic since consumers are paying higher prices for the same quantities. However, it appears demand from the cow-calf beef sector is elastic with consumption declining as the shavings price has increased.

Substitutes for SDS in agriculture need to perform nearly as well or better than wood fibre, and there needs to be adequate supply of the substitute available at a cost similar or lower to that of SDS. Some suggested fibre alternatives such as hemp and straw do not meet these criteria. A further consideration for materials used for animal bedding is that they be free of chemical and heavy metal contaminants that may impact animal health or plants and soils where used bedding products are applied. Recycled or composted manure solids and sand show potential for reducing the total amount of wood fibre use in the dairy and poultry sectors. There appears to be limited opportunity for substitutes for SDS in blueberry production. However, research in Oregon State suggests there may be some opportunity to reduce SDS use by combining the use of sawdust with weed mats. The blueberry industry, with limited options for substitutes, highlights that sector-specific applied research is necessary to properly evaluate alternatives and support adaptation to reduce use and find economic alternatives.

An informed response to the wood fibre issues being faced by the agriculture sector is needed. For example, increasing the amount of roadside fibre processing in the central interior through policy mechanisms, may help with structural wood fibre deficits in the forest industry, but is likely to have limited benefit for agriculture consumers of SDS. Large industrial consumers (i.e., pellet producers) will continue to use SDS before turning to roadside chipped material because it lowers manufacturing costs. The wood fibre requirements of the agriculture sector, including type, total demand, the regional distribution of demand, as well as transportation differentials, need to be at the forefront of any policy discussion related to supply solutions. Opportunity to manufacture product specifically for the agriculture sector may be possible at smaller scales in certain areas, but the profitability of this kind of operation needs to be positive or it would not be sustained.

With wood fibre deficits predicted to continue into the near future, the agriculture sector will need to adapt to reduce dependency on wood fibre use in livestock operations. Leadership from Agriculture sector partners is needed to support adaptation in this area. Government also has role in facilitating

adaptation in agriculture through its goals related to food security and creating viable agriculture businesses. Based on the information, analysis and findings that make up this assessment the following recommendations are provided:

1. The province and industry partners should consider collaborating on a response plan to deal with a sudden disruption of critical SDS supply in the Lower Mainland, Thompson-Okanagan and on Vancouver Island. Key points to establish would be:

    a. Minimum bedding product standards and sector priorities and
    b. Most efficient mechanisms for securing residual fibre supply, delivery, and distribution
    c. Roles and responsibilities
    d. Potential for incorporation or support from existing provincial/federal emergency programs.

2. This assessment report should form part of the background materials used in the development of a potential response plan, and other adaptation planning and support.

3. The agriculture sector should consider undertaking assessment on the residual fibre supply in neighboring US States of the Pacific Northwest to identify whether there is a surplus of SDS supply in that region that could potentially serve Lower Mainland agriculture. A secondary objective would be to assess adaptations in agriculture production where wood fibre use is important or has been used in the past and now substituted with new technology or products.

4. The province should consider continuing to provide information to the agriculture sectors on the status of the residual fibre supply (production and industrial demand balance), by purchasing outputs from the BC Fibre Model every 1-2 years and reporting changes. Future use of the Model should include and require a document detailing all inputs, outputs, and assumptions. Developing capacity within FLNRORD Compensation and Business Risk and Analysis Branch to carry out this function could be explored. Alternatively, FLNRORD may consider developing another version of the Model.

5. The province should consider supporting individual agriculture sectors in research, pilot demonstrations, and adaptation efforts to explore substitutes for residual wood fibre, and new applications that may reduce dependency on this resource. One example could be to test, pilot and research the use of a shavings mill and/or grinder with or without screens. This work might be initiated through a collaboration with FP Innovations and one of the agriculture sector associations.

6. Future research and adaptation projects should be regionally based and sector specific to ensure resource constraints and opportunities of each region and the requirements of each sector are appropriately considered.

7. Producer associations should advise regulatory boards and research councils and other organizations about the need for applied scientific and economic research on bedding (dairy), litter (poultry) substitutes, and various applications that would support adaptation.

8. Based on future research findings and additional expert investigation, producer groups and associations (e.g., BC Dairy Association and BC Chicken Growers Association) should work with their respective regulatory boards and through the National Farm Animal Care Council to develop recommendations for manure and litter reuse and substitute materials.
9. Government and the steering committee for this project should consider the recommendations and discuss the value of continuing the steering committee for the purpose of developing a joint strategy for wood fibre use in BC agriculture.

1 Introduction

In January 2021, the Ministry of Agriculture, Food and Fisheries (AFF) requested a proposal to assess agriculture sector demand for residual wood fibre. The request was made following a sector wide fibre shortage precipitated by the shutdown of lumber manufacturing during the first stage of the COVID-19 pandemic in March 2020. Shortages of animal bedding, one of the main uses of residual wood fibre in agriculture, raised immediate concern for animal welfare and potential food security. At the time, a joint Ministry group supported by AFF, and the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) was formed to identify options for making an emergency supply of fibre available for the poultry and dairy sectors. Fortunately, lumber mills came back online before the crisis deepened.

Even before the shortage caused by COVID-19, agriculture producers had been experiencing supply constraints and increased prices for residual wood fibre. These changes were being driven by fundamental shifts in the BC Forest Industry. Chief among them, were reductions to the annual allowable cut (AAC) for timber harvest authorized on provincial Crown land following the massive Mountain Pine Beetle salvage harvest, and increased demand by other residual wood consumers, particularly the bioenergy industry. Also, to be more efficient, primary mills had reconfigured their infrastructure and were using more residual wood fibre to power their processing plants.

Given the significant structural changes taking place in the forest industry, there was an identified need to explore the overall fibre supply, potential alternatives to wood fibre use in the various sectors, and the economic effects on agriculture operations.

1.1 Assessment Objectives

The specific objectives of the agriculture wood fibre use assessment were to:

1. Identify total provincial, regional, and sector-specific residual wood fibre demand for agriculture; and estimate provincial and regional residual wood fibre supply. Variables should include, but not be limited to volume, type of fiber, supply sources, reliability of supply, timing of availability, regional differences, and trade-offs agriculture has had to make.
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The assessment is focused primarily on those parts of the agriculture sector that have enough demand on an annual basis that the wood fibre is sold and delivered to the farm in bulk, i.e., truckload volumes. There is a value-added component of the industry that supplies small amounts of packaged wood fibre to retail customers. This aspect is addressed briefly in the market development section under section 5.

1.2 Wood Fibre Flows in BC

Wood fibre flows in the BC forest industry are depicted in Figure 1. Processing of raw logs by various manufacturing facilities is the main source of residual wood fibre from BC's forest sector. The byproduct from these mills includes chips, sawdust and shavings (SDS), and hog fuel. These sources of fibre are used by both primary and secondary plants including pulp and paper, oriented strand board (OSB), pellet and bioenergy plants. Recently, encouraged by government policy and programs to increase utilization of onsite and roadside harvest waste, some wood fibre from these sources is now part of the residue stream. This material is typically chipped and used to supplement forest sector consumer demand.

BC's Agriculture sector has long been a consumer of residual wood fibre, but this use has previously not been given much consideration. For the most part, agriculture was thought of as a beneficiary of waste and surplus product left in the system after all the demand from consuming secondary plants and mills was filled.

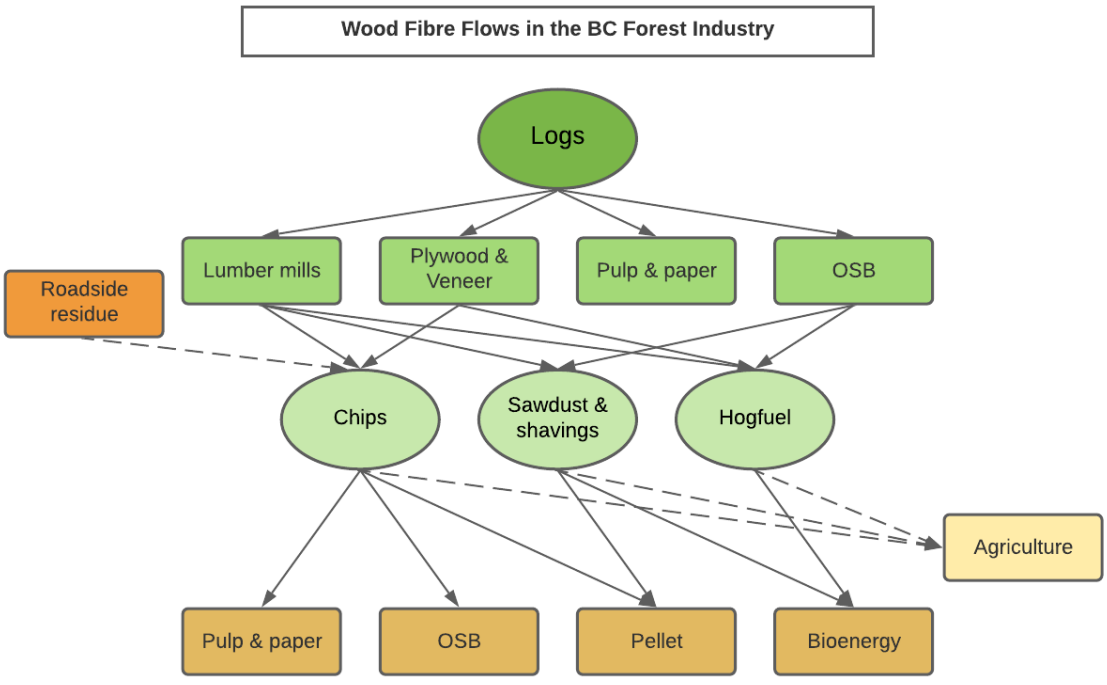


Figure 1 Graphic showing wood fibre flows in the BC forest industry

Source: Adapted from Ghafghazi, S., K. Lochhead, A.H. Mathey, N. Forsell, S. Leduc, W. Mabee, and G. Bull. 2017. Estimating Mill Residue Surplus in Canada: A Spatial Forest Fiber Cascade Modeling Approach. *Forest Products Journal*. 67(3–4):205–218.

1.3 Fibre Flow Models

Average fibre outputs from various manufacturing processes have been estimated by different models. These are usually expressed as a percent of the total input biomass measured by volume or weight. For example, the output of SDS residue from lumber processing is around 15% (sawdust 7% and shavings 8%); woodchips represent 33% and bark 5%.[1]

1.4 Measurement Standards

Both volume and weight-based units are used to measure quantity of wood fibre at different stages of the manufacturing process. Raw log inputs are typically measured in cubic meters (m^3) of solid wood. Wood volume can be converted to weight by using standard bulk density values for different tree species. Moisture content is a factor in this conversion, and there are different bulk density values for green and dry wood (defined as 12% moisture.). The residual fibre from manufacturing is usually measured in tonnes (t). Dry fibre (SDS) is measured in bone dry units (BDU), which is equivalent to 2400 lbs. Bone dry tonnes (1000 kg) is also used. Provincial exemption orders authorized under section 128 of the *Forest Act* to allow SDS export use BDUs.[2]

Sawdust, shavings, and hog fuel are also sold on a volume basis. The fibre unit (FU) is equivalent to 200 cu. ft. and is often used as a standard for product transported and distributed by truck. The FU is a convenient form of measure in situations where truck scales may not be available, and it is by far the most common form of measure for wood fibre trade in the agriculture sector.

When raw logs are processed into various products, the physical characteristics of different parts of the log are changed. Solid wood turned into sawdust, for example, has a different density than the wood it comes from. Expansion factors have been developed to account for the change in volume created by processing wood into chips or residues all with different sizes and shapes. Wood fibre residues settle after being piled, or they may be mechanically compressed, and this changes their volume. Compaction factors are sometimes applied to account for these changes. Products settle over time because of gravity. The FU is considered a gravity packed unit, in that the measurement does not account for any mechanical compression.

To properly assess supply and demand, both sides of the balance must be measured in the same units. Most agriculture demand (consumption) is reported in FUs, so this is the standard of measurement adopted for this assessment. Since the residue outputs from raw log volume are reported in m^3 (solid wood), expansion factors were applied to the solid wood equivalents to get closer to the actual volume of the different residues produced. The factors for sawdust, shavings and hog fuel were 2.5, 4, and 2.74, respectively.[3] A standard 10% reduction factor was applied to all expanded volumes to account for some gravitational settling.

2 Assessment Approach (Methods)

Various information sources were used to complete the assessment. They included:

- Phone interviews and meetings with agriculture producers and companies, producer association representatives and staff

- Phone interviews with forest industry company managers and staff, SDS suppliers and distributors
- Agriculture and forest industry documents, reports, and published research papers
- Statistics Canada and BC provincial data and
- Internet website and webpage documents.

2.1 Agriculture Demand

Residual wood fibre from BC's forest industries is used in different aspects of production by BC's agriculture sectors. One of the primary and critical uses of SDS is for livestock bedding and poultry litter. Wood fibre is also used as a beneficial mulch in blueberry production, and as a component in soil mixes and growing mediums used by the greenhouse and nursery sectors.

To assess agriculture demand, the province was divided into agriculture regions (Figure 2). The regions generally correspond to Statistics Canada Census Regions. These regions are also call Economic or Development Regions. The exception is the Central Interior – Highway 16 region which combines two Census Divisions (Bulkley-Nechako and Fraser-Fort George) that are from different census regions.[4] The darker brown shaded area in Figure 2 is the Agricultural Land Reserve, which serves as very general proxy for the location of agriculture production in the province.

The assessment considers the use of residual wood fibre in the following agriculture sectors:

1. Dairy
2. Beef
3. Poultry
4. Pork
5. Equine
6. Berries
7. Greenhouse and Nursery

Agriculture production is regionally distributed in BC. For example, dairy, poultry, and berry production is heavily concentrated in the Lower Mainland, with secondary areas of production in the Thompson-Okanagan and Vancouver Island regions. There is some additional dairy production in the Kootenays, Central Interior and Peace. Beef production is distributed throughout the province, but associated wood fibre use is variable region to region. Likewise, the equine sector is quite diverse throughout the province but there is a significant population of horses in the Lower Mainland and on Vancouver Island, which represents a considerable demand for wood fibre. Use of wood fibre by the greenhouse and nursery sector is also concentrated in the Lower Mainland, Vancouver Island and Thompson Okanagan. Commercial pork production is in decline in BC, and current production systems do not use wood fibre.

2.1.0 Participation

The regional distribution of production largely dictated the approach taken for selecting and engaging with participants from the respective agriculture sectors. The steering committee members were the first point of contact and engagement, and all the producer steering committee members contributed information as project participants. Staff and representatives from producer associations, including the

Figure 2 Map of BC agriculture regions and the Agricultural Land Reserve (ALR)

BC Dairy Association, BC Broiler Hatching Egg Commission, BC Egg Marketing Board, BC Turkey Farmers, BC Pork Producers Association, Horse Council of BC, BC Cranberry Grower's Association and the BC Landscape and Nursery Association were interviewed and, in some cases, provided contact information for participants. This input was particularly helpful for the dairy sector where there is both province wide production, and considerable variation in manure management and bedding systems.

A meeting with representatives of the BC Pork Producers Association confirmed that wood fibre use by that sector was negligible and no further engagement was required. Similarly, the executive director of the BC Cranberry Growers Association indicated that historic use of hog fuel for berms and field access had shifted to other fill materials, there was now minimal use of wood fibre cranberry growers. The small area of cranberry production, approximately 2,632 ha (6,500 acres) concentrated in the Lower Mainland, also meant that if there is minor use in production that the total volume would be minimal. The provincial AFF industry specialist for berries was engaged to discuss use of wood fibre in other berry crops. It was confirmed that the most significant use is in blueberry production, with only incidental use in other crops. Participant contacts for blueberries were provided by the AFF industry specialist.

2.1.1 Demand Profiles

A non-statistical survey approach was used to establish characteristics of wood fibre use among different types of enterprises in each sector. An interview frame was created in Filemaker Pro, and

used to document participant responses, which were exported to an Excel spreadsheet for analysis. Basic information on each enterprise including location, scale and specific details of wood fibre use was recorded. Use variables included preferred fibre type, supplier information, volume used, rate of use, recent price paid, WTP, and adaptations to deal with potential shortages. A statement regarding information and privacy, a request for informed consent to participate was included as part of the interview frame.

Participants were interviewed in March and April 2021 by phone or zoom audio, with interview times ranging from 20-40 minutes. Some participants had multi-enterprise operations. For example, one poultry producer also had a beef feeding operation, another had broiler, turkey, and pullet production operations. In these cases, a survey record was created for each of the enterprises. Several participants provided detailed use information in Excel or table form.

The objective of the survey was to establish a typical or average demand profile for each type of enterprise. The number of participants was increased for sectors that potentially had more variability in production practices and use. Given the broad scope of the assessment and the number of sectors, limits had to be placed on the final number of participants.

Demand profiles for each sector were based on common units. For example, the actual consumptive use in large animal operations, i.e., dairies, beef farms, and equine operations were converted to standard units, i.e., demand in FUs/year/100 milking cows, or FUs/year/100 horses, etc. For poultry, the standard consumptive unit was based on FUs/year/1000 kgs in the subsectors where quota is based on total weight. In the subsectors where quota is based on number of birds, the standard for consumption was 1000 birds. For blueberries, the standard consumption unit was based on FUs/year/acre.

Once the wood fibre consumption was standardized for each enterprise, maximum, minimum, and average demand were calculated from the sample. A final standard value was then selected by considering characteristics of the sample. These average consumption/standard units of demand were combined with aggregate data from the Census of Agriculture or other sources, to provide an estimate of total demand by region. For example, total blueberry demand would be estimated by multiplying the FUs/year/acre by the total acreage reported by the Census of Agriculture. For poultry, provincial quota values, either in kilograms or number of birds, depending on the subsector, were used to estimate total demand.

For some sectors, additional adjustment factors were applied to account for variations in practice in operation type, and between regions. This was especially true for the equine estimate, where it was necessary to account for the difference in practices in keeping ranch and guide outfitter horses in rural regions versus horses used for recreation, racing, and sport in the Lower Mainland. Some of assumptions underlying these adjustments are discussed in Section 4, Agriculture Demand.

Part way into the assessment it was recognized that the demand profile approach could not be used for estimating use by the nursery and greenhouse sector. This is because wood fibre use is widely distributed to intermediate suppliers and soil mixers, before going to other intermedairies for retail distribution. Information on this use was provided by a limited number of interviews with soil mixers, and direct queries to major wood fibre suppliers and distributers in the Lower Mainland, Thompson-Okanagan and on Vancouver Island. Unfortunately, the low response rate from this group meant that it was not possible to create a meaningful summary of this demand for this report.

2.2 Wood Fibre Supply

Wood fibre supply was estimated with the aid of the BC Fibre Model (the "Model"). It provided a strategic analysis of residual fibre supply within the regions identified in Figure 2 for the 2018-2026 period. A description of the Model, and its key assumptions and outputs included in this report, are provided in section 3. In addition, telephone interviews with BC forest sector or trucking distribution companies that either supply or consume residual products were conducted to relate current conditions to Model output.

3 Wood Fibre Supply

Over the past fifteen years the BC forest industry has undergone significant change with reductions to AAC, reduced timber harvests and mill closures because of the mountain pine and spruce beetle infestations, devastating wildfires, and reductions to the timber harvesting land base. In 2016, the provincial AAC was 72.5 million cubic meters, but it was forecast to decrease to less than 60 million cubic meters by 2026.[5] FLNRORD has responded to these timber supply issues by developing policies designed to increase use of residual fibre and leave less useable wood in the forest. These policies have, in part, helped maintain a relatively steady demand for SDS over time. In 2005, aggregate forest industry demand for SDS was 5.9 million cubic meters per year. Demand has remained relatively constant since then and was estimated in the Model to be slightly less, at 5.8 million cubic meters per year in 2020.

Lumber and pellet mill infrastructure in BC is shown in the maps in Appendix A (Figure 15, Figure 16). Lumber mill capacity is oriented toward timber supply volume, which is evidenced by the number of large capacity mills in the Central Interior. Mills are also located near highways and railways to minimize transportation costs for primary and residual products. Similarly, pellet plants are located close to lumber mills because transportation logistics for fibre input and product outturn are important economic considerations for this industry (Photo 1).

Photo 1 Pinnacle Renewable Energy pellet plant at Strathnaver along Highway 97 just north of Dunkley

3.1 BC Fibre Model

The Model is a proprietary Excel spreadsheet model of the BC forest sector that provides strategic assessment of sawlog, pulp log, woodchips, sawdust, shavings, and hog fuel availability over a 45-year planning horizon, from 2005 to 2050. It is owned and maintained by Industrial Forestry Services Ltd of Prince George, BC. It uses both historical and forecast information to assess impacts of changes to fibre demand and supply by region and forestry sub-sector. [i]

3.1.1 Model Assumptions

Industrial fibre demand is defined within the Model as annual roundwood-equivalent mill capacity from all mill types. [ii] This includes fibre used by lumber mills, veneer plants, shake and shingle mills, post and pole mills, pulp and paper and engineered panel board mills and all residual fibre consumers, including power boilers, pellet, and board plants. It is assumed that shortfalls in SDS and hog fuel would be replaced with post-harvest roadside residual fibre (the next lowest cost alternative). Sawmill run rates have been rationalized to meet regional timber supply and demand, and a sawmill's production dictates SDS and hog fuel supply. SDS and hog fuel demand has not been rationalized and assumes its consumers run at full capacity moving forward. For most operations a default 95% is used to represent full capacity for the model output used in this report. The capacity factors for any consuming mill can be adjusted in the model output to reflect operational curtailments when this information is known.

Total capacity within the Model is updated as mills open, expand or close. For example, in 2019, Pinnacle Pellet in Smithers, BC opened with an estimated capacity of 147,990 FUs. On the other hand, Viridis Okanagan Pellet, owned by Westwood Fibre in Westbank, BC, closed in 2016. The Model is updated to reflect capacity changes as information becomes available.

Industrial demand in the Model includes an estimate for agriculture, but only for the Coastal Region. The Model owner suggests this is a provisional estimate, and there is no information available on how it was derived. For this reason, this figure was excluded from all analysis, and the information collected for the assessment was relied upon to represent agriculture demand for residual fibre.

Fibre supply is defined in two ways within the Model. First, supply is the actual harvest in cubic metres for all management units within a region where annual data is available. Harvest data is obtained from the FLNRORD Harvest Billing System (HBS), which is the official record of all timber harvested and scaled in BC. Second, supply is forecast as the allowable AAC for all forest tenures and adjusted for the expected harvest on private and federal lands. The tenures include tree farm licences, First Nations woodland licences, woodlots, community forests, volume-based licences in timber supply areas and private and federal timberland sources. For the purposes of this analysis, fibre supply forecasts are held constant at the current AAC.

The Model does not define industrial demand or supply in economic terms that involves end-product prices as factors of demand or input costs as factors of supply. Mill consumption assumes that the fibre purchased for manufacturing purposes is within a mill's economic margin.

[i] See Appendix B for a map of BC defining the BC Fibre Model regions.
[ii] The term "industrial demand" refers to milling capacity from the "various", pulp, pellet, and co-generation sub-sectors. It does not include agricultural demand.

3.1.2 Model Outputs

The Model compiles annual coniferous roundwood log capacity data for each lumber mill within a region, based on individual mill capacities, operating rates, and lumber recovery factors. Lumber recovery factors are the ratio of roundwood log volume input to the volume of lumber output that is "recovered". This demand data becomes the primary breakdown of roundwood volume for lumber mills, planer mills, and veneer and plywood plants. The residual fibre products manufactured from these dimension lumber and veneer plants includes chips, sawdust, shavings, and hog fuel. The bark portion left after processing is included in the hog fuel category within the Model. Residual fibre volume is based on output assumptions like those described in section 1.3. Product volumes are compiled as roundwood (cubic meter) equivalents based on standard output factors associated with each manufacturing process. The output data from the scenario run for the assessment is current to April 2021.

3.1.3 Model Limitations

The Model accurately represents the wood fibre industry in BC and accounts for the flow of inputs and outputs, there are however some limitations. As described above, it uses input data from several sources, and reporting and recording accuracy will vary among these sources. For historic outputs, actual timber harvest data is the timber supply input for the Model, and this volume is known. When AAC is used to forecast timber supply, there is greater uncertainty because it may change (i.e., most likely decrease) due to changes in government policy. In the short run, loss of timber because of large and high severity wildfires like those occurring in the 2021 fire season, will also affect supply. Timber and fibre can be stockpiled as companies will attempt to rationalize operations with current market conditions. While the Model can account for fibre inputs from logging debris, there is currently no way to quantify this volume.

There is potential for error in the application of assumptions related to rates of recovery and manufacturing processes. Outputs and efficiencies may change when a plant or a mill adds equipment or changes process.

The standard expansion factors used to convert model outputs to FUs for the purposes of this report could over or underrepresent actual volumes of wood fibre produced. Is not possible within the scope of this work to account for differences in volume due to species, moisture content or particle size and thickness due to different equipment and processes that might be used. However, it should be kept in mind that the Model supply and demand outputs are calculated on a solid wood basis. Therefore, when constant expansion factors are applied to both the supply and demand as they have in this report, notional surpluses or deficits remain the same on a percentage basis regardless of the units of measure. These limitations should be kept in mind when considering the Model outputs and analysis used in this report. Results should be interpreted broadly and considered with information provided by informed interview sources.

3.2 Regional Wood Fibre Supply and Industrial Demand

3.2.1 Sawdust and Shavings

Table 1 presents a Model summary of regional SDS supply and industrial demand for the 2018 to 2026 period. The figures are presented in FUs, which are converted from cubic meters using the standard conversion factors described in s. 1.4.

Supply for the 2018-2020 period is based on actual harvest from all sources and the 2021-2026 period forecast using existing AACs. Provincial demand has been relatively constant over this period, estimated at 3.1 million FUs per year.

The surplus or deficit is the difference between supply and industrial demand. The results show a provincial surplus of 628,753 FUs in 2018 that becomes a deficit of -417,617 FUs in the following year. The deficit increases in 2020, to -461,091 FUs. By 2022, a small surplus is forecast which remains for the rest of the period. There are chronic deficits (both actual and forecast) for the Central Interior, Cariboo, and Thompson-Okanagan regions, where competition for SDS from the co-generation, pulp and especially the pellet industries is high. SDS is preferred by these facilities, because dehydration and manufacturing costs are lower for this material compared to other types of fibre. It is noteworthy that no explicit forest industry demand for SDS is identified for the Coast region. When SDS is used by industry in this region it is typically mixed with hog fuel. Exporting SDS volumes from one region to another may mitigate supply problems for one or a group of mills, but transportation increases material cost. The problem is that in key regions, deficits are structural. Additional fibre supply may be obtained from high-cost sources, such as roadside logging debris. These structural deficits suggest that the agricultural sector will continue to face significant competition for this fibre from the pellet industry.

Table 1 Summary of regional sawdust supply and industrial demand 2018-2026 in FUs

Region	Description	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Peace	Supply	242,727	192,013	219,675	239,150	239,150	239,150	239,150	239,150	239,150
	Industrial Demand	227,313	227,313	227,313	227,313	227,313	227,313	227,313	227,313	227,313
	Surplus/Deficit	15,413	-35,300	-7,638	11,837	11,837	11,837	11,837	11,837	11,837
Central Interior - Hwy 16	Supply	1,235,815	1,011,378	968,151	1,037,210	1,097,409	1,042,921	1,042,921	1,042,921	1,042,921
	Industrial Demand	1,421,144	1,569,135	1,569,135	1,628,331	1,628,331	1,628,331	1,628,331	1,628,331	1,628,331
	Surplus/Deficit	-185,329	-557,757	-600,984	-591,121	-530,922	-585,410	-585,410	-585,410	-585,410
Cariboo	Supply	546,040	375,061	390,712	389,056	393,730	394,517	379,426	379,426	379,426
	Industrial Demand	442,538	442,538	442,538	501,734	501,734	501,734	501,734	501,734	501,734
	Surplus/Deficit	103,502	-67,477	-51,826	-112,678	-108,005	-107,217	-122,308	-122,308	-122,308
Thompson-Okanagan	Supply	471,884	304,550	366,087	425,621	425,621	425,621	425,621	425,621	425,621
	Industrial Demand	487,776	487,776	487,776	487,776	487,776	487,776	487,776	487,776	487,776
	Surplus/Deficit	-15,892	-183,226	-121,689	-62,156	-62,156	-62,156	-62,156	-62,156	-62,156
Kootenay	Supply	403,887	331,875	335,577	425,545	425,545	425,545	425,545	425,545	425,545
	Industrial Demand	16,575	16,575	16,575	16,575	16,575	16,575	16,575	16,575	16,575
	Surplus/Deficit	387,312	315,300	319,002	408,971	408,971	408,971	408,971	408,971	408,971
Coast (Mainland and Vancouver Island)	Supply	411,109	328,742	287,926	370,503	370,485	370,485	370,529	370,529	370,529
	Industrial Demand	0	0	0	0	0	0	0	0	0
	Surplus/Deficit	411,109	328,742	287,926	370,503	370,485	370,485	370,529	370,529	370,529
West Rupert	Supply	11,782	11,782	23,563	42,414	42,414	42,414	42,414	42,414	42,414
	Industrial Demand	0	88,794	88,794	88,794	88,794	88,794	88,794	88,794	88,794
	Surplus/Deficit	11,782	-77,013	-65,231	-46,380	-46,380	-46,380	-46,380	-46,380	-46,380
Mackenzie	Supply	181,026	139,283	59,519	63,957	107,437	150,917	150,917	150,917	150,917
	Industrial Demand	220,973	220,973	220,973	50,846	50,846	50,846	50,846	50,846	50,846
	Surplus/Deficit	-39,947	-81,690	-161,454	13,111	56,591	100,071	100,071	100,071	100,071
Province (Total)	Supply	3,504,270	2,694,684	2,651,211	2,993,456	3,101,790	3,091,570	3,076,524	3,076,524	3,076,524
	Industrial Demand	2,875,517	3,112,301	3,112,301	3,060,567	3,060,567	3,060,567	3,060,567	3,060,567	3,060,567
	Surplus/Deficit	628,753	-417,617	-461,091	-67,111	41,224	31,003	15,957	15,957	15,957

Note: BC Fibre Model regions were amalgamated to match agriculture regions. West Rupert and Mackenzie supply regions have negligible agriculture production, and these areas are not included in the defined agriculture regions.

Regional SDS demand for the BC Interior is summarized in Figure 3 which breaks demand out across four subsectors – "various" (minor own-use), pulp, pellet, and co-generation plants, for 2020. The figures are expressed as a percentage of total Interior SDS demand. The pellet industry is the dominant sector in four of the five Interior regions.

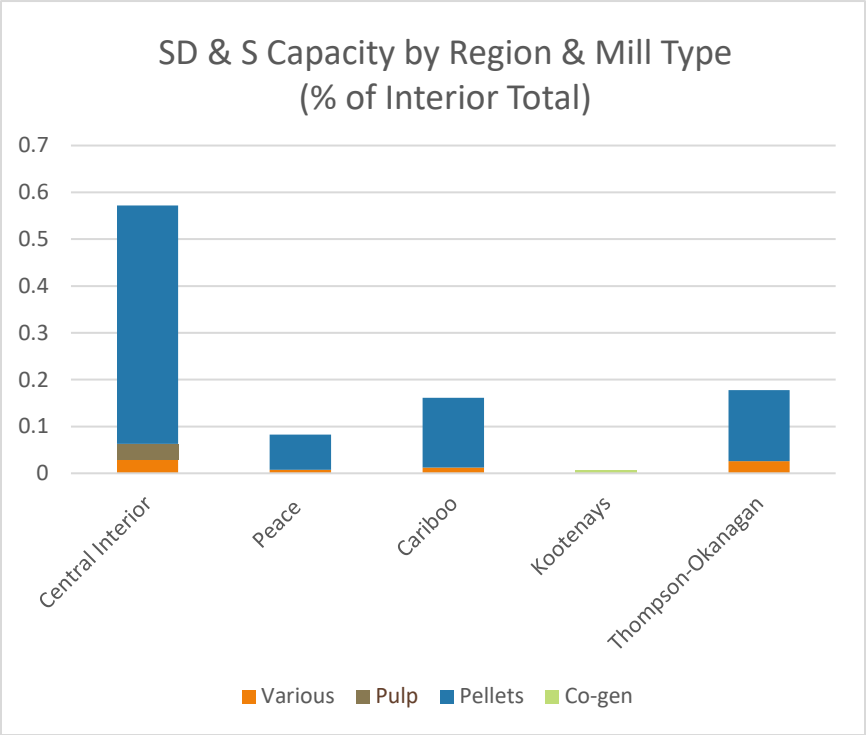


Figure 3 BC Interior Sawdust (SD) and Shavings (S) Capacity by Region and Mill Type, 2020

3.2.2 Hog fuel

Table 2 is a summary of regional hog fuel supply and industrial demand for the 2018-2026 period. This table is analogous to the calculations presented in Table 1 for SDS. Again, the difference between supply and industrial demand is the regional surplus or deficit. Regional results are summed to give provincial totals. The results show that BC is in a deficit position for the entire 2018-2026 period. Both actual and forecast supplies of hog fuel are less than the quantity demanded. The provincial deficit was -1,550,427 FUs in 2018 and increased to -1,949,631 in 2020. The forecast deficit is in the range of -1,821,673 to -1,852,235 FUs for the 2021-2026 period. Major for hog fuel deficits exist in all the Model regions except W. Prince Rupert and Kootenay.

Table 2 Summary of regional hog fuel supply and industrial demand 2018-2026 in FUs

Region	Description	2018	2019	2020	2021	2022	2023	2024	2025	2026
Peace	Supply	142,430	119,928	132,202	130,670	130,670	130,670	130,670	130,670	130,670
	Industrial Demand	158,506	158,506	158,506	158,506	158,506	158,506	158,506	158,506	158,506
	Surplus/Deficit	-16,076	-38,578	-26,304	-27,836	-27,836	-27,836	-27,836	-27,836	-27,836
Central Interior - Hwy 16	Supply	686,165	628,532	629,628	631,857	638,863	612,021	612,021	612,021	612,021
	Industrial Demand	1,148,785	1,161,091	1,161,091	1,161,091	1,161,091	1,161,091	1,161,091	1,161,091	1,161,091
	Surplus/Deficit	-462,620	-532,559	-531,463	-529,234	-522,228	-549,071	-549,071	-549,071	-549,071
Cariboo	Supply	355,079	291,586	246,384	240,937	238,310	240,899	237,142	237,142	237,142
	Industrial Demand	511,011	511,011	511,011	511,011	511,011	511,011	511,011	511,011	511,011
	Surplus/Deficit	-155,932	-219,425	-264,627	-270,074	-272,700	-270,112	-273,868	-273,868	-273,868
Thompson-Okanagan	Supply	341,051	286,854	321,572	339,747	339,747	339,747	339,747	339,747	339,747
	Industrial Demand	793,927	793,927	793,927	793,927	793,927	793,927	793,927	793,927	793,927
	Surplus/Deficit	-452,876	-507,073	-472,355	-454,180	-454,180	-454,180	-454,180	-454,180	-454,180
Kootenay	Supply	346,390	330,703	330,391	353,444	353,444	353,444	353,444	353,444	353,444
	Industrial Demand	290,678	290,678	290,678	290,678	290,678	290,678	290,678	290,678	290,678
	Surplus/Deficit	55,711	40,025	39,713	62,766	62,766	62,766	62,766	62,766	62,766
Coast (Mainland and Vancouver Island)	Supply	722,287	712,410	626,913	618,906	618,293	618,293	618,544	618,544	618,558
	Industrial Demand	1,169,646	1,169,646	1,169,646	1,169,646	1,169,646	1,169,646	1,169,646	1,169,646	1,169,646
	Surplus/Deficit	-447,359	-457,236	-542,733	-550,740	-551,353	-551,353	-551,102	-551,102	-551,088
West Rupert	Supply	6,603	6,603	13,206	23,771	23,771	23,771	23,771	23,771	23,771
	Industrial Demand	0	0	0	0	0	0	0	0	0
	Surplus/Deficit	6,603	6,603	13,206	23,771	23,771	23,771	23,771	23,771	23,771
Mackenzie	Supply	127,417	112,454	40,227	37,547	63,072	88,598	88,598	88,598	88,598
	Industrial Demand	205,296	205,296	205,296	144,256	144,256	144,256	144,256	144,256	144,256
	Surplus/Deficit	-77,878	-92,842	-165,068	-106,709	-81,184	-55,658	-55,658	-55,658	-55,658
Province (Total)	Supply	2,727,421	2,489,069	2,340,523	2,376,880	2,406,171	2,407,442	2,403,938	2,403,938	2,403,952
	Industrial Demand	4,277,848	4,290,155	4,290,155	4,229,115	4,229,115	4,229,115	4,229,115	4,229,115	4,229,115
	Surplus/Deficit	-1,550,427	-1,801,085	-1,949,631	-1,852,235	-1,822,944	-1,821,673	-1,825,178	-1,825,178	-1,825,164

Note: BC Fibre Model regions were amalgamated to match agriculture regions. West Rupert and Mackenzie supply regions have negligible agriculture production and are not included in the defined agriculture regions.

Figure 4 provides a breakdown of hog fuel demand for all six provincial regions in 2020, which includes the Coast. Provincial demand forecasts measured as annual capacity, stays relatively constant within the Model over the 9-year analysis period since it is not possible to predict industrial expansion or contraction. Regional demand for each product group in Figure 4 (i.e., various, pulp, pellet, and co-generation plants) are expressed as a percentage of the provincial total hog fuel demand. Hog fuel demand in the central Interior region is split 4% to each of the "various" and pellet sectors, and 9% and 13% to the pulp and co-generation sectors, respectively. In contrast, on the Coast, 27% of the provincial hog fuel demand is destined for the pulp sector.

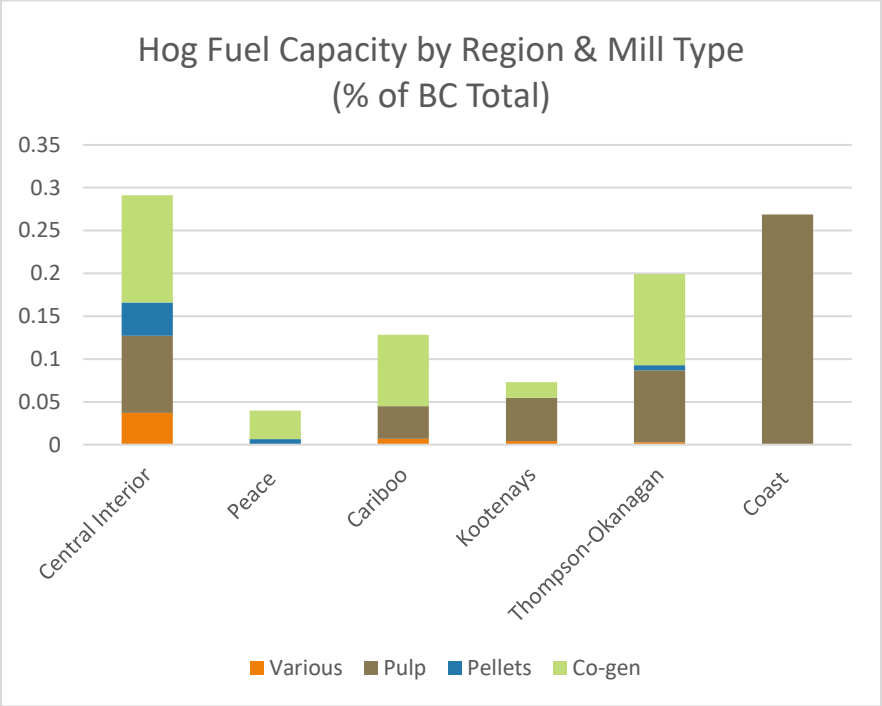


Figure 4 BC Hog Fuel Capacity (industrial demand) by Region and Mill Type, 2020

3.2.3 Current Supply Summary and Mill Price

BC forest product company fibre managers were canvassed for their views on the state of BC residual fibre markets in Spring, 2021. Their collective opinion agreed with the trends presented in the Model, that supplies will continue to be constrained for both sawdust, shavings and hog fuel and competitive conditions will continue to intensify. This is despite recent market conditions, where record prices for dimension lumber and panels have been observed, mills have run at two-shift or more capacity, which has, in part, resulted in a glut of residual fibre[i]. These same managers opined that a year ago, in Spring,

[i] One fibre manager stated that the current oversupply of residual fibre is caused by the fact that SDS consuming plants have encountered production issues this past year that has led to the stockpiles of this material in various parts of BC. He also emphasized that this is a short run condition that is not expected to last very long.

2020, “conditions were just the opposite”. Residual fibre was in short supply at that time due to Covid-19 related mill shutdowns.

One of the key factors that has impacted residual fibre supply, especially SDS, is the contractual arrangements that forest product companies have entered with pellet plant companies. Prices for these products vary with contract term, proximity to consuming mill, the quality of the material produced, and the incremental value to the consuming mill. Current Central Interior prices for shavings and sawdust range between $40-$50/ODT ($32-$40/FU) and $30-$40/ODT ($24-$32/FU) respectively.[i] Prices are lower in the Kootenays at where there is an identified surplus, with one mill reporting a price of $20/ODT ($16/FU).

Hog fuel prices in the Central Interior are significantly lower than SDS, ranging between $10-$20/ODT ($8-$17/FU). In the short run, there is downward pressure on these hog fuel prices in some locales. One manager is currently offering to give his company’s hog fuel away.

[i] FU prices are estimates based on assumed bulk density of 140 kg/m3 for loose SDS, and 146 kg/m3 for loose hog fuel.

4 Agriculture Demand Estimates

4.1 Wood Residue Products Used in Agriculture

There are a wide variety of uses for wood fibre in agriculture. Each application has specific product requirements.

4.1.1 Sawdust and Shavings

Dry whitewood (Spruce, Pine, Fir – SPF) SDS is the primary wood residue used for livestock bedding and litter. Western red cedar (WRC) SDS are not preferred for milking dairy cattle, horses, and poultry bedding because of its aromatic and chemical properties, presumably related to plicatic acid and thujaplicins, which are natural fungicides. Western red cedar has been reported to cause slivers in chick feet. Yellow cedar (cypress) SDS can be the preferred product for horse bedding, but its use is mostly limited to the Coast and Vancouver Island where this species occurs.

The physical characteristics of wood fibre are a factor as well. Pure SDS have different densities and absorption properties, and sometimes the two products may be mixed to suit the application. For example, in poultry, wood fibre is often blown into the barn, and it must have a certain density to be applied effectively. Pure shavings are too light to be placed in the barn using this method (Photo 2).

Photo 2 Broiler chicks on fresh bedding material (Source: www.denbow.com)

Dry shavings are typically preferred for large stock like dairy and beef cattle and horses because it absorbs moisture better and is thought to provide better animal comfort (Photo 3). While some hog fuels may be used, there is a risk of introducing salts or other contaminants.

Photo 3 Dry whitewood shavings are preferred for large animal bedding. (Source: www.denbow.com)

Contaminants in wood residue are a concern for animal health and one of the main reasons why clean, dry bedding from primary mill sources is preferred by livestock producers. Clean dry shavings are also preferred for beef cattle that are bedded outside during early spring calving. There is greater flexibility in the products that can be used for both inside and outside bedding packs for replacement heifers and growing animals; hog fuel of various types can be preferred for outdoor use in beef feedlots.

Whitewood sawdust is the preferred mulch for blueberry production while pure shavings are less desirable because they are light and can blow away (Photo 4).

Photo 4 Sawdust/shavings applied to blueberry planting in Delta.

4.1.2 Hog fuel, Chips and Bark

Hog fuel is a mixture of sawdust, shavings, and bark, and its quality can vary depending on the producing mill (Photo 5). The term is sometimes applied more generally to course and undifferentiated wood fibre, i.e., chipped material (Photo 6).

Photo 5 Red cedar hog fuel used to create an in-field parking lot for U-pick operation in the Fraser Valley.

Photo 6 Material described as 2-inch hog fuel. (Photo Courtesy of Ledcor)

One of the well-established uses for hog fuel is for outside horse paddocks and exercise pens. As mentioned in the introduction, hog fuel was used as a base in Lower Mainland cranberry fields, but this

is no longer a widespread practice. There is some minor use of chipped material in orchards and vineyards, but this is not a widespread practice.

One of the main uses of hog fuel, chips and bark products in agriculture is for composting and soil mixing and for products sold into the landscape industry where Douglas-fir bark mulch and bark nuggets are favored. As mentioned in Section 2, this use is difficult to quantify from the demand side because of product specialization, the number of end users and a multi-level distribution network.

4.2 Survey Summary

A total of 28 participants were engaged specifically for the demand survey. This number does not include additional information interviews carried out with other sources, including staff from producer organizations. A total of 34 different enterprises were documented from the group of participants. The distribution of participant enterprises by region is shown in Table 3. The greater number of participant enterprises from the Lower Mainland (14) reflects both the variety and size of the respective agriculture sectors in this region.

Table 3 Summary of survey participant enterprises by region

Regions	Enterprises in Survey
Cariboo	1
Central Interior - Hwy 16	5
Kootenay	2
Lower Mainland-Southwest	14
Thompson-Okanagan	6
Vancouver Island-Coast	6
Grand Total	**34**

The distribution of the survey enterprises by agriculture sector is shown in Table 4. Dairy, equine, and poultry enterprises had the highest representation. The increased sampling was intended to address the variety and types of fibre use among these three sectors.

Table 4 Summary of survey participant enterprises by agriculture sector

Sector	Enterprises in Survey
Beef-Cow-calf	2
Beef-Feedlot	5
Berries-Blueberries	2
Dairy	10
Equine	8
Poultry	7
Grand Total	**34**

The average prices paid by participant enterprises in the survey by region are listed in Table 5. It was not possible to get price information from every participant which explains the difference between the number of enterprises and price points that were recorded in the survey. The prices reported here

reflect the cost of SDS delivered to the farm. The exception is the Central Interior price which is the average of an FOB price and a delivered price, and the Kootenay price which is an FOB price at the mill. Part of the average price in the Thompson-Okanagan is made up of a hog fuel and sawdust mixture (two cases). However, prices in the winter of 2021 for this product were just $5-10 less than the prices for SDS. Additional services like the blow-in costs into broiler barns were excluded from the recorded prices.

The provincial average price paid by producer participants is close to $70/FU ($68.41). The regional prices tend to reflect overall supply and demand conditions and are better indicators of the market. For example, in the Kootenay region where there is a supply surplus indicated by the BC Fibre Model, the lowest price in the survey was recorded ($23/FU) whereas the highest prices were recorded from the dairy sector on the lower mainland at $100-115/FU. These prices were associated with a single supplier that had indicated sourcing dry shavings from the Kootenays and hauling them to the lower mainland. One reason for the higher price is freight costs. Other than this variation there appeared to be little price divergence in this sector. When reporting prices participants reflected on the increased cost of SDS and recounted how steeply prices had risen in the past 2 years. Some recalled prices in the range of $35-40/FU.

Table 5 Summary of average prices paid by participant enterprises in the survey by region.

Region	Price Points Recorded	Average Price/FU
Central Interior - Hwy 16	2	$59.00
Kootenay	1	$23.00
Lower Mainland-Southwest	12	$79.08
Thompson-Okanagan	6	$61.92
Vancouver Island-Coast	6	$64.26
Total	**27**	**$68.41**

4.3 Agriculture Sector Demand Profiles

The information provided by the survey participants was used to create wood fibre demand profiles for each of the agriculture sectors.

4.3.1 Dairy

According to the Statistics Canada biannual livestock survey there were 89,300 mature dairy cows in BC as of January 1, 2021. This is up from 75,853 dairy cows reported by the 2016 census of agriculture. Dairy production in Canada is a supply managed industry. The BC Milk marketing board 2019-2020 annual report indicates there were 462 licenced milk producers in the province, down from the 490 licenced producers in 2015/16. This would represent an average herd size of about 155 mature cows per licence using the 2016 numbers. However, the total provincial numbers reported by Statistics Canada includes dairy cows that are managed on unlicenced operations or are not included in commercial dairy production. Therefore, the average herd size for commercial operations is lower than 155.

The biannual livestock survey does not report numbers on a regional basis, so the most recent census must be relied upon to determine the regional distribution of dairy cattle and production by the regions defined for the assessment (Table 6). The main dairy production region in BC is the Lower Mainland, with 72.6 % of the total dairy herd. This is followed by the Thompson-Okanagan with 14.4% and Vancouver Island with 7.6%. The Kootenay and Central-Interior regions each have just over 2% of the provincial herd, while the Peace has less than 1%. Cow numbers increased in the Lower Mainland and Interior regions and were down on Vancouver Island from 2011 to 2016. This trend is expected to continue to be reflected in the 2021 census of agriculture, when it becomes available.

Table 6 Dairy cows in BC by region 2016

Region	Dairy Cows	Percent
Lower Mainland-Southwest	55,086	72.6%
Vancouver Island	5,776	7.6%
Thompson-Okanagan	10,928	14.4%
Kootenay	1,696	2.2%
Cariboo	507	0.7%
Central Interior - Hwy 16	1,593	2.1%
Peace	262	0.3%
Total	75,848	100.0%

Source: Statistics Canada. Table 32-10-0424-01 Cattle and calves on census day. Note: Totals include only the regions established for the assessment.

4.3.1.1 Bedding Systems

Dairy barns are complex systems specially designed to optimize cow comfort, health, and productivity. Bedding and manure handling are integral parts of these systems and there are multiple variations in use. There are bedded pack, free stall, and compost pack barns.[6] Some free stall systems may have deep bedding that includes mattresses or matts that are used in combination with straw or wood shavings. Sand is a bedding option in deep bed free stall designs that has desirable characteristics.[7] All of the systems require different amounts of bedding to optimize cow comfort and prevent injury and disease, and this is somewhat dependent on the barn and manure handling system. Sand can be cleaned and recycled in a properly designed system. Similarly, used shavings and manure solids can be pressed, dried, and reused for bedding. A critical point is that the choice of bedding needs to be part of the barn and manure handling design.

4.3.1.2 Wood Fibre Use

All 10 dairy producer participants in the survey used wood shavings and/or sawdust in their operations, even though three of the participants use sand bedding in their milking barn. Despite sand being desirable bedding for mature cows, it is not preferred for young stock. To sustain production, most dairies keep calves and replacement heifers. These animals, as well as dry cows, are managed separately in pens, sheds and barns that are bedded with shavings and/or sawdust. One dairy located in the Central Interior discussed plans to use barley straw for bedding, to reduce their reliance on wood shavings. Despite having a sufficient land base and ability to grow barley for both grain and straw, this practice is not without its challenges. The wet fall of 2020 was disastrous for grain harvesting, and a vast among of the crop did not make maturity so there was no dry straw for bedding.

Given the range of systems and practices there was considerable variation in the amount of wood fibre used per 100 milking cows. For example, pasturing cows can reduce the amount of barn time and total bedding consumption. The most efficient non-sand system (94 FUs/100 cows/year) used manure separation screens and a screw press to extract moisture from bedding material. This product is recycled back into the system with different proportions of new shavings, depending on the season and what stock is being bedded.

Among the dairies using wood fibre exclusively, the highest use was reported by dairies in the Central interior and on Vancouver Island. The most efficient sand system, in terms of additional wood fibre use, was also on Vancouver Island (80 FUs/100 cows/year). The other two sand systems in the survey reported substantially more wood fibre use.

4.3.1.3 Assumptions and Regional Demand

To develop the regional demand profiles, the sample was sorted by region and bedding system (i.e., sand and wood fibre, and wood fibre exclusively). Maximum, minimum, and average demand values (FUs/100 cows/year) were calculated in a summary table. The table values were used to derive an assumed demand for each region. The demand for the Lower Mainland and Thompson-Okanagan is assumed to be 225 FUs/100 cows/year). This is somewhat higher than the consumption of 194 FUs/100 cows/year rate reported in a 2017 survey of New England dairies in the US.[8] However, the Lower Mainland use rate includes bedding for all the other stock associated with maintaining 100 milking cows, i.e., dry cows and replacement heifers. Higher demand values were assumed for the other regions. The typical wood fibre demand for dairies that also use sand is assumed to be 160 FUs/100 cows/year.

The cow numbers from Table 6 were used to estimate total regional and provincial wood fibre demand for the sector. The regional demand values are based on milking cows, so the numbers in Table 6 were reduced by 15% to account for the portion of the herd that are dry cows. The provincial dairy industry specialist estimates that approximately 30% of the provincial dairy cow herd is bedded on sand. This assumption was applied to apportion the provincial herd to the number of cows on sand and cows on wood fibre bedding. It was assumed that all cows in the Kootenays, Cariboo, and Central Interior regions are bedded on wood fibre and there are no sand systems in these regions. It was assumed that the dairy cows in the Peace Region are bedded on barley or wheat straw.

Logically, the total annual wood fibre use by region follows the distribution of the provincial dairy herd, with largest demand estimated for the Lower Mainland at 96,211 FUs/year (Table 7). The assumptions used to estimate the demand implies that Lower Mainland producers are more efficient, which explains why the percent of total demand is less than the Lower Mainland share of the provincial dairy cow herd on a percentage basis. Likewise, the higher level of use that is assumed on Vancouver Island increases the share of total use on relative percentage basis. Total annual demand by the provincial dairy sector is estimated at 139,408 FUs/year.

Table 7 Estimated SDS use by the dairy sector (FUs/year)

Region	FUs/year	Percent
Lower Mainland-Southwest	96,221	69.0%
Vancouver Island	14,385	10.3%
Thompson-Okanagan	19,088	13.7%
Kootenay	2,573	1.8%
Cariboo	1,724	1.2%
Central Interior - Hwy 16	5,416	3.9%
Peace	0	0.0%
Total	139,407	100.0%

4.3.1.4 Participant Input on Wood Fibre Supply

Several participants indicated that the wood fibre supply had changed. In some cases, producers were using (accepting) more green material or mixed material, i.e., sawdust, or a higher proportion of sawdust. In one instance, red cedar shavings were being accepted. Some indicated that in the recent shortage, their use was being curtailed. One producer indicated that they had not experienced shortages others had, but this was reflected in the price they were paying and the long-term relationship they had with the supplier.

Straw was often mentioned as a potential substitute. This was considered an acceptable substitute but not necessarily a practical one especially in the southern interior regions and on the coast. Several mentioned their interest in having more sustainable integrated systems. However, there was a broad recognition that this can only be realized with a significant capital investment. In some cases, recent barn upgrades included more efficient bedding facilities.

4.3.2 Beef

Unlike dairy production where animals are housed in barns and sheds year-round, most beef production in BC takes place completely outside on range, pastures, feeding areas and in feedlots. Beef cattle are raised in all regions of the province, but the largest number are in the interior regions (Table 8). There are two areas of the beef sector where wood fibre is sometimes used. In cow-calf enterprises, the predominant production model in BC, whitewood shavings are used for bedding calving grounds and sheds. This use is seasonal, i.e., late winter, early spring, and is not a province wide practice. Shavings, sawdust, chips, and hog fuel are also used in feedlots, that may be backgrounding or finishing animals. While backgrounding operations can be integrated with cow-calf operations throughout the province, there is some concentration of confined feeding operations in the Thompson-Okanagan region where conditions are drier.

Table 8 Beef cows, steers over 1 year and heifers for slaughter (combined) by region 2016.

Region	Beef Cows	Percent	Steers (1yr and over) and Heifers for slaughter	Percent
Lower Mainland-Southwest	5,454	2.6%	5,462	9.9%
Vancouver Island	3,889	1.8%	2,429	4.4%
Thompson-Okanagan	67,943	32.0%	24,190	43.7%
Kootenay	12,015	5.7%	1,710	3.1%
Cariboo	39,479	18.6%	5,871	10.6%
Central Interior - Hwy 16	32,767	15.4%	7,582	13.7%
Peace	50,928	24.0%	8,087	14.6%
Total	212,475	100.0%	55,331	100.0%

Source: Statistics Canada. Table 004-0221 - Census of Agriculture, cattle and calves on census day, every 5 years. Note: Totals include only the regions established for the assessment.

4.3.2.1 Wood Fibre Use

The use of shavings in cow-calf operations is a common practice in the Central Interior region. It is presumed that use in this area is related to winter and spring weather conditions, and customary practice that evolved with an abundant supply of low-cost kiln dried shavings. Straw and other crop residues are widely available in the Peace region, and the use of shavings for bedding is rare. The need for bedding at calving in the southern regions is somewhat dependent on calving season, and elevation. There has been a shift to calving later in the year in many areas that allows calving to take place on open hillsides. Spring weather conditions in the south at low elevation are generally milder than on the central plateau, making bedding material less crucial. Some operators that have used shavings in the past have indicated that the practice cannot be justified at current prices in high demand regions. As a substitute, where straw is not widely available, lower quality hay or meadow hay is fed and what is left over can serve as bedding material.

There were two cow-calf enterprises in the survey, one small (85 cows) and one large (300 cows), both based in the Central Interior. The simple average of the shavings use was 35 FUs/100 cows/year.

Use of wood fibre in beef feeding operations is variable depending on the weather conditions, and how many animals are being fed relative to the capacity of the lot. This part of BCs beef sector is more dynamic than the cow-calf sector and fluctuates with market conditions and feed prices. There were 5 beef feeding enterprises recorded in the survey. Three were in the Thompson-Okanagan, one in the Central Interior and one on Vancouver Island. The operations in the Thompson-Okanagan were larger scale (800-4000 head), and used a combination of hog fuel and sawdust, while the other two were small scale (60-110 head) and used shavings. All reported that use was concentrated in the winter period and associated with feeding a single group of animals per year. The volume of fibre used in the southern interior operations averaged 38 FUs/100 head, while the Vancouver Island operation used 50 FUs/100 head/year. The small Central Interior operation was the lowest at 21 FUs/100 head/year.

4.3.2.2 Assumptions and Regional Demand

The dispersed nature of fibre uses in this sector presented some challenges estimating demand. This was addressed by applying utilization factors to the total number of animals in each region before

calculating the aggregate demand. These utilization factors were based on professional knowledge of practices in the regions in addition to information gathered through participant interviews. For example, for the cow-calf sector a utilization factor of 0 was applied to the Peace since there is essentially no use in that region. The highest use factor of 0.6, was applied to the Central interior, followed by the Lower Mainland and Vancouver Island at 0.5. Cariboo was .1, and Thompson-Okanagan was 0.2. A constant demand rate of 35 FUs/100 cows/year was used for all regions.

Utilization factors were also applied to the number of feeder animals the feeding subsector. This was to account for variations in practice where little or no wood fibre is used, particularly at operations that are only feeding 1-10 animals. A factor of 1 was applied to the Thompson-Okanagan since feeding is concentrated in definable feedlots in this region. A factor of .7 was applied to the Lower Mainland and Vancouver Island, and .5 to the Cariboo and Kootenay. In the Central Interior the factor was .6, and the Peace was .2. The regional demand rates from feeder enterprises noted above were applied to the regions they originated from. The Central Interior rate was used in the Peace, the Vancouver Island rate was applied to the Lower Mainland, and rate of 30 FUs/100 head/year was applied to the Kootenay's.

Both the Statistics Canada Census of Agriculture and the biannual cattle inventory are imperfect for providing an estimate of numbers of cattle on feed on a regional basis. The census which provides a regional breakdown, reports numbers of steers one year or older and heifers for feeding and or slaughter on May 10th, which may not capture all animals that were fed earlier in the winter. The Statistics Canada biannual livestock survey gives an estimate of all the animals in the province on different operations on January 1 and July 1 each year. As of January 1, there were 66,900 head (calves under 1 year, steers 1 year or older, and heifers for slaughter) on feeder and stocker operations and feeding operations. To arrive at the numbers for estimating wood fibre used by beef animals on feed by region, the total number of steers one year or older and heifers for feeding or replacement from the 2016 census, as a percentage of the total number, was multiplied by the 2021 January 1 provincial total.

Members of the BC Association of Cattle Feeders also provided a summary of feeding capacity of operations in the Thompson-Okanagan. The number of head on feed derived from the Statistics Canada data for the region was 72% of the total capacity estimated by the Association, which is a reasonable representation of actual demand since it is rare for all the lots to be at full capacity in any given winter.

The estimated wood fibre demand for the two beef subsectors is summarized in (Table 9). The single largest demand is for feeder cattle in the Thompson-Okanagan at 11,114 FUs/year. The combined total demand for both sectors in all regions is 32, 570 FUs/year.

Table 9 Estimated wood fibre use by the Beef sector.

Region	Cow-calf FUs/year	Percent	Feeder FUs/year	Percent	All Beef FUs/year	Percent
Lower Mainland-Southwest	954	6.2%	2,311	13.5%	3,266	10.0%
Vancouver Island	681	4.4%	1,028	6.0%	1,708	5.2%
Thompson-Okanagan	4,756	30.7%	11,114	65.1%	15,870	48.7%
Kootenay	841	5.4%	310	1.8%	1,151	3.5%
Cariboo	1,382	8.9%	745	4.4%	2,127	6.5%
Central Interior - Hwy 16	6,881	44.4%	1,155	6.8%	8,036	24.7%
Peace	0	0.0%	411	2.4%	411	1.3%
Total	15,495	100.0%	17,075	100.0%	32,570	100.0%

4.3.2.3 Participant Input

Participants from both beef subsectors discussed adjustments they and other producers have made in response to supply issues. The cow-calf enterprises, one near Vanderhoof and the other near Smithers, both receive shavings through contracts with local lumber mills. The Nechako Regional Cattlemen negotiated an ongoing contract for shavings that has been in place since 2011 for the Vanderhoof area. This started initially to secure supply and formalize price at a time when industrial demand in that area eliminated shavings access for individual producers. Beef cattle and dairy producers in this area, including the Vanderhoof participant, receive shavings from a single 28' tandem truck operated by one of the members. Freight is charged at $112/hr. and $45/hr. standby for waiting while loading. The participant in Smithers is also a dairy producer and ended up taking on delivery to serve their own farm, and other local producers. The Smithers contract is less formal than the Nechako Regional Cattlemen's contract, which raises future supply concerns for Bulkley Valley beef and dairy producers since it is not very secure.

Some straw is available in the Vanderhoof area and is transported to the Smithers area. However, the fall of 2020 was extremely wet and barely crops were either not harvested or harvested very late, and so there was little straw available.

Similarly, the larger feeders in the Thompson-Okanagan have been forced to adapt to supply issues. In one case this meant stockpiling hog fuel and sawdust whenever possible to meet future needs. This operator also started selling and delivering compost to help reduce the costs associated with wood fibre. Still, there is concern about ongoing supply and the rising cost of fibre. Straw is considered a limited option because it is costly. There is little grain production in this area, and any additional straw supply would have to be transported from Southern Alberta. A certain amount of straw is already demanded for dairy cattle rations in the Armstrong-Enderby area, and in the Lower Mainland, and so this straw price for feed becomes the base price for bedding.

Another feeder in the region bought a used tub grinder to process their own fibre for their feedlot and a few other smaller customers. The wood supply comes from a nearby manufacturing plant and is made up of whitewood lath and off-cuts. Sourcing fibre from this plant was brought about by fibre supply shortages and involves additional labor and fuel, bringing costs close to mill delivered fibre costs but there is greater security of supply.

4.3.3 Poultry

The commercial poultry sector in BC is highly regulated and specialized. It includes:

- Broiler Production
- Broiler Egg Hatching
- Layer and Egg Production
- Turkey Production

Quotas for broiler and turkey production are based on weight (in kilograms) while the quotas for broiler egg hatching and layers is based on the number of birds. Broiler, egg, and turkey production is concentrated in the Lower Mainland, with some production in the Thompson-Okanagan and Vancouver Island. Broiler egg hatching is based in the Lower Mainland exclusively (Table 10). In some subsectors, production for all interior regions is combined but has been allocated to a specific region in the table. The allocation of this minor demand does not materially affect the overall assessment.

Table 10 Regional distribution of commercial poultry production in BC.

Region	Broiler Quota (Kgs/cycle)	Percent	Turkey (Kgs/Year)	Percent	Layers (birds)	Percent
Lower Mainland-Southwest	33,062,283	85.9%	21,428,800	94.4%	2,759,945	84.9%
Vancouver Island	695,336	1.8%	681,000	3.0%	194,562	6.0%
Thompson-Okanagan	4,744,429	12.3%	522,100	2.3%	241,225	7.4%
Kootenay		0.0%	0	0.0%	12,097	0.4%
Cariboo		0.0%	0	0.0%	0	0.0%
Central Interior - Hwy 16		0.0%	0	0.0%	0	0.0%
Peace		0.0%	68,100	0.3%	5,612	0.2%
Total	38,502,048	100.0%	22,700,000	100.0%	3,213,441	98.8%

Source: BC Chicken Marketing Board Annual Report," 2020; "BC Turkey Farmers," April 2021; "BC Egg Marketing Board Annual Report 2020. Note: "Interior" broiler production included as Thompson-Okanagan. A small portion of this quota may be in the Kootenay and Peace regions.

4.3.3.1 Wood Fibre Use

Each poultry subsector has different practices and demand for litter material, which is almost exclusively whitewood SDS. The broiler subsector has the highest and most consistent demand for wood fiber due to scale, uniform practice, and short production cycle (typically 8 weeks), that ends with barn clean out and application of new litter. Practices and housing in the broiler hatching subsector are consistent, but the limited number of operations means that total use is low. Practices and use of SDS is more varied in egg and turkey production, which is dictated by the housing and management, and compared to broiler production, less litter is used. About 70% of BC egg production comes from conventional (caged) systems that do not use litter material.[9] SDS can be part of operations that are growing pullets for laying and in free run and free-range systems.

4.3.3.2 Assumptions and Regional Demand

Of the 7 poultry enterprises in the survey, 3 were broiler, 2 were turkey, one was a broiler hatching egg producer, and one was layer pullets. Barn design and space requirements/bird are a factor in how much litter is required. For broilers, a simple average of the reported use per year per 1000 kg of quota was used to estimate aggregate regional and provincial demand. The production cycles per year is assumed to be 6.5. The same approach was used to estimate sawdust shavings use for turkey production, assuming 4.3 cycles per year. The demand figures used were 1.48 FUs/1000 kg/year for broilers and .07 FUs/1000 kg/year for turkeys, highlighting how much less litter is needed in turkey production.

For the hatching egg production, a combined total annual use for 15,000 birds was reported. This included amounts used for brooding, and in the laying barn. The laying barn layout at this operation was like some of the enriched housing used for about 30% of the table egg layer flock, so the same demand figure was applied to 30% of the birds in that subsector. The number of birds per fibre unit was also reported by the pullet enterprise, and this value was applied to the birds in the provincial laying flock. For the broiler hatchery calculations, the total quota birds were divided by two because the units are spread over a two-year cycle. Since part of the quota birds for the laying flock are considered in pullet production, the total layer quota number was also divided in half.

There is specialty, organic and small flock production within the quota systems, where practices are expected to be variable. For broilers, this production is captured in the total quota and assumed to be like conventional broiler production in terms of wood fibre use. None of the assumptions are aimed at quantifying shavings consumption by backyard and unregistered flocks, which may be provided by commercially packaged shavings.

The SDS use for the poultry sector in FUs/year is estimated at nearly 62,000 FUs/year (Table 11). At 56,962 FUs/year the broiler subsector accounts for 91.9% of the total sector demand. Broiler hatching makes up 3.8%, while turkey and layer and pullet make 2.6 and 1.7% respectively. The regional distribution of demand closely follows the regional distribution of broiler production shown in Table 11.

Table 11 Estimated SDS use by the poultry sector (FUs/year)

Region	Broiler	Turkey	Broiler Hatching	Layer and Pullet	Total
Lower Mainland-Southwest	48,914	1,512	2,355	921	53,702
Vancouver Island	1,029	48	0	65	1,142
Thompson-Okanagan	7,019	37	0	81	7,137
Kootenay	0	0	0	4	4
Cariboo	0	0	0	0	0
Central Interior - Hwy 16	0	0	0	0	0
Peace	0	5	0	2	7
Total	56,962	1,601	2,355	1,072	61,991
Percent	91.9%	2.6%	3.8%	1.7%	100.0%

4.3.3.3 Participant Input

Like dairy producers, the poultry sector participants indicated that newer barns were more efficient for wood fibre use. Barn design, age and use also affects whether litter is placed with a skid steer, or blown in. Blow in cost is around $22-25 per FU. One large producer indicated that the preferred product was not always available and occasionally wetter sawdust had to be accepted. This adds cost, because heat and ventilation must be turned up in the barns to dry the material before chicks can be placed. In the severe shortage in the spring of 2020, permission was sought from regulators to heat treat litter to allow reuse. Only marginal reductions can be made in the amount of litter used without causing health issues for the birds. In a couple of instances, the producers mentioned alternative products, including paper and peat moss. Neither of these substitutes were found to be acceptable. The paper was not absorbent enough, and the peat moss, which was used successfully in the broiler hatching operation, produced dirty eggs that were unacceptable to the market.

4.3.4 Equine

The equine sector is diverse in BC, and includes horses kept for recreation, racing, sport, breeding, and guiding, ranching and other work. Each group is managed under different practices, and this varies by region. The Horse Council BC has initiated three different studies on the economic impacts related to the equine industry, and the most recent work was relied on to inform the assumptions in this assessment.[10] The 2019 Equine Industry Economic Impact Study, based on a provincial survey of 2,502 households, estimates there are 57,580 horses in BC, down from approximately 95,000 horses in 2009.

These numbers are significantly larger than the numbers recorded in the Census of Agriculture over the same period. The census figures also show declining horse number over the period, with 33,363 reported in 2016. The difference of roughly 24,000 is attributed to the fact that the census does not capture horses kept on properties that are not classified as farms.

The industry profile established by the economic impact study was used to estimate the number of horses in the various subsectors by region. A provincial total of 57,580 horses was used as the base number for these estimates. Further adjustments were made to the distribution by referencing the Census data to ensure numbers in the northern regions were comparable to those reported in 2016. It is expected that most horses in these regions would be kept on farms, and therefore should be captured by the Census. Most BC horses are in the Lower Mainland, followed by the Thompson-Okanagan and Vancouver Island. The majority are kept or used for recreation purposes, which includes all the horses that are not included in the sport, race or working categories.

Table 12 Estimate of BC Horse population by region and subsector.

Region	Recreation	Sport	Race	Working/Ranch/ Guiding	Total	Percent
Lower Mainland-Southwest	8,733	2,767	5,962	615	18,076	31.4%
Vancouver Island	7,797	1,966	778	554	11,094	19.3%
Thompson-Okanagan	6,238	1,238	3,370	1,661	12,506	21.7%
Kootenay	1,248	291	389	308	2,235	3.9%
Cariboo	1,871	437	1,685	1,169	5,162	9.0%
Central Interior - Hwy 16	2,183	218	389	615	3,405	5.9%
Peace	3,119	364	389	1,230	5,102	8.9%
Total	31,188	7,282	12,960	6,150	57,580	100.0%

4.3.4.1 Wood Fibre Use

Wood fibre use by the horse sector participants was quite mixed, and like the other sectors, housing and management practices have a direct effect on wood fibre use. Two horse owners interviewed in the survey did not use wood fibre. One breeder located in the Cariboo near Quesnel, had access to straw and so was using that for bedding in brood mare, weanling, and yearling stalls. Another respondent from the Kootenays, was using outside sheds and was not using any wood fibre bedding. The remaining participants included two independent horse owners and 4 different stables and boarding operations. Two of these were in the Lower Mainland, one on Vancouver Island and one in the Thompson-Okanagan. The number of horses boarded at these operations ranged from 12 to 65 horses. The independent owners kept from 3-5 horses.

Among the stables and boarding facilities, whitewood shavings were the preferred product although one mentioned a preference for some sawdust mixed in. One stable in the lower mainland was getting predominantly yellow cedar shavings. Of the independent owners one was having shavings delivered, while the other had switched to commercial wood pellets for bedding. There was a substantial difference in amount of bedding used, and this was dependent on whether stalls were open with run

outs or entirely closed, with horses having no access to an outside paddock. The two commercial stalls had rubber mats, and were bedded to different depths, which represents a difference in the shavings used. The large mainland stable stalling high performance sport horses year-round was using 640 FUs/100 horses, while the Vancouver Island stable was using nearly double that amount. The Thompson-Okanagan operation was using 385 FUs/100 horses/year. The independent operations used less shavings, mainly because the stalls were open, or the horses were stalled only at night. Shavings use with the in-out stall was 160 FUs/100 horses/year. The total pellet use converted to FUs based on the pellet density and the standard expansion factor for shavings was equivalent to 283 FUs/100 horses/year.

Use of cedar hog fuel in paddocks and riding area was reported by one of the independent horse owners at 83 FUs/100/year. Materials like sand and synthetics are used for riding arenas at commercial facilities, and use of hog fuel, for small paddocks and exercise areas, is assumed to be associated with independent owners and small stables. Only shavings used for stall bedding are considered in this part of the assessment.

4.3.4.2 Assumptions and Regional Demand

To address the significant variation in stalling practices between the horse subsectors and regions, utilization factors were applied to account for operations where there is no wood fibre use, or where fibre use is minimal. For example, little or no wood fibre use would be associated with horses used on ranching work in the interior. On the other hand, more horses are stalled, and more shavings are used in the Lower Mainland and on Vancouver Island. An extremely high use rate of over 1200 FUs/100 horses/year recorded on Vancouver Island was considered an outlier, or potentially in error, and so the use rate of 640 FUs/100 horses/year was used to represent demand for sport and racehorses. A rate of 200 FUs/100 horses/year was used as the demand for recreation and working horses.

According to the participants, more independent horse owners who are stalling their horses are using commercial wood pellets for bedding (Photo 7 Eagle Valley wood pellets produced in Princeton, and available at retail outlets for use as horse bedding). The associated wood fibre for pellet manufacturing is accounted for under industrial demand, and in this example a part of this fibre stream is going back to the agriculture sector. To ensure no double counting, it was assumed that 40% of recreational horses are being bedded with pellets. The constant demand of 283 FUs/100 horses/year was used for this deduction from the total shavings demand by the horse sector.

Photo 7 Eagle Valley wood pellets produced in Princeton, and available at retail outlets for use as horse bedding. Talon brand from Eagle Valley is labelled specifically as stall bedding.

The associated utilization factors and the estimated shaving use for bedding by the horse sector is summarized in Table 13. Total use is estimated at 116,735 FUs per year. About 48% of this use is based in the Lower Mainland, while approximately 20% is in the Thompson Okanagan. Nearly 20% of the estimated use is based on Vancouver Island.

Table 13 Estimated shavings use by the BC horse sector

Region	Utilization Factor (Rec. and Working)	Utilization Factor (Sport and Race)	Shavings Use FUs/Year (All sources)	Pellet Use FUs/Year	Net Shavings Use FUs/Year	Percent
Lower Mainland-Southwest	0.7	0.9	63,364	7,407	55,957	47.9%
Vancouver Island	0.7	0.9	27,495	6,617	20,878	17.9%
Thompson-Okanagan	0.25	0.75	26,065	2,235	23,830	20.4%
Kootenay	0.25	0.75	4,042	440	3,602	3.1%
Cariboo	0.15	0.5	7,701	516	7,185	6.2%
Central Interior - Hwy 16	0.15	0.5	2,783	475	2,308	2.0%
Peace	0.15	0.5	3,714	738	2,975	2.5%
Total				18,429	116,735	100.0%

4.3.4.3 Participant Input

Like the other livestock sectors, the horse sector has specific wood fibre preferences. Input from two large stables suggests there is a high willingness pay for the desired product, and that price increases

could be passed on to stable customers and boarders. One survey participant suggested they would go so far as to import shavings from the US if they had to. Essentially the message was the customer base made up of high-performance horse owners would not accept a reduction in quality or change in bedding material. In one instance there was mention of a chopped straw substitute called Equine Straw in response to a query about supply shortage on Vancouver Island during the Western Forest Products Inc. strike in 2019. Equine Straw is packaged in Manitoba and is available at some retail outlets on Vancouver Island.[11] Changes in the supply were mentioned by the participants from the interior, although none were directly impacted. However, one of the beef feedlot operators who used to deliver shavings and still has a small customer base said that he is constantly getting calls from horse owners looking for shavings.

4.3.5 Berries

Wood fibre use in BC berry production is limited almost exclusively to blueberries; however, this represents a significant demand. Commercial blueberry production is based mostly in the Lower Mainland with nearly 9,200 ha (22,734 acres), which is almost 97% of the provincial total.[12] There are small areas of production on Vancouver Island and in the Thompson-Okanagan, each with under 2% of the total area under production.

4.3.5.1 Wood Fibre Use

The two blueberry enterprises that were documented in the survey were both of significant scale. One had 48 ha (115 acres) under production, while the other had 182 ha (450 acres). Practices were similar, with both indicating they had yearly demand for fibre, and they would try to re-mulch every 3-4 years. This would mean that about 1/3 to 1/4 of the area would be covered in a single year. Annual use was reported to be a little less at the smaller farm, at around 3.3 FUs/acre/year. The larger farm reported use of about 5 FUs/acre per year.

4.3.5.2 Assumptions and Regional Demand

One of the participants was a blueberry production consultant and a grower. They acknowledged that standard application of wood fibre mulch was not necessarily required on all soils, even though it is recommended. This point fits with field observations in the Lower Mainland where there are productive blueberry fields with no mulch applied. It was assumed about 65% of the area under production would benefit from recommended mulching practices. This was applied as a utilization factor in both the Lower Mainland and Vancouver Island for determining the aggregate demand estimate.

The lower rate of 3.3 FUs/acre/year reported in the survey is the same as the AFF recommendation of 10 FUs/acre applied every three years for established crops.[13] An application of 15 FUs/acre is recommended when the planting is being established. Blueberries are a long-lived crop, and while there are new plantings being established to take advantage of improved varieties, this potential extra use is difficult to account for the overall demand. It made sense to settle on an overall rate of 4 FUs/acre/year for the current area under production, which is midway between the two demand rates reported in the survey.

Table 14 Estimated SDS use by the blueberry sector

Region	Total Acres	Use Factor	Treated Acres	FUs/Acre/Yr	FUs/Yr	Percent
Lower Mainland-Southwest	22,734	0.65	14,777	4	59,108	95.8%
Vancouver Island	437	0.65	284	4	1,136	1.8%
Thompson-Okanagan	368	1.00	368	4	1,472	2.4%
	23,539		15,429		61,717	100.0%

4.3.5.3 Participant Input

Both participants referred to recent fibre supply shortages, increasing costs, and tightening profit margins in blueberry production generally. While whitewood SDS was the most commonly available material, now cedar SDS is being used, in part because it is available and cheaper. When queried about alternative products, heavier chip and composted materials were mentioned, although there is some uncertainty about performance, and wood chips do not spread as easily as sawdust. One of the producers said they had tried weed mats (porous, woven polyethylene), but the product does not have all the benefits on soils and yield that a wood mulch does (see s. 5.3).

4.3.6 Greenhouse and Nursery

Wood fibre products used in the greenhouse and nursery sector are widely distributed with many end consumers. A substantial part of the fibre demand for the sector is delivered through secondary processors. These include businesses that compost and mix wood fibre into soil products. While the industry is represented in all regions, most demand is in the Lower Mainland, Thompson-Okanagan and on Vancouver Island.

4.3.6.1 Wood Fibre Use

Soil mixers like Sumas Gro Media near Abbotsford use several types of fibre to create a range of products (Photo 8). According to the published technical information, their perennial soil mix for nursery and blueberry applications contain significant amounts of bark mulch (75% and greater) and aged chip material. Technical information on two of the soil mixes produced by Sumas Gro Media is included in Appendix C.

Photo 8 Various wood fibre source materials for soil mixing at Sumas Gro Media in Abbotsford

Douglas-fir bark mulch is one of the most desirable wood residues for use in soil mixing and for landscape and gardening applications because of lower acidity and wood fibre content than bark from other species. Higher proportions of wood fibre reduce overall nitrogen levels in soils and compost. Bark is aggregated and partially composted by various distributers and wholesaled in bulk or bagged form. Bark mulch is typically sold in landscape supply and feed stores (Photo 9).

4.3.6.2 Assumptions and Regional Demand

The main assumption is that most, if not all, the residual wood fibre required by the sector comes through primary suppliers. To assess demand, suppliers in the three southern regions were contacted and asked to provide a breakdown of the volume delivered to the sector on annual basis. At the time this report was completed, only one of the suppliers (from the Thompson-Okanagan) had provided information (Table 15). Based on the response 39% of the total 5,197 FUs was Douglas-fir bark mulch, and another 39% was hog fuel. About one fifth (19%) of the total or 988 FUs was SDS.

4.3.6.3 Supplier Input

Westcoast Bark in Burnaby is one of the significant intermediate suppliers in the Lower Mainland, and indicated they were forced to accept some hemlock bark because of supply constraints in April 2020. Hemlock bark mulch has a higher wood fibre content, because of the way it debarks when it is peeled from logs during primary processing. They adapted to the higher wood content by mixing the hemlock bark with Douglas-fir bark mulch. Sumas Gro Media also uses a large amount of Douglas-fir bark mulch and some cedar sawdust (3-5mm) and indicated there has been some supply constraint.

Photo 9 Bark mulch from the Lower Mainland for bulk sale at landscape supply outlet in Saanich on Vancouver Island.

Table 15 Estimated wood fibre use by the greenhouse and nursery sectors based on information from primary suppliers

Region	No. of Suppliers	Douglas-fir Bark Mulch	Red/Yellow Cedar Bark Mulch	Hog fuel	SDS	FUs/Yr	Percent
Lower Mainland-Southwest	4	*	*	*	*	*	*
Vancouver Island	1	*	*	*	*	*	*
Thompson-Okanagan	1	2,027	156	2,027	988	5,197	*
	*	*	*	*	*	*	

**No response from suppliers*

4.4 Total Estimated Demand Sawdust and Shavings

Except for the greenhouse and nursery sector, the demand profiles discussed in the previous section are predominantly made up of whitewood SDS, which is the preferred material. There are some minor exceptions. For example, there is some use of hog fuel in the beef feedlot and equine sectors. There is some cedar sawdust use in blueberry production and even in dairy, but this is related to supply restrictions on white wood products and is not by choice. By and large, the estimated demand in these sectors is for whitewood SDS, and because of the animal health risks and issues involved with substitution, without other adaptations or research, this could be described as "critical wood fibre demand" for agriculture.

The agricultural demand estimates for SDS are summarized by sector and region in Table 16. Total provincial demand is estimated at 412,421 FUs/year. The largest combined demand is in the Lower Mainland at 268,255 FUs/year or 68% of the provincial total. The Thompson-Okanagan has the next highest demand at 67,397 FUs/year (16.3%), followed by Vancouver Island at 39,249 FUs (9.5%).

By sector, the largest demand comes from the dairy sector at 139,408 FUs/year, followed by equine at 116,735 FUs/year. The poultry and blueberry sectors have nearly identical demand at 61,991 and 61,717 FUs/year respectively. The beef sector has the lowest demand overall, with the combined demand of the feeder and cow-calf subsectors estimated at 32,570 FUs/year. The individual sector demand in each region is represented in Figure 5.

Table 16 Summary of estimated SDS demand by agriculture sector and region (FUs/year).

Region	Dairy	Poultry (All)	Beef Feeder	Beef Cow-calf	Equine	Blueberries	Total	Percent
Lower Mainland-Southwest	96,221	53,702	2311	954	55,957	59,108	268,255	65.0%
Vancouver Island	14,385	1,142	1028	681	20,878	1,136	39,249	9.5%
Thompson-Okanagan	19,088	7,137	11114	4756	23,830	1,472	67,397	16.3%
Kootenay	2,573	4	310	841	3,602	0	7,330	1.8%
Cariboo	1,724	0	745	1382	7,185	0	11,036	2.7%
Central Interior - Hwy 16	5,416	0	1155	6881	2,308	0	15,760	3.8%
Peace	0	7	411	0	2,975	0	3,393	0.8%
Total	139,408	61,991	17,075	15,495	116,735	61,717	412,421	100.0%

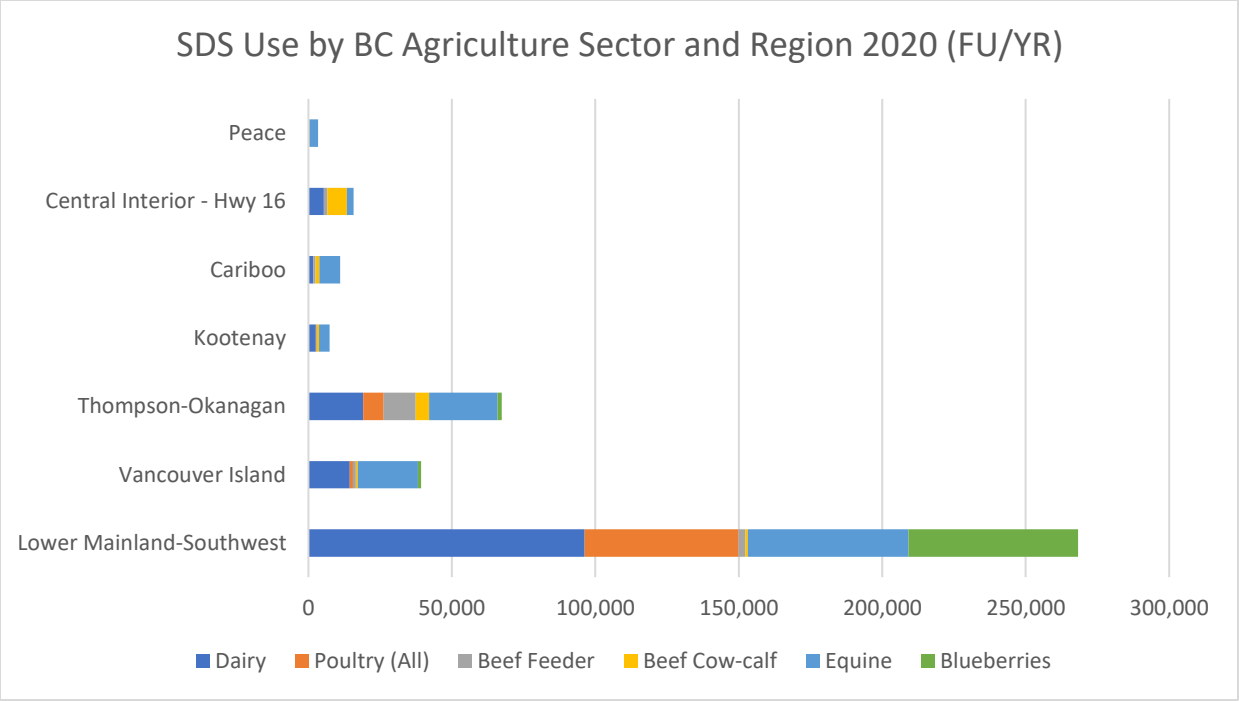


Figure 5 Summary of estimated SDS demand by agriculture sector and region.

4.5 Total Estimated Demand for Hog Fuel

Hog fuel uses in agriculture are primarily in the greenhouse and nursery, equine sectors. Both uses are difficult to estimate. Information on the total greenhouse and nursery sector demand was sought by surveying primary suppliers in the Lower Mainland, Thompson-Okanagan, and on Vancouver Island. A delayed response from all but one supplier means there is insufficient data on which to base an estimate for this draft of the report. There is some variable hog fuel demand from the beef feeder sector, however for the purposes of the assessment this consumption was included with total SDS demand.

5 Analysis and Discussion

The assessment of agriculture demand for wood fibre has revealed critical supply requirements, mainly for whitewood SDS, supply constraints, and high prices. It is important now to put this demand into perspective with the overall supply and demand in the province, and consider economic implications, potential adaptation options and wood fibre alternatives.

5.1 SDS Total Supply and Demand – Regional Balances

There are important regional distinctions that need to be drawn in this analysis as it relates to agriculture demand. In this section, agriculture demand for SDS does not include use of SDS by the Greenhouse and Nursery sector. However, there are some inputs of red cedar SDS to this sector.

5.1.1 Coast Balance

The aggregate demand from agriculture on the Coast is 307, 504 FUs/year (Lower Mainland and Vancouver Island regions combined). This region is unique among others in the province because no industrial consumers of SDS are explicitly identified in the Model. However, SDS is diverted to industry consumers with hog fuel. Agriculture is likely the main consumer of the SDS supply, which amounted to an estimated 411,109 FUs in 2018. A considerable portion of the SDS on the coast is made up of red and yellow cedar. For example, in 2018, 58% of the total SDS output was from cedar species. This fell to 44% in 2020, and the Model predicts it will stabilize at 45%. Since cedar is not a preferred or useable product in the dairy and poultry sectors, this puts considerable strain on the remaining white wood SDS supply, as would any diversions of white wood SDS to hog fuel. Effectively, this means that although the required supply is available and is predicted to be available, the balance is sensitive, with events like the mill shut down in March 2020 having an immediate effect. The overall supply and demand dynamic is illustrated in Figure 6.

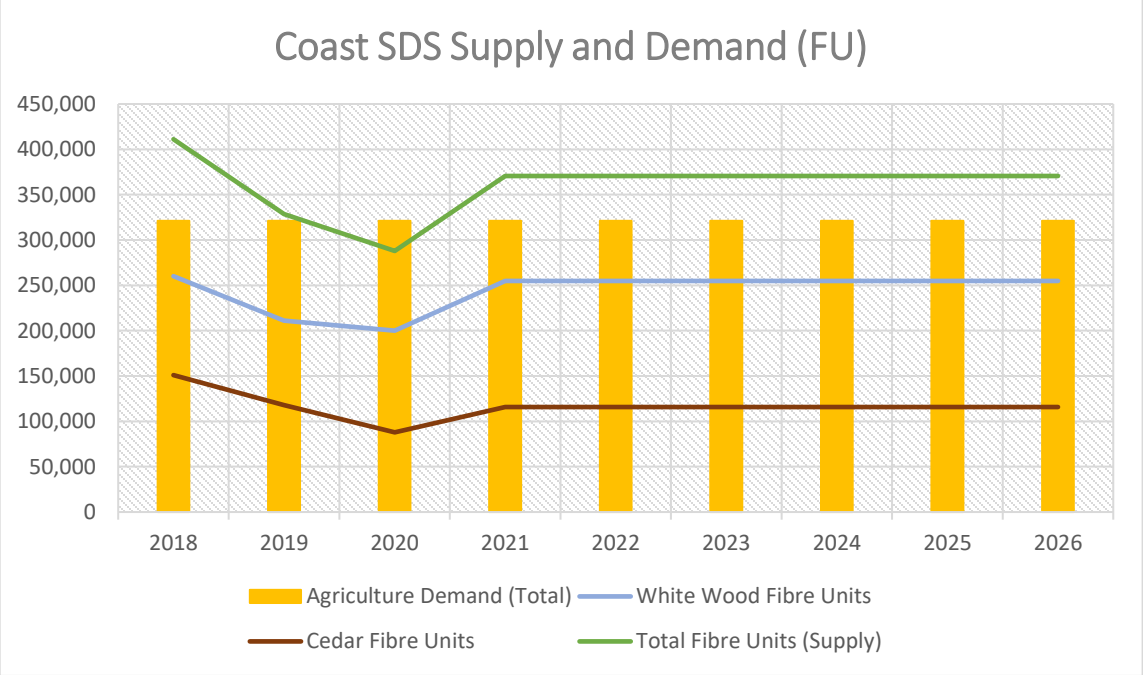


Figure 6 Coast Region (Lower Mainland and Vancouver Island) SDS supply and demand (actual and projected)

5.1.2 Thompson Okanagan Balance

The regional balance in the Thompson-Okanagan is very different than on the Coast. Agriculture has much lower SDS requirements, but still a sizeable critical demand of 67,397 FUs/year (Figure 7). Total supply is predicted to stabilize at around 425,000 FUs. However, industrial demand, almost exclusively from the pellet industry amounts to 487,776 FUs. This puts agriculture at a significant disadvantage in capturing part of the supply because of the dispersed unaggregated nature of this demand. Cedar makes up a small part of the supply, at around 4-5%, and interestingly cedar sawdust and hog fuel are finding their way into agricultural uses, because the whitewood SDS supply has decreased significantly.

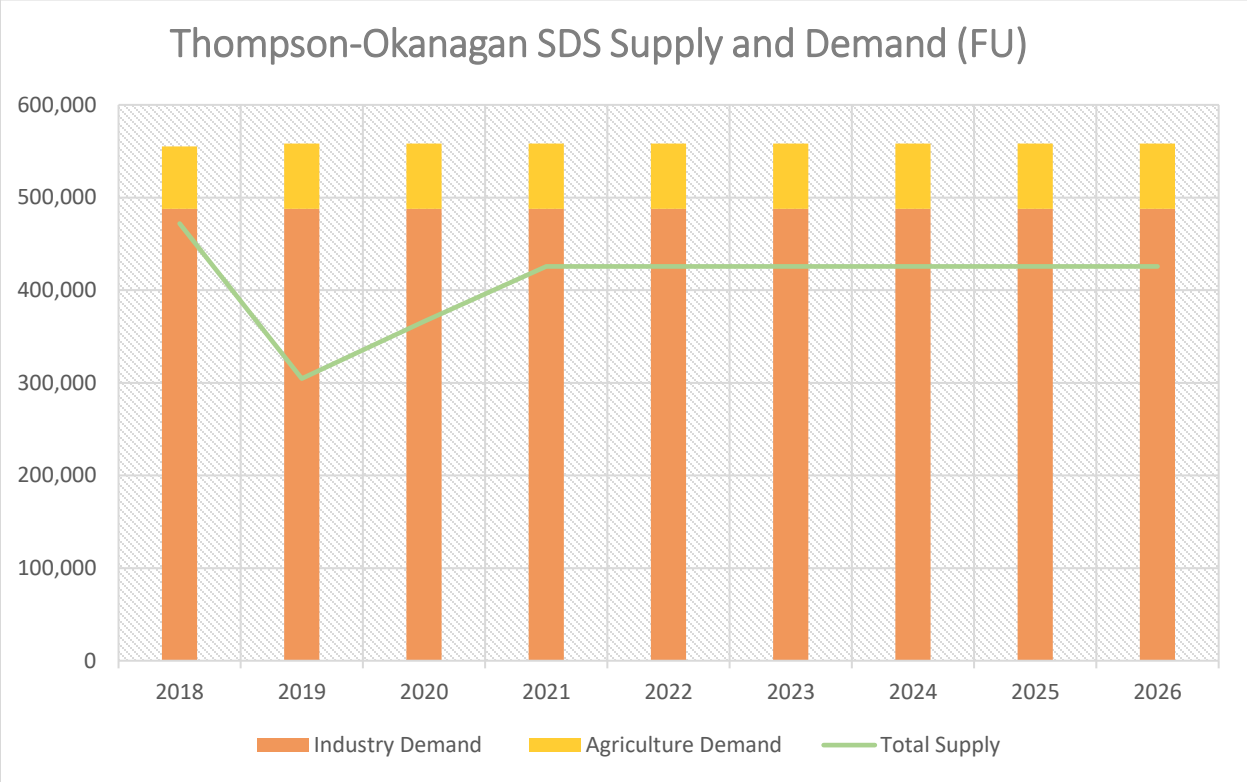


Figure 7 Thompson-Okanagan Region SDS supply and demand (actual and projected)

5.1.3 Kootenay Balance

The Kootenay region is the only agriculture region in the province where there is an identified SDS surplus (Figure 8). There are, however, exports from this region both to the US, and to the Thompson-Okanagan to meet industrial demand, and to the Lower Mainland to meet agriculture demand. Agriculture demand is relatively low (7,330 FUs/year) and is mostly from the dairy and equine sectors.

5.1.4 Cariboo Balance

Agriculture demand is higher in the Cariboo than in the Kootenay at just over 11,000 FUs/year. Some of the demand for dairy may be substituted with straw, based on observed production at the main dairy farm in the region. This farm is in a drier area than the northern dairy operations discussed in s. 4.3.1. and is also under irrigation. Total SDS supply is around 400,000 FUs, while industrial demand is about 450,000 FUs (Figure 9).

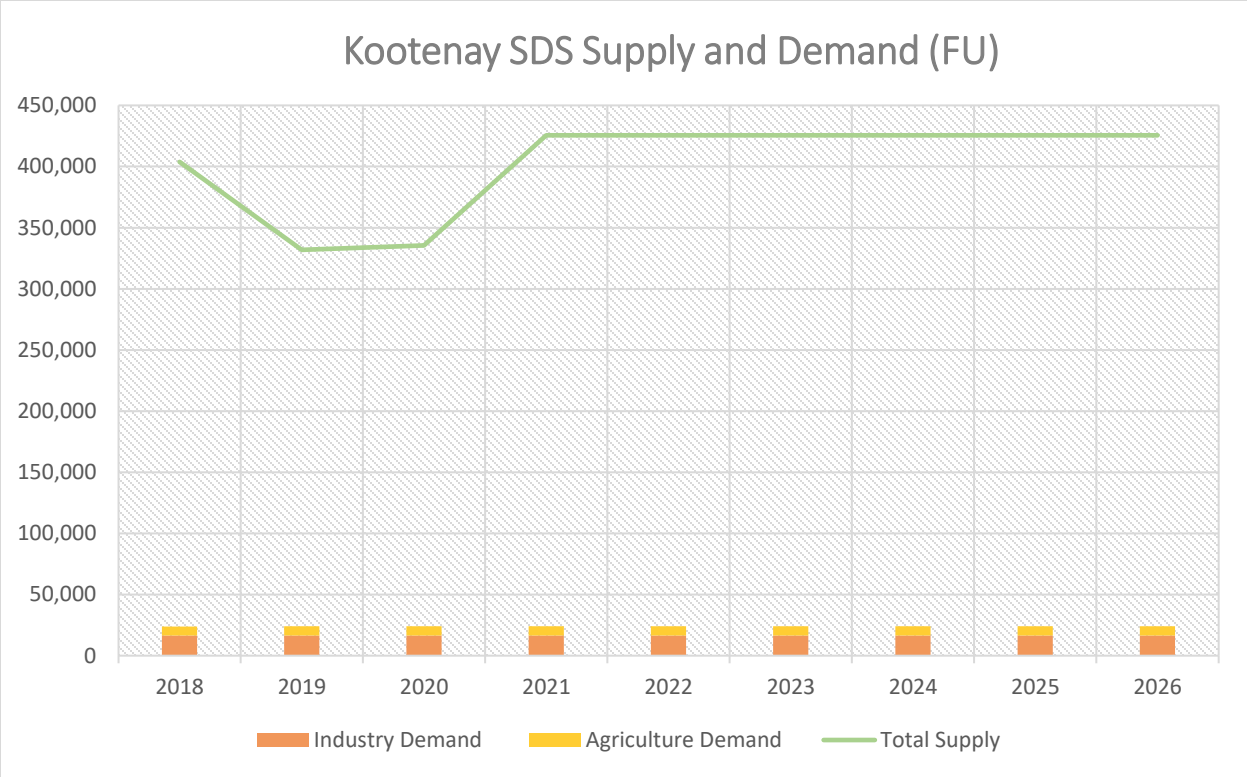


Figure 8 Kootenay Region SDS supply and demand (actual and projected)

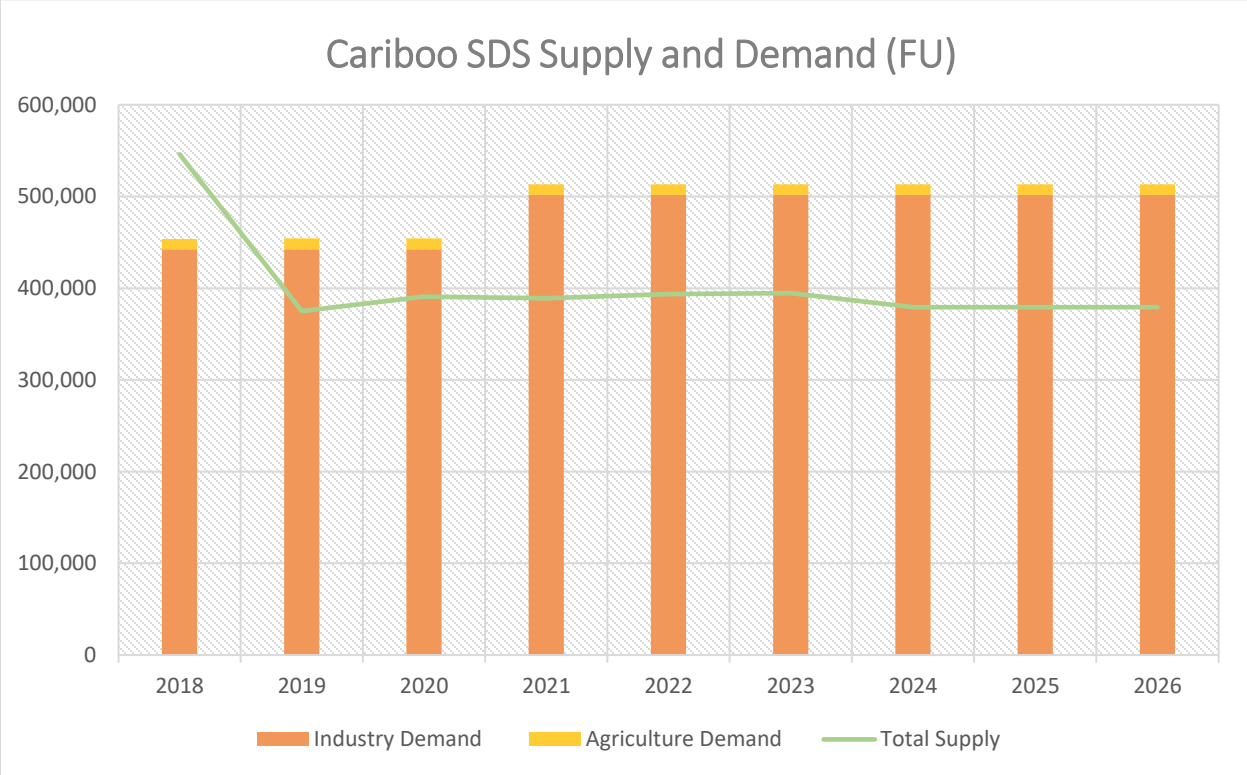


Figure 9 Cariboo Region SDS supply and demand (actual and projected)

5.1.5 Central Interior Balance

In the Central Interior, the SDS supply is substantially larger than any other region, hovering close to 1M FUs. However, projected industrial demand is close to 1.6M FUs. Agriculture demand hardly registers in the balance with estimated demand at around 16,000 FUs. This situation helps illustrate why Central Interior livestock producers (beef and dairy) have struggled to capture supply gaining some access to the market by aggregating individual demand through the Nechako Regional Cattlemen contract. This example is discussed in more detail in the economics section.

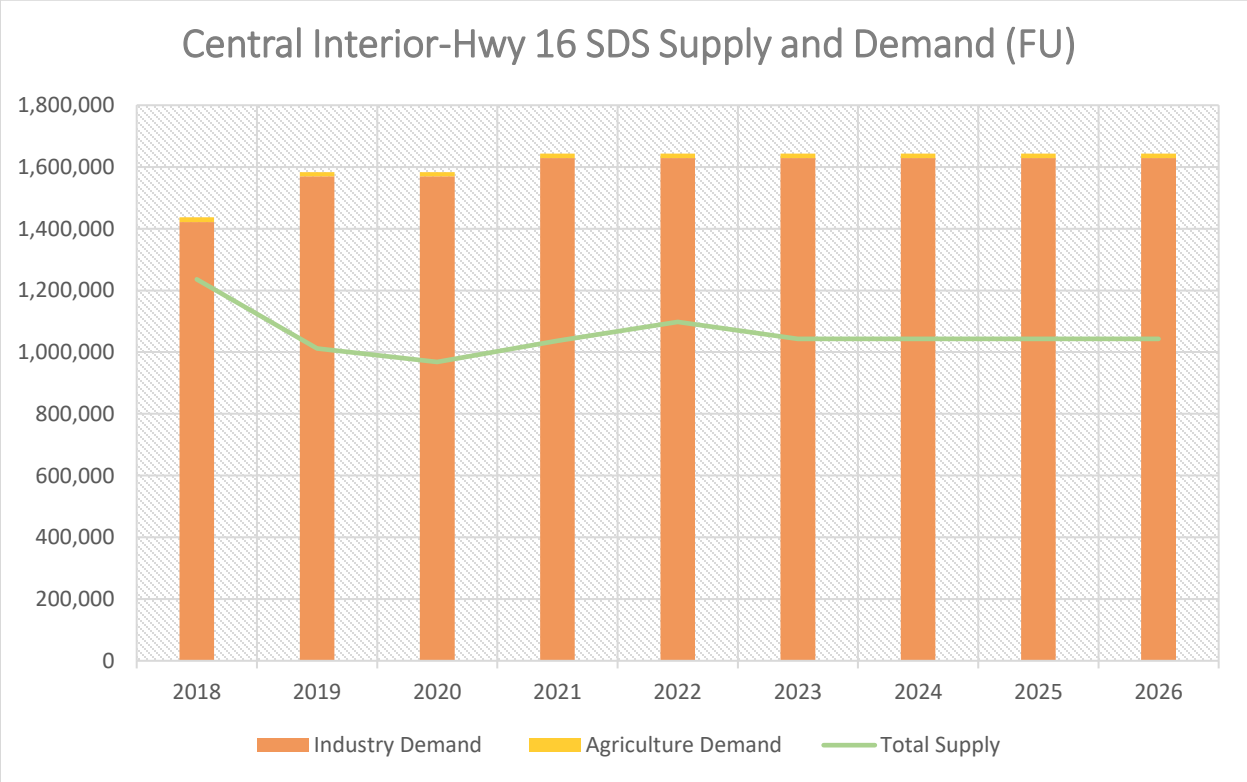


Figure 10 Central Interior Region SDS supply and demand (actual and projected)

5.1.6 Peace Region Balance

The Peace Region SDS supply is small in comparison to other regions projected to be around 242,000 FUs, with industrial demand slightly less at 227,313 FUs. A dip in supply in 2019 and 2020 created a marginal deficit in those years. The agriculture demand estimate is the smallest of any region at just under 3,400 FUs, concentrated in the equine sector. There was some feedback from this sector to AFF in early 2020 that there was supply restriction. Efforts to engage with equine sector participants in this region for the assessment were unsuccessful. There is some commercial dairy and poultry production in this region at two different Colony farms. Identifying practices and use to this level of detail in a region with such low overall demand was not possible within the scope of the assessment. The assumption is that straw is produced on these farms and is available as substitute in the dairies, while there may be some minor SDS use in poultry operations and in beef feeding.

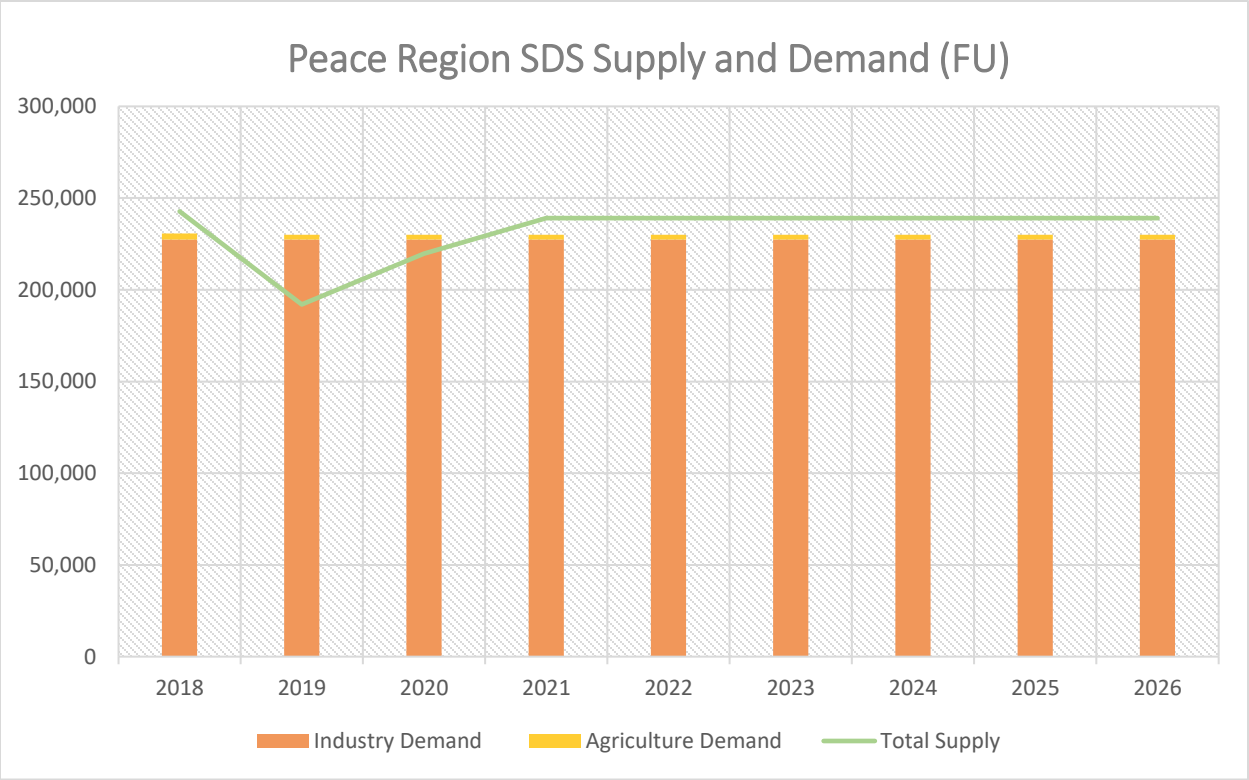


Figure 11 Peace Region SDS supply and demand (actual and projected)

5.2 Economics and the SDS Market

The prices recorded in this survey indicate that agriculture consumers of SDS are paying competitive prices in all areas of the province. Several participants reported 100% price increases in the last two years. More critical for some has been the decrease in fibre supply as well as the inability to secure fibre on a consistent basis. For some operations, substitution with a type of fibre that is less preferred has accompanied the price increases. These circumstances relate to structural aspects of the current wood fibre market, product preferences and regional supply and demand. So far it would seem that agriculture consumers have been willing to pay higher prices to secure critical supply. The question is what adjustments and adaptations might be required if predicted supply continues to decrease, and industrial demand stays at current levels.

5.2.1 Willingness to Pay

The impression left from participant responses to queries about further price increases is that current price is close to, or already at, their maximum WTP. The exception is the equine sector, where commercial stables are willing to pay more to satisfy recreational boarders and owners of high-performance horses. The question of maximum WTP may not be all that helpful in the analysis of the problem. For one, maximum WTP is a hypothetical price, and frankly no one wants to pay more for a product that has already seen significant price increases. Also, SDS is currently a critical input on most dairy and poultry operations in the province. Use can be reduced slightly, but a certain amount of bedding or litter is required in any given system in these two sectors. In the short term at least, this

demand appears to be inelastic since consumers are paying higher prices for the same quantities. Finally, SDS prices are not the only input cost increase that BC livestock producers are facing. In the last 20 months North American feed grain prices have also risen sharply, due to reduced world stocks and increased demand from China. For example, from January 2020 to May 2021, the Alberta barley price has risen from $206.90/tonne to $286.89/tonne, or roughly 39%.[14] Nearly all the grain needed to sustain BC's Thompson-Okanagan and Lower Mainland livestock sectors must be imported from Alberta, the BC Peace Region, or the Midwest with the added cost of rail and/or truck freight. Freight costs for grain to reach Vancouver Island are even higher. Over roughly the same period, the Farm Input Price Index for BC (all farm inputs) as risen from 120.3 to 127 (2012=100).[15]

To fully assess the impact of SDS price increases across the board, individual sector enterprise budgets would need to be updated, considering all inputs and market prices, and clearly this is not possible within the scope of this assessment. The added cost of SDS is possibly another contributing factor leading to more consolidation and integration of production and processing in BC agriculture.

To give some sense of the magnitude on the cost side, a small dairy in the Lower Mainland milking 150 cows in a reasonably efficient conventional manure handling system could have had an annual SDS bill of $17,625 in 2018-19. By 2020-21, the cost would have risen to $37,013.[i] Similarly, a mid-sized broiler operation with a quota of 132,000 Kg may have paid $6,838 for SDS (excluding blow in) in 2018-19. The cost for the same amount of fibre in 2020-21 would be $14,652.[ii]

5.2.2 Cost Recovery and Elasticity of Demand

There can be considerable variation in the amount of SDS used on dairy and poultry operations, but this variation is due largely to the bedding system and/or the physical infrastructure in place on the farm. In most cases there is no opportunity to reduce shavings use and maintain production levels without making structural (system) changes that would involve significant capital investment. This partially explains why in the short term at least, demand appears to be inelastic among this group of consumers. Another factor possibly affecting the response to increased SDS prices are the producer price adjustments made by the commissions and marketing boards associated with each industry.

Milk price adjustments are set by a formula:

> Price adjustment in % = (50% of the variation in the cost of production) + (50% of the consumer price index)

The costs of production are measured annually by the Canadian Dairy Commission. The most recent published study (2020) reflects a cost of production increase of 3.4% from 2018 to 2019 mostly due to labour and cash cost increases.[16] Between 2017 to 2018 the cost of production increase was 6.6%. Bedding costs are not explicitly identified although it is assumed they fall under other animal cash costs. This cost category in fact went down in the 2018-2019 period. This may suggest that cost of production measured through a national level survey are not sensitive enough to fully account for increased costs specific to BC producers. On the other hand, more significant production cost increases are expected in the 2021 and 2022 cost of production reports.

[i] Assumptions: dairy use rate of 235 FU/100 cows/year, prices $50 and $105/FU for each period, respectively.
[ii] Assumptions: poultry use rate of 1.48 FU/1000 kg/year, prices $35 and $75/FU for each period, respectively.

In the broiler sector, producers collectively negotiate a minimum live price with processors every eight weeks. The BC live price is based on the live price in other provinces and the cost of production, which like the dairy industry, would include the cost of bedding. A 2016 study by Price Waterhouse Cooper found that the BC broiler industry had the highest live prices in Western Canada, and these were well above the live prices in Ontario and Quebec.[17] The BC chicken industry is currently in a price formula review process led by the BC Farm Industry Review Board to provide stability and ensure orderly marketing for all stakeholders.

Certain segments of the commercial equine sector appear to have inelastic demand for shavings. These operations can pass along price increases to their customers. Recreational horse owners boarding at outside facilities, or their own properties, are likely more sensitive to price increases than sport horse owners. It is worth pointing out that the sector is not insensitive to broader economic conditions, and these factors could potentially impact overall SDS demand from the sector in the future. The significant reduction in the BC horse population after the severe and extended economic downturn precipitated by the US housing crisis in 2008 suggests there are upper limits on consumption within this sector.

As price takers the BC beef sector has no ability to pass along production price increases. Information gathered from participant interviews suggests that on a provincial level the sector has already adjusted to a limited supply and high price SDS market through adaptation to later calving, and different bedding practices. There is still demand and interest in shavings, particularly in areas like the Central Interior where use of shavings for bedding on calving grounds and barns has been a common practice for many years. However, it appears this demand is elastic with consumption declining as the shavings price has increased.

Since 2012, the Nechako Cattlemen have kept an annual record of both price and volume in relation to an SDS contract they have undertaken with a local lumber mill. This provided an opportunity to estimate a demand function using this data. Some adjustments were applied to the data to account for a change in the numbers of animals in the area over the period. For example, one large feedlot operator and several small operators left the business in 2015 and this decrease in demand cannot be attributed to an increase in the price of shavings alone. Census data from 2011 and 2016 for areas Bulkley-Nechako Areas F and D was reviewed to assess how real demand, based on the number of animals, may have changed over the period. An adjustment factor of 20% was applied to years after 2016 to account for a real loss in demand due to a reduction in cattle in feedlots, but an overall increase in the total cow herd. The estimated demand function is shown in Figure 12.

There may in fact be other factors, including weather, that could have affected the demand for shavings over the 8-year period. The graph shows that price is a significant factor, it predicts that should price increase substantially over current levels, consumption will move lower. There is one dairy included in this data, and all else being equal this is expected to have a moderating effect on the demand decrease as price increases, because that demand is constant and will continue to make up a greater proportion of the total shavings used.

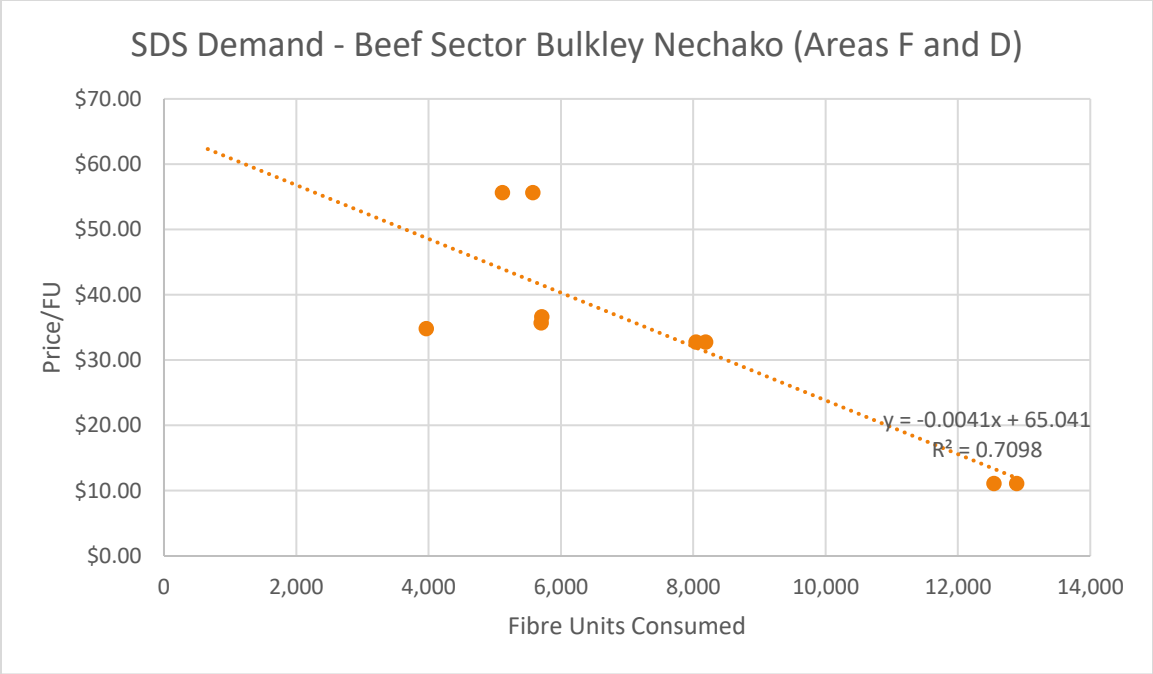


Figure 12 Estimated shavings demand function for the beef sector Bulkley-Nechako Areas F and D

The blueberry sector, like the cattle sector, is largely unable to pass on any cost of production increases to customers. Worldwide increases in blueberry production and trade tariffs have reduced profit margins for BC producers, which has placed additional pressure on the industry. Application of sawdust to Blueberry plantings increases production but is not essential in the same way bedding is required to meet codes of practice in dairy and poultry. There is no real evidence to support the notion that sawdust consumption has declined with recent price increases in SDS, but it is suspected.

Suppliers and primary consumers in the landscape and nursery sector are positioned to pass along wood fibre cost increases to wholesale and retail customers. Overall, this sector appears to have been less sensitive to recent wood fibre shortages. It is assumed this is because hog fuel, which has fewer primary consumers outside the pulp and paper industry, makes up a substantial part of the demand. The other main component in the mix is Douglas-fir bark, of which the landscape industry is a primary consumer. This sector can also use red cedar SDS which has less demand than whitewood SDS.

5.2.3 Market Development

It is important to identify that a significant SDS market has developed around agriculture demand and that there are value chain components. For example, farm costs for SDS in the Lower Mainland discussed in s. 5.2.1 are based on delivered prices and include freight and processing/handling costs passed along by suppliers. A similar value chain exists for bark and hog fuel in the Greenhouse, Nursery and Landscape sectors.

Agriculture demand for SDS on the Coast is significant, with many consumers who need constant bulk delivery of a preferred product. With relatively few mill sources and lots of customers, a system of supplier/transporters has developed to aggregate product and efficiently match it with customer preferences. Exact product requirements become well known through long term supplier-customer relationships. As fibre supply decreases this service has likely had a valuable moderating impact

because of supplier stockpiling, mixing and substitution, even if at times some customers have received a less desirable product than they are used to.

In other regions of the province agriculture overall demand is low, and even though there are potential customers, volume per customer is also relatively low. In this situation, there is no way to capture supply that has already been contracted to large industrial customers. The transaction costs associated with mills selling wood residue to individual agriculture consumers is too high. Nor is there enough volume to encourage intermediate suppliers to aggregate fibre from the lumber mills to supply agriculture consumers. This is certainly the situation in the Central Interior, which led the Nechako Regional Cattlemen to negotiate a contract with a local mill in 2012 and essentially become a supplier/aggregator. This kind of arrangement still has some risk because total volume is so far below that of a single industrial customer contract. On the other hand, there would likely be no supply for agriculture without the contract. The total demand in the Bulkley Valley is even lower than in the Vanderhoof area, and this is likely why it has been difficult to enter a formal contract with the lumber mills located there.

The situation in the Thompson-Okanagan region lies between these two extremes in market development with minor supply services emerging around more substantial agriculture demand. Unlike the Coast however, agriculture is not the only consumer vying for the SDS supply in this region. The pellet industry is the most significant industrial consumer in this area and by using dry whitewood material in production, plant energy costs are reduced.

To illustrate these regional differences in the agriculture SDS market the participants and the product flows on the Coast (Lower Mainland and Vancouver Island), Thompson-Okanagan and the Central Interior are diagrammed in Figure 13. Although the scope of this assessment was focused primarily on bulk wood fibre residue required by commercial agriculture, the packaged market for SDS has been included in Figure 12. The packaged shavings go mostly to horses, poultry, sheep, goats, and other small animals. None of this use was quantified in this study, although some of the shavings use is possibly captured in the estimated demand for the equine sector generally, since all horses in the province were considered.

5.2.3.1 Packaged Products

This is an important segment of business for suppliers and processors because of the higher prices that are charged for (unit) shavings volumes in small packages. A representative of one of the large mills in the Thompson-Okanagan who was interviewed for the assessment, suggested this is a valued part of the market they would not want to lose. Although agriculture has had challenges securing bulk supplies of SDS, packaged shavings is a segment that will continue to have supply because of consumer's willingness to pay premium prices. Example products are shown in Photo 10. The mini-flake shavings on the left are from Klassen, one of the major suppliers in the Lower Mainland, and the price of $12.99 at this retail store on Vancouver Island is equivalent to $520/FUs. The same product is priced on the Klassen website at $6.99/bag which would be equivalent to $280/FUs.

Several of the participants from the equine sector made mention of the Thunder Bird Show Park, a large equestrian facility located in Langley, and the importance of shavings to that operation. One is a co-owner of the park and shared that as many as 800 horses from BC and outside the province come to the park events that last up to two weeks at a time. All the shavings used are commercial packaged

shavings brought in by the park, and then sold to competitors. Branding on the CO-OP Otter Feed, Pine Shavings in the clear packaging (compressed to 3 cu ft.), indicates they are a Thunderbird Official Partner, suggesting this is the shavings product brought into Thunder Bird Show Park. The value of this market segment to all the participants in the value chain will most certainly ensure future supply.

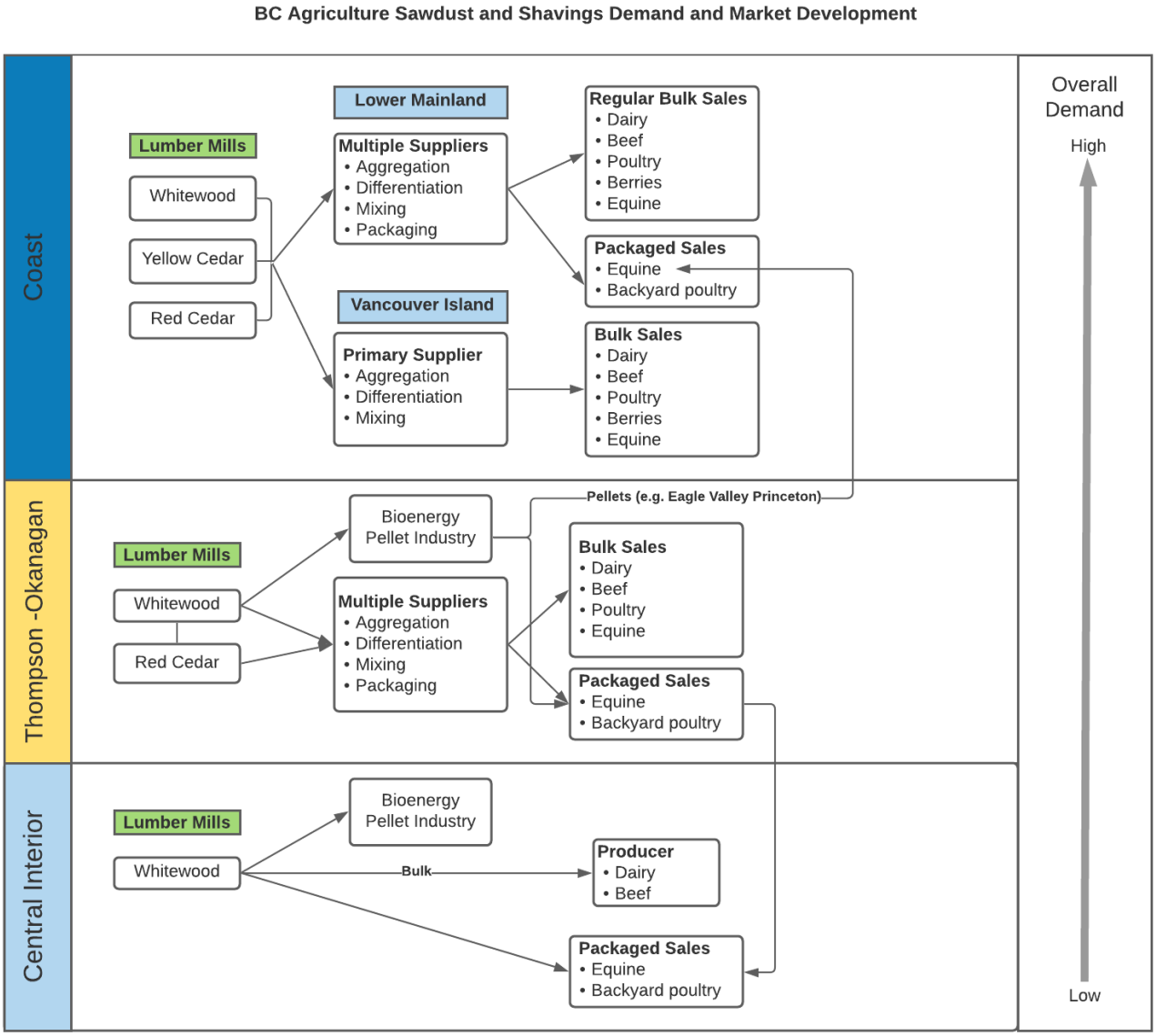


Figure 13 Diagram of agriculture SDS market development, product flow and relative demand

Photo 10 Klassen Mini-Flake shavings and Triple S brand white wood shavings for sale at retail feed stores.

5.2.3.2 Transportation

Freight cost is a factor in the delivered prices for SDS. In the Lower Mainland suppliers face freight costs to transport SDS from local mills to their supply yards, where they aggregate and process the material. These costs are incorporated into material prices charged to customers. Freight costs for delivery from suppliers to farms is often included in the prices they pay as well, with fuel surcharge added on top. A large portion of the demand can be satisfied by Lower Mainland lumber mills, but as described in s. 5.1.1, cedar makes up a significant portion of this supply, which is not suited for some uses. Dry SPF shavings are imported from the Interior to help balance this demand, and this added freight cost is a factor in the price of all shavings on the Coast. Even though there is a SDS shortfall in most of the interior regions, some premium shavings are finding their way to the Coast.

For example, during the earlier work done on this topic in 2020, one of the main suppliers was hauling shavings from Midway in the west Kootenays to the Lower Mainland. What made this possible is the SDS surplus that exists in the Kootenay Region (see s. 5.1.3). Survey information revealed a midpoint price being charged by this supplier to Lower Mainland dairies was $110/FU. Price at the Midway mill, also discovered through the assessment, is around $16/FU. Applying some basic assumptions, including a truck rate of $145/hr., distance from Chilliwack to Midway (367 Km), round trip travel time, loading/unloading time, it is possible to estimate a freight rate per FU using two different trailer configurations. For a standard 53-foot walking floor trailer hauling 19.6 FUs, the freight cost for this trip is estimated at $79/FU. For a 53-foot possum trailer hauling 22.5 FUs, freight cost is estimated at $69/FU. The cost of SDS at $16/FU FOB Midway added to the freight, brings the suppliers delivered cost

to $95/FU and $85/FU for the walking floor, and possum trailers respectively. This leaves a supplier margin of $10 or $20/FU, depending on which trailer configuration is used.

5.3 Residual Wood Fibre Alternatives

Participants were probed about potential alternatives or substitutes for the residual wood fibre used in their operations. Sand, straw, and composted material (recycled bedding) were frequently mentioned by participants using wood fibre for animal bedding.

To be suitable, alternatives need to function nearly as well or better than wood fibre in the application, and there needs to be adequate supply of the substitute available at a cost similar or lower to that of wood fibre. A further consideration for materials used for animal bedding is that they be free of chemical and heavy metal contaminants that may impact animal health or plants and soils where used bedding products are applied. In blueberry production whitewood SDS performs multiple functions including weed control and moisture retention. While yard waste mulch and weed mats (porous, woven polyethylene) have been applied, results have been mixed. Composted animal waste can raise soil pH and provide additional K, which can negatively affect blueberry production. One of the blueberry producers in the survey, mentioned trying weed mats, but abandoning them and returning to wood fibre use. Research in Oregon suggests there may be some opportunity to reduce SDS use by combining the use of sawdust with weed mats.[18]

The blueberry industry, with limited options for substitutes, highlights that sector-specific applied research is necessary to properly evaluate alternatives and support adaptation. This is especially true for unconventional substitutes that have had limited use either in BC or other parts of the world. The remainder of this section will focus on substitutes for wood fibre for use as animal bedding, primarily for dairy cattle and poultry.

5.3.1 Sand

As noted in s. 4.3.1.2, it is estimated that 30% of the BC dairy herd is bedded on sand. Producers use sand primarily for milking cows, preferring shavings for young stock. The insulative properties of straw and shavings are better than sand, and this is important for calves in cold conditions. This means that there are still some shavings used with sand systems. There were only 3 sand systems in the survey, and this is an insufficient number to make firm conclusions about the efficiency of sand as a substitute for wood fibre. One farm reported using as many shavings as some farms in the all-shavings group; however, the other two dairies used considerably less. In these two instances SDS use was 40-64% less than the standard demand rate of 225 FUs/100 cows/year assumed for Lower Mainland dairies.

Two of the three dairies using sand were not recycling. This means that sand must be continually purchased. It also means that sand must be excavated out of manure settling ponds to keep them from eventually filling up. In both these examples, the sand was being spread on cultivated fields. Both producers consider that soil properties will be improved, up to a point, with this practice. Based on the reported use, the annual sand cost for the dairy in the Thompson-Okanagan (assuming 150 cows) is around $9,000. The operation on Vancouver Island (assuming 150 cows for equivalency), is paying $19,000. This reflects both a higher rate of use at the dairy on Vancouver Island, and higher sand cost ($12 vs $14/t). There is additional bedding cost for the shavings used in these operations.

An important consideration in relation to sand use is long-term sustainability. Sand is a valuable non - renewable resource, and supplies may be limited in some areas with competing uses. The Thompson-Okanagan producer mentioned that the seam of sand close to his farm had run out, and now the sand had to come from a greater distance, adding to his delivered costs.

The more sustainable option is to recycle sand. This requires capital investment to adapt manure handling systems, which in some cases may be needed to use sand at all. Sand is also hard on equipment, such as pumps. The operator recycling sand mentioned making a $50,000 investment when taking over the farm, and a recent additional investment putting in a sand washing/reclamation lane. Incompatibility with existing manure systems was the most frequently cited avoidance factor for sand in a bedding cost study in New England.[19]

Sand was not mentioned as an alternate bedding system by the poultry participants, but fine (mortar) sand has been used as bedding/litter material in chicken production outside North America. A 2005 study for the southern US found that from a bacteriological point of view, sand can be a viable litter alternative to shavings where it is locally available.[20] Another study from southern Africa also found sand had potential as an alternative litter for broiler production.[21] A related study found that the food pad dermatitis score (FPD), a key indicator of litter suitability, was not significantly different for all the materials tested including sand.[22] The applicability of this research undertaken in environments quite different than BC is uncertain, and sand may not perform as well in colder conditions.

Horses can be stalled on sand floors, and the material provides good animal comfort. However, one of the main concerns with sand use is ingestion, which can lead to colic when feed is consumed directly from the stall floor.[23] Sand does not pack and when other bedding is used it can mix with the sand and make cleaning difficult. This was mentioned by one of the participants as a reason why sand is not used.

5.3.2 Straw

Barley and wheat straw is proven to be an effective bedding material and is used in dairy operations in other parts of Canada and around the world. One of the dairies in the Central Interior is growing barley and is trying to increase the amount of barley straw that it uses as bedding. The simple issue for BC is that there is limited cropland available on which to grow grain crops outside of the Peace Region, the Vanderhoof area and the Creston Valley. In other areas, higher value crops are grown on a limited amount of land. For dairies, this crop is silage corn, which makes up a significant and valuable part of dairy feed rations on the Coast and in the Thompson-Okanagan region. Most of the straw used on BC dairies is in Total Mix Rations (TMR) rations and must be imported. This adds significantly to the price of straw. For example, truck freight from southern Alberta to Chilliwack will add as much as $140/ton. By the time straw reaches the Lower Mainland, it is worth $180-200/ton.

There is a straw supplier in the Lower Mainland producing chopped straw for delivery to dairies, and a smaller number of poultry operations. Most dairies use the chopped straw in TMR, but during the severe supply shortage in spring 2020, more chopped straw was being used for bedding. The price for this product at that time was $230/ton (chopped) and is estimated to be roughly equivalent to $142/FU when used as bedding (Photo 11).

Straw is commonly used for litter by broiler operations in Europe, however it is not widely used on poultry operations in BC. Despite widespread use in Europe, lower FPD scores have been observed for pine shavings when compared to straw in broilers and turkeys.[24] Even with the increased cost of shavings, straw is still the more costly option and is a potentially a less desirable product for use in poultry.

Photo 11 Chopped straw in storage on Lower Mainland dairy, and cow bedded on chopped straw (Photo's courtesy of Healey Hay & Strawdust Supply Inc.)

Straw could play a role during short term curtailment of lumber mill operations or in other emergency situations. Any emergency initiative involving straw would need to be focused primarily on the dairy sector which would keep a limited supply of dry SDS available for the poultry sector. However, the additional costs associated with freight (truck or rail), chopping and related logistics should be expected. There is also market and price risk associated with this alternative. For example, because of widespread drought conditions in Western Canada in 2021, straw prices are expected to be even higher than 2020. A significant demand for straw created by an emergency response in southern BC would likely move Alberta or Washington State FOB straw prices higher generally, and it is uncertain whether a sufficient supply could be procured in an emergency. Most grain farmers recognize that they are exporting valuable nutrients from fields when they bale straw, so most straw is chopped and returned to the field at harvest, which limits total supply. In a best case- scenario straw could be part of a comprehensive planned response to address a short-term supply shortage.

5.3.3 Other Substitutes

Sand is the main inorganic bedding substitute for SDS, although some recycled gypsum product from the construction industry has been used on dairies in the US. While the gypsum product meets necessary requirements for cow comfort, absorbency, and low bacterial counts it has been associated with livestock and human deaths.[25] Under anerobic conditions the calcium sulphate in gypsum is converted

microbially to hydrogen sulfide gas (H_2S). In concentrations over 100 ppm, H_2S gas is injurious to animal and human health and may cause death. Most all other substitutes for SDS bedding are organic.

5.3.3.1 Recycled or composted manure solids

One of the dairy participants was using recycled manure solids (MNS) for bedding. This operation also had low shavings use at 94 FUs/100 cows, just 42% of the standard dairy demand rate of 225 FUs/100 cows. The producer indicated more shavings were used in combination with the recycled manure solids during the summer, as a preventative measure to control bacteria concentration. The main adaptation at this dairy are the incorporation of separation screens and a screw press which eliminates moisture from the solids. The dehydrated solids go back into the barn without additional treatment. This operation was also supplying solids to two other dairies for bedding young stock. Some of the material is also sold to the gardening and landscape sector, although this is a breakeven enterprise. The biggest savings come with the reduced shavings use, and reduced costs associated with spreading solids on the forage production fields. The complete cost of this system was not provided, but the producer indicated there are increased maintenance and cleaning costs. A recent repair of the screw press unit cost $22,000. Despite this expense, the technology was viewed as being easier to manage and keep running than Bedding Master equipment (see reference below).

In the example above the separated solids are used without additional processing. There are two other ways manure is recycled to create bedding. It can be composted in a large drum composter aerobically (Bedding Master is an example), or it can be produced from anerobic digester, which also produces biogas as a biproduct.[26] There are examples of both systems being used in BC, but these are associated with large dairy operations. In a 2011 report from Washington State, all but one dairy farm digesters were associated with operations of 1000 cows or more.[27]

Like sand, cow comfort is high with MNS. One of main concerns of dairy farmers considering the use of MNS for bedding is the potential effects on animal health and production. Use of MNS for bedding has been associated with increased incidence of environmental mastitis in milk cows. However, in Wisconsin research, streptococci and streptococci-like organisms were high in both sand and MNS bedding systems, although total gram-negative bacteria (coliform and *Klebsiella spp*.) were highest in the deep bedded MNS system.[28] The authors concluded that bedding is not the only source of environmental exposure, and more research is required to determine associations of bacterial counts from bedding samples and mastitis rates. Management practices including cleaning and replacement are a factor, as are seasonal changes in temperature and humidity. Practices employed to manage bacterial count by the participant in the example above, appear to be supported by the research.

The practice of recycling chicken litter for reuse, particularly in broiler operations, is well established in the US. While the barn is empty at the end of a cycle, litter may be de-caked, tilled/windrowed, or treated with acid-based amendments before use by the incoming flock.[29] The Canada Chicken Farmers Animal Care Manual, which is based on the *Code of Practice for the Care and Handling of Hatching Eggs, Breeders, Chickens and Turkeys* (2016), and developed using the National Farm Animal Care Council's Code development process, requires that litter must be cleaned out after each flock and replaced with clean bedding materials.[30] There apparently is an exception to allow a second flock of turkeys on used litter. It was reported in interviews for this work, that a flame-heat treatment was allowed by the provincial board to dry used litter before new broiler flock placement during the severe SDS shortage in 2020 on at least one farm.

5.3.3.2 Paper and Cardboard

Shredded paper and cardboard products are used for bedding in dairy and poultry operations in other jurisdictions, although it appears the use is not widespread. According to one BC poultry producer contacted during the SDS shortage in 2020, shredded newspaper was tried for a period in some Lower Mainland poultry barns, implying that it was less suitable than SDS. While there is some indication in the literature that shredded paper has absorbency (water holding capacity) equivalent or higher to that of wood shavings, paper also releases more ammonia (NH_3) than wood shavings.[31] In evaluation of litter materials for broilers, it was concluded that combining paper with wood shavings could reduce the total cost of litter, but this would be at the expense of increased ammonia volatilization. The replacement of newsprint by digital media, likely means this product is less available than it once was, and the mixed paper stream is likely a less suitable product.

Paper was trialed by a beef producer in the Vanderhoof area, and another area dairy producer was part of project supported by Community Futures in the 2000s that trialed shredded carboard. Both producers were interviewed for this project. The beef producer indicated that the paper did not have enough absorbency and broke down too quickly. This result is perhaps not surprising given that the bedding was not under cover. The dairy producer indicated there were a couple cases of calf scours while the trial was on, but that these may not have been associated with the use of cardboard bedding. Overall, it was felt the trial was too short to be conclusive one way or another. It was also reported by staff at Bulkley-Nechako Regional District (BNRD), with knowledge of the project that the cardboard broke down too easily.

Recycling cardboard is a challenge in rural areas. The BNRD has banned this material from landfills they operate, although waxed cardboard associated with food packaging is currently being landfilled. After the cardboard is baled, there is a cost associated with freight to Prince George and Vancouver to get it into the recycling stream. Assuming the effectiveness of clean shredded cardboard for use as bedding and best practices were established, the scale of the cardboard waste stream in the region could supplement the dairies operating in the region but would not be sufficient to replace wood fibre bedding entirely. Total cardboard output from both commercial and residential sources in the BNRD is estimated at 1400 tonne/yr.[32] If all this product were shredded and used, it may supply enough bedding for 1/3-1/2 of the dairy cows in the region (475 – 800 head). Shredded product yield and use rate should be established through applied research, and trials should include a combined shavings and shredded cardboard treatment.

5.3.3.3 Shavings from Alternate Sources

Waste wood is another material that BNRD would like to eliminate from their solid waste stream. In the past some of this material was ground and used in regenerative agriculture projects in the district. Currently the wood waste stream is 50% contaminated wood, 30% brush and 20% clean wood. The clean wood portion is around 805 tonnes.[33] If this product were converted to shavings, it would produce an estimated 1000 FUs, or approximately enough for 400 dairy cows per year. One of the issues, would be the cost of cutting the shavings and transport to get material from transfer stations to a suitable site for processing, and redistribution. It is likely there would be seasonal variation in the supply that would need to be considered assuming the material can be processed into a suitable bedding product. The overall cost and viability of this option would require more detailed investigation.

The economics of any operation set up exclusively to produce bedding needs critical evaluation. A study from New England found the investment in trailer mounted Tremzac 248T, a shavings mill manufactured in Quebec, was not justified if use was limited to single farm of small to average size (53 cows). In this example, the source of wood was pine from a woodlot attached to the farm. Cost may be justified if the machine could be operated 40 hours a week and serve several farms, or a single large farm.[34] At this output, the machine would produce 2560 FUs/yr., enough bedding for 1,138 cows using the standard demand rate for BC established in this report. It is worth mentioning the feedlot example from the Thompson Okanagan, in this discussion (see s. 4.3.2.3) where a lower cost grinder was purchased to make bedding material used by the farm and other customers. The source material in that example was residue from secondary wood manufacturer located close to the farm. This appears to be an effective adaptation but could not be duplicated more widely given the limited nature of the source material.

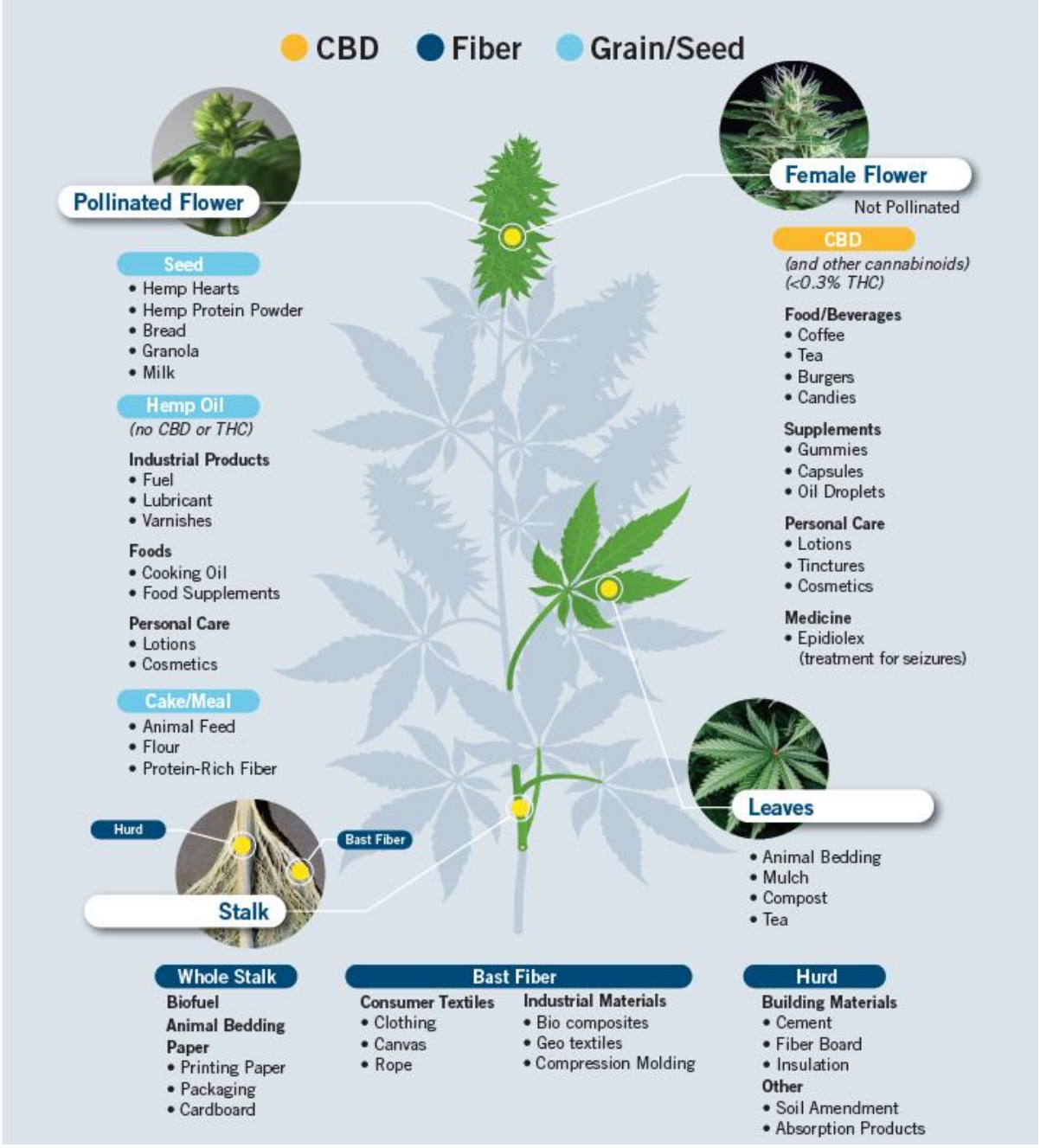
The land and resource compliment of dairies in New England may be different than BC. The average size of private woodlot owned by dairy farms in New England is 64 ha, and it was determined that a patch cut of .4 ha/year would supply enough shavings for the average farm.

There were other considerations discussed in the New England study, but not incorporated into the analysis, including the importance of debarking and kiln drying on shavings quality in milk production. It was suggested that this processing might be done at a local mill. These added costs raise more questions about the efficiency of attempting to make shavings on a small scale. The type and location of source material, and harvest rights would be key factors in the assessment of this type of venture in BC. Getting access to a forest harvest tenure was one option discussed by the Nechako Regional Cattleman's, to secure a shavings supply. Ultimately, the issue of supply was solved by aggregating membership demand and negotiating a contract for shavings with a local lumber mill and contracting the trucking with one of its members. The contract, however, has not insulated the members from price increases and falling demand as discussed in s. 5.2.2.

5.3.3.4 Hemp

Hemp production has been mentioned as a potential source of bedding material for BC livestock producers. Hemp provides multiple products and requires processing to extract the full value from the plant. The successful alignment of investment in processing facilities with a sustainable crop production area is likely a long way in the future. Industry development will be even more challenging in BC, where there is limited land area available for cultivated crop production. Business proposals for processing facilities tend to be over optimistic in their appraisal of the crop production environment and market potential. An example is the proposal announced by the BC Hemp Corporation based in Prince George.[35]

The uses for different parts of the hemp plant are shown in Figure 14. Several parts can be used for animal bedding, but the most suitable product for applications discussed here may be the hurd (or shives), which comes from the inner part of hemp stem. The bast fibre is used primarily for rope and textiles. The main driver of the expansion in industrial hemp production worldwide is demand for CBD (cannabidiol).[36]



Source: CoBank Knowledge Exchange, 2019.

Figure 14 Graphic showing products and uses from different parts of the hemp plant

In Canada, industrial hemp is a regulated crop under the *Cannabis Act* 2018; and there are over 50 approved hemp cultivars.[37] Canada was the first country to approve commercial hemp food products, and hemp grain remains an important output from the production in Canada. Bioactive parts of the plant are now being processed by licenced operators in Canada, or approved importers outside Canada. The total area in hemp production in Canada was 22,243 ha in 2020. Alberta and Saskatchewan are the largest producers with 8,332 and 6,164 ha respectively, which represents 65% of total Canadian production.[38] BC hemp production area in 2020 was 537 ha, with 230 licences issued for cultivation.

Alberta has 265 licences for cultivation, which gives some indication of the current scale of production in BC.

According to a 2020 Alberta Government report, most of the hemp fibre produced in Canada is not being economically used because of a lack of separation processing capacity.[39] It suggested hemp straw bales were being disposed of or used for livestock windbreaks. Use of this hemp straw for animal bedding was not mentioned. A recent European study found that hemp straw (shives) could be a suitable bedding alternative for dairies with either free stall or compost bedding pack systems. In this study, the hemp straw was processed 65% of the particles were over 50mm in size, with another 25% between 2-8mm.[40]

The developing nature of the industrial hemp market, regulated crop production and the processing requirements will limit the viability of hemp as a substitute for wood fibre bedding by commercial dairy and poultry operations in BC. The limited area available for crop production in BC is an additional constraint affecting economics and future supply. As the industry continues to develop in Alberta and Saskatchewan, compressed and packaged hemp bedding could become more available and be a viable product for recreational horse owners in the Lower Mainland and Vancouver Island who are willing to pay a premium. However, European research has demonstrated that straw pellets were superior to hemp both in terms of ammonia retention and generation of airborne particles. Both variables are important in maintaining a healthy stable environment for horses.[41]

5.4 Current Animal Health Requirements (Code of Practice)

The code of practice for the care and handling of broilers was mentioned in s. 5.3.3.1 in relation to use of recycled manure. Litter must be monitored daily, and litter must be cleaned out and replaced with clean bedding once the barn has been cleaned. Dairy cattle, beef cattle and equine also have codes of practice for care and handling developed under the National Farm Animal Care Council (NFACC) Code development process.[42] In the bedding management section for dairy cattle a range of bedding materials are suggested including clean sand, straw, kiln-dried shavings, or sawdust. Recommended best practices include chopping straw to decrease the amount of straw required, adding dry bedding daily in bedded pack pens, and adding bedding as needed and tilling twice per day in composted bedded-pack pens.

For beef cattle, bedding is recommended to insulate against the bare ground and reduce buildup of manure on hides under cold conditions. Dry bedding is recommended when calving indoors and when isolating sick animals. No bedding types are specified.

In the equine code of practice, straw, shavings, shredded paper, and peat moss are mentioned as examples of bedding materials. Recommended practices include having a sufficient bedding depth to absorb urine, removing wet and soiled bedding at least once per day, provide bedding on stall matts, and using bedding that is as dust free as possible.

5.5 Implications of Supply Restriction

The kind of wood fibre supply restrictions that have been experienced by agriculture producers is not unique to BC. There have been supply shortages for pine shavings in the US, created by similar circumstances, i.e., reduced output and competition from different uses, including energy. Livestock

producers in these areas have been forced to adapt to other materials for bedding and litter, and a fair amount of research has been conducted on various bedding materials and systems to help support adaptation.

The situation in BC does however, present unique challenges. For one, the range of bedding substitutes is more limited here than in some regions. The high demand area centered in the Lower Mainland means that many inputs including feed must be imported which adds substantially to costs. Residual wood fibre was the one local natural resource that was produced in abundance, and agriculture producers have grown to rely on the availability of this product. The forest industry is moving into a new era in BC, and this supply can no longer be relied upon by agriculture. Climate change related impacts including the Mountain Pine Beetle epidemic, recent spruce beetle outbreaks, and increased wildfire risk places additional uncertainty on the future wood fibre supply. Restructuring of the forest industry, which may include new policies related to old growth timber harvest could further impact timber supply.

5.5.1 Short Term Risks

Agriculture production risks are associated with both the price and supply of wood fibre. Supply risk is the more critical of the two in the short-term. Those sectors that rely on a critical supply of SDS have so far paid competitive market prices to maintain supply. However, it was made clear when BC lumber mills shut down in 2020, that the supply balance is fragile and any additional delay in mill start up could have precipitated an animal care and food supply chain emergency. In other parts of the province, where overall agriculture demand is lower and industrial demand is high, some agriculture producers have been shutout of supply arrangements completely.

Despite the apparent abundance of wood fibre supply in the early summer of 2021, there is a risk of an acute shortage in the near term, as the outputs from the BC Fibre model suggest. The significance of the threat is that SDS deliveries could stop suddenly without warning and there will be no time for producers to prepare and adapt. Supply is critical for poultry operations where SDS is often placed directly into barns by the suppliers just before chicks are placed. Dairy producers typically have covered storage for a portion of their annual demand (e.g., two months). However, in both cases supply disruption could have an immediate effect on individual operations depending on the timing of the production cycle for poultry operations, and the date of the last SDS delivery for dairy producers. In this situation support or intervention by government may be required to help secure or create a critical supply of bedding to avoid a significant food system disruption or animal health crisis.

5.5.2 Longer Term Adaptation

In the medium to long term, more adaptation in the various agriculture sectors is needed to adjust to the reality of a less available wood fibre supply, particularly among those that rely on whitewood SDS. Already, some operators in the dairy sector have moved in that direction with the adoption of systems that use recycled sand or manure solids. The poultry sector needs to take steps in the same direction. Significant capital investment may be required to improve infrastructure on some operations, but continued reliance on inexpensive wood fibre should not be an assumption in future planning and expansion. Ultimately future operations will need to be more efficient, and this will inevitably mean expansion to achieve better economies of scale. There was not enough data in this survey to examine farm scale and consumption, but research has shown bedding costs per cow are lower on larger dairies.[43]

Successful adaptation is not to say shavings use will be eliminated. More efficient use by agriculture would allow operation with less volume, assuming production remains at current levels. This could occur through reduced use and applications that combine SDS with other types of bedding, such as shredded cardboard. In the case of blueberries, the combined application of weed mats and sawdust could reduce total consumption by that sector. There should be interest in seeing the existing supply chains in the Lower Mainland, Thompson-Okanagan and on Vancouver Island continue because they add value by aggregating supply and providing customers with a preferred product. Suppliers could play a role in future innovation, adaptation, and emergency response.

Applied research is needed to support this adaptation. In this respect, relying on the findings from other jurisdictions may be inappropriate because of differences in climatic conditions and the production environment in BC. This is particularly important in relation to suggested substitutes like straw and hemp for dairy operations and sand for poultry. Agriculture producer organizations and their respective research councils need to thoughtfully consider the issue of reduced SDS supply, increased costs, and the impact this will have on future production.

Economic and scientific investigation is needed to fully evaluate systems, applications, and alternatives. For example, use of shredded cardboard for bedding, needs to be explored in a more robust manner in the province. At first glance, this option sounds appealing, especially where there are cardboard recycling challenges but a complete economic analysis, including processing and supply issues is required. Just as important is the suitability question. There is an impression left by the few research articles that were reviewed for this report, that cardboard may release more ammonia than other bedding types and this could be a concern for animal health.

The evaluation of alternative bedding and bedding systems also needs to consider resource availability, energy efficiency and nutrient management on a regional basis. For example, excess nutrients from manure application in the Lower Mainland, Vancouver Island and parts of the Thompson-Okanagan is a problem, so bedding and manure handling systems that minimize the amount of additional nutrients through field application could have significant co-benefits.

6 Conclusions and Recommendations

There are several conclusions drawn from this assessment that provide some of the basis for the recommendations that follow. The system of residual wood fibre use by agriculture in BC is complex, regional and sector specific. The demand for SDS in the Lower Mainland is significant and specialized. Use by dairies, poultry, and parts of the equine sector represents a constant and critical demand, and the product requirements of each sector differ. The apparent demand by the blueberry sector is substantial, but there is some flexibility in the timing of application and in the product used. The demand profile in the Thompson-Okanagan has some similarities to the Lower Mainland, but total demand is much lower. Total demand in other interior regions is very low, but there is still critical demand from dairies and parts the beef sector.

There are broad-based structural deficits for residual wood fibre in the Interior driven by demand from industrial consumers. Climate change related impacts, including increased wildfire size and severity and insect infestation, are likely to further reduce supply. The effects of these deficits in the southern Interior will have an ongoing impact on the SDS supply in the Lower Mainland. Supplies of Douglas-fir

bark required by the greenhouse and nursery sectors will also be affected. Changes in policy related to old growth timber harvest and reductions in the provincial Crown land base could also affect the future supply for all types of fibre.

An informed response to the wood fibre issues being faced by the agriculture sector is needed. For example, increasing the amount of roadside fibre processing in the central interior through policy mechanisms, may help with structural wood fibre deficits in the forest industry, but is likely to have limited benefit for agriculture consumers of SDS. Large industrial consumers (i.e., pellet producers) will continue to use SDS before turning to roadside chipped material because it lowers manufacturing costs. The wood fibre requirements of the agriculture sector, including type, total demand, the regional distribution of demand, as well as transportation differentials, need to be at the forefront of any policy discussion related to supply.

Realistically, there is limited opportunity to address the needs of agriculture on the supply side at the provincial scale due to the current market structure for wood fibre residue, and agriculture's specialized and comparatively low total demand. Opportunity to manufacture product specifically for the agriculture sector may be possible at smaller scales in certain areas, but the profitability of this kind of operation needs to be positive or it would not be sustained.

The COVID-19 pandemic demonstrated there is a substantial risk related to the critical supply of SDS for the dairy and poultry sectors. While industry wide mill closures of this magnitude might not be expected to occur again soon, this kind of supply disruption is now a known risk in the current environment. Under a declared state of emergency government may consider measures that would create or redistribute a critical supply of SDS to prevent food system disruption or impacts to livestock. To be prepared for this type of scenario in the future, government and industry need to work together.

With wood fibre deficits predicted to continue into the near future, the agriculture sector will need to adapt to reduce dependency on wood fibre use in livestock operations. Leadership from Agriculture sector partners is needed to support adaptation in this area. Government also has role in facilitating adaptation in agriculture through its goals related to food security and creating viable agriculture businesses.

Hopefully, this report will bring more understanding to the problem and the challenges faced by the agriculture sector, and assist with planning future research, projects, and support.

Based on the information, analysis and findings that make up this assessment the following recommendations are provided:

1. The province and industry partners should consider collaborating on a response plan to deal with a sudden disruption of critical SDS supply in the Lower Mainland, Thompson-Okanagan and on Vancouver Island. Key points to establish would be:

    a. Minimum bedding product standards and sector priorities and
    b. Most efficient mechanisms for securing residual fibre supply, delivery, and distribution
    c. Roles and responsibilities
    d. Potential for incorporation or support from existing provincial/federal emergency programs.

2. This assessment report should form part of the background materials used in the development of a potential response plan, and other adaptation planning and support.

3. The agriculture sector should consider undertaking assessment on the residual fibre supply in neighboring US States of the Pacific Northwest to identify whether there is a surplus of SDS supply in that region that could potentially serve Lower Mainland agriculture. A secondary objective would be to assess adaptations in agriculture production where wood fibre use is important or has been used in the past and now substituted with new technology or products.

4. The province should consider continuing to provide information to the agriculture sectors on the status of the residual fibre supply (production and industrial demand balance), by purchasing outputs from the BC Fibre Model every 1-2 years and reporting changes. Future use of the Model should include and require a document detailing all inputs, outputs, and assumptions. Developing capacity within FLNRORD Compensation and Business Risk and Analysis Branch to carry out this function could be explored. Alternatively, FLNRORD may consider developing another version of the Model.

5. The province should consider supporting individual agriculture sectors in research, pilot demonstrations, and adaptation efforts to explore substitutes for residual wood fibre, and new applications that may reduce dependency on this resource. One example could be to test, pilot and research the use of a shavings mill and/or grinder with or without screens. This work might be initiated through a collaboration with FP Innovations and one of the agriculture sector associations.

6. Future research and adaptation projects should be regionally based and sector specific to ensure resource constraints and opportunities of each region and the requirements of each sector are appropriately considered.

7. Producer associations should advise regulatory boards and research councils and other organizations about the need for applied scientific and economic research on bedding (dairy), litter (poultry) substitutes, and various applications that would support adaptation.

8. Based on future research findings and additional expert investigation, producer groups and associations (e.g., BC Dairy Association and BC Chicken Growers Association) should work with their respective regulatory boards and through the National Farm Animal Care Council to develop recommendations for manure and litter reuse and substitute materials.

9. Government and the steering committee for this project should consider the recommendations and discuss the value of continuing the steering committee for the purpose of developing a joint strategy for wood fibre use in BC agriculture.

Appendix A –BC Lumber and Pellet Processing Facilities (Maps)

Figure 15 Map of primary BC lumber mills by capacity (MBF – million board feet).

Source: Mill capacity and locations based on mill survey conducted by the BC Ministry of Forests, Lands and Natural Resources Operations, last published 2019. https://www2.gov.bc.ca/gov/content/industry/forestry/competitive-forest-industry/forest-industry-economics/fibre-mill-information/major-timber-processing-facilities-survey. *Downloaded from Data BC May 14, 2021. Contains information licensed under the Open Government Licence – British Columbia.*

Note: For lumber mills, capacity is measured assuming mills run two 8-hour shifts, 240 days per year. Actual production can be higher or lower than capacity depending on actual mill production schedules.

Figure 16 Map of BC pellet mills by capacity in tonnes.

Source: Mill capacity and locations based on mill survey conducted by the BC Ministry of Forests, Lands and Natural Resources Operations, last published 2019. https://www2.gov.bc.ca/gov/content/industry/forestry/competitive-forest-industry/forest-industry-economics/fibre-mill-information/major-timber-processing-facilities-survey. Downloaded from Data BC May 14, 2021. Contains information licensed under the Open Government Licence – British Columbia.

Note: Output capacity is estimated based on three 8-hour shifts, 345 days per year.

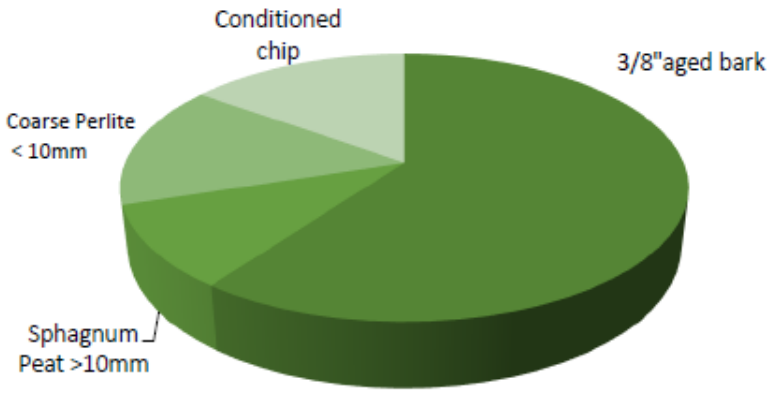
Appendix B - BC Fibre Model Regions.

Appendix C – Technical Blend Data Examples Sumas Gro Media

Sumas Gro Media Ltd. Technical Blend Data

Blend: Perennial Blend

Composition:



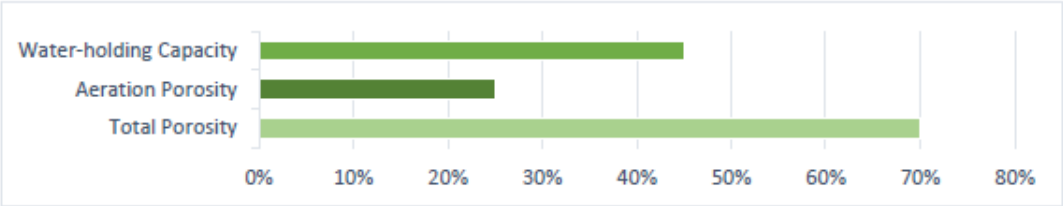
Chemical Data

Incubated pH	5.0-6.0
Electrical Conductivity(g/l)	0.5-1.0

Nutritional Value

NH4	40ppm
NO3	40ppm
Phosphorus (mg P2O5/L)	250ppm
Potassium (mg K2O/L)	80ppm
Magnesium	50ppm
Calcium	50ppm

Physical Data



Benefits

Well draining mix with high aeration for perrenial crops with a quick turns. Incorpoate controlled release fertilizer with high nitrate for short compact growth and good shelf life.

Suitable Crops

Herbaceous perennials; Lavendula, Huechera, Helleborous

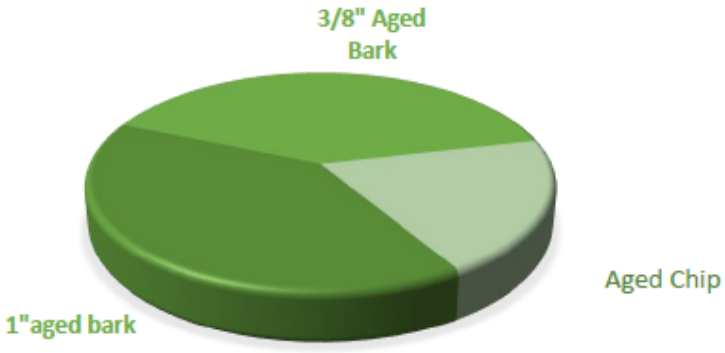
SUMAS GRO MEDIA LTD

All product information we provide is tho the best of our knowledge. All application and usage reccomendations fro Sumas Gro Media lid. Are non binding guidelines.

Sumas Gro Media Ltd. Technical Blend Data

Blend: Blueberry

Composition:



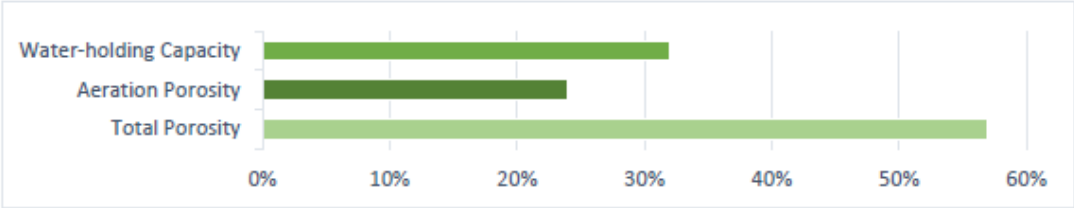
Chemical Data

Incubated pH	4.5-50
Electrical Conductivity(g/l)	1.0-1.5

Nutritional Value

NH4	-
NO3	-
Phosphorus (mg P2O5/L)	30ppm
Potassium (mg K2O/L)	50ppm
Magnesium	15ppm
Calcium	75ppm

Physical Data



Benefits

Our acid blueberry blend provides idea summer and winter conditions for your blueberry liners to bulk up. Ensure stong branching with a proper controlled release fertilizer.

Suitable Crops

Blueberries, Rhododendron, Azalea, Thuja, Taxus, Natives

SUMAS GRO MEDIA LTD.

End Notes

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