

**ANALYSIS OF BEST MANAGEMENT PRACTICES AND
EMISSION INVENTORY OF AGRICULTURAL SOURCES
IN THE LOWER FRASER VALLEY**

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EXECUTIVE SUMMARY

Air quality management programs, including those in the Lower Fraser Valley (LFV), have focused largely on motor vehicle and major industrial sources of emissions, and to a lesser extent on light industrial, commercial, institutional and residential sources. Compared to air quality management initiatives for these other sources, emissions from agricultural operations have been relatively untouched. However, within the Lower Fraser Valley airshed, emission inventory studies show that, as emissions from vehicles, fuels and industrial sources are reduced through regulations, agreements and other programs, the impact of agricultural operations along with marine vessels and non-road engines become increasingly important.

This study has been commissioned to:

- Develop an updated and comprehensive emissions inventory for the agricultural sector in the Lower Fraser Valley; and
- Review existing best management practices (BMPs) for agricultural sources of emissions and identify the preferred BMPs for application in the Lower Fraser Valley

The two pollutants of primary concern in the LFV airshed are ozone and fine particulate matter (PM_{2.5}), both of which contribute to smog formation. Ground-level ozone is a secondary pollutant formed in the atmosphere, through reactions involving “precursor” pollutants, including primarily nitrogen oxides (NO_x) and volatile organic compounds (VOC), and to a much lesser degree, carbon monoxide (CO). PM_{2.5} arises both from primary emissions and secondary formation. Primary particulate matter is emitted directly to the atmosphere from various sources, such as industrial stacks, motor vehicle exhaust and burning. Fine particulate can also be formed secondarily, by reaction of NO_x, SO_x, VOCs, ammonia (NH₃) and other gases in the atmosphere.

Light duty motor vehicles currently remain major sources of smog precursor emissions, but their contribution has declined due to the combined effect of tighter emission standards and the beneficial effects of the AirCare vehicle inspection and maintenance program. New Tier 2 emission standards for light duty vehicles that came into effect in 2004 model year vehicles will further reduce emissions from light duty vehicles in the future, off-set somewhat by the growth in number of vehicles and distances driven annually. Emission forecasts prepared by the Greater Vancouver Regional District (GVRD) show that emissions from marine vessels, agricultural sources and non-road engines become increasingly important in the years beyond 2015. The non-road engines category includes emissions from agricultural equipment.

The updated emission inventory prepared for this study (summarized in Table S-1) confirms the significance of the agricultural sector in terms of regional emissions of ammonia, particulate matter and greenhouse gases. Using the 2000 Lower Fraser Valley emission inventory and forecasts (GVRD, 2002 and 2003a, 2003b) as the basis, the main revisions made include:

- Updating of the base quantities used for animal emissions, with more recent information from the 2001 Census of Agriculture.
- Application of revised methodologies for calculating ammonia emissions from management of manure.

- Incorporation of new estimates for agricultural non-road engines and equipment using the new version of the U.S. EPA NONROAD model released in 2004.

In order to improve future agricultural emission inventories, a number of recommended refinements, or developments which should be monitored were noted:

- Emissions from fuel combustion in boilers used to heat greenhouses are not presently included in agricultural emission inventory totals, nor are they quantified. It is estimated that greenhouse boilers account for about 11% of the heat input capacity of all boilers in the Lower Mainland (Levelton, 2004), and that emissions could be of the same order of magnitude. However, more detailed assessment of emissions from greenhouse boilers may be warranted, particularly in light of fuel switching issues, such as the conversion from natural gas to distillate oil or solid fuels such as wood waste, which have different emission impacts.
- The GVRD could be approached to consider separating out agricultural sources in future emission inventory compilations. While there is an agricultural sources category, the burning, space heating, non-road engine, miscellaneous area source and solvent evaporation categories also include certain agricultural source emissions.
- Emissions of greenhouse gases and ammonia from agricultural operations are increasingly being studied by government agencies and agricultural research organizations, and these studies should be monitored.

A second objective of this project was to review existing best management practices in the Lower Fraser Valley and other jurisdictions, and develop a list of preferred BMPs for application in this airshed. Research conducted for this study showed that many jurisdictions use BMP compilations and programs for the agricultural sector. Although many of these BMPs focus on water quality and soil, most also have associated air quality benefits.

Initially, the intent of this study was to develop a list of preferred BMPs based on an assessment of costs and benefits associated with the measures. However, it was found that reliable data on the costs of implementing agricultural BMPs is lacking. The lack of economic data is due to the fact that agricultural BMPs have not typically been required as part of regulatory programs, and information on costs and benefits has not been needed to justify their implementation. In addition, many of the BMPs have low cost implications, or even represent a cost savings to the agricultural sector.

As a result, a more qualitative approach was used to select a list of the most promising BMPs for application in the Lower Fraser Valley. The parameters used in this assessment included: a qualitative ranking of BMPs as being of high, medium, low or negative cost; a review of barriers to implementation; discussion with industry and government representatives; and consistency with direction being provided to agriculture sources under federal and provincial environmental programs.

From the long list of BMPs reviewed, a short list of preferred BMPs was prepared, consisting of:

- Reduced tillage and cover cropping;
- Relay cropping;
- Management of riparian areas and field margins;
- Changing feed rations for both dairy and poultry operations;
- Improved application of manure to grass land and corn land;
- Improved manure storage systems and practices;

- Nutrient management programs and plans;
- Improved fuel storage; and
- Dust control.

A regulatory approach is not recommended for the adoption of agricultural BMPs in the Lower Fraser Valley. Command and control approaches have not historically been used for the agricultural sector, and there is even some question as to the regulatory authority of the BC MWLAP and GVRD to regulate air emissions from agricultural sources. The FVRD does not have delegated regulatory powers with respect to air pollution control.

For many of the BMPs listed above, cost is not the most significant barrier to implementation, but rather attitude and a need to overcome resistance to changing historical practices. The list of preferred BMPs has low or negative cost implications, yet provide significant opportunity for emission reductions. This combination should allow the use of voluntary, education-based approaches.

Some of the elements which should be considered in implementing the BMPs are:

- Development of communication materials which explain the low costs and emission reduction benefits of implementing BMPs, and emphasize the potential cost savings through adoption of better management practices. Another benefit is improved public perception of agricultural operations.
- Guidance documents and training materials should be developed because of the variability in the agriculture sector. These could build on BC Ministry of Agriculture, Food and Fisheries Environmental Guidelines and Environmental Farm Plan reference guides. In addition, many jurisdictions as well as academic organizations have technical assistance materials developed for agricultural BMPs, which provide a useful resource for the development of similar materials in the Lower Fraser Valley.
- Utilize the interest in environmental stewardship and sustainable agriculture from the agricultural community. By engaging the agricultural sector in the development of BMP programs and building partnerships. Agricultural advisory committees are used in many U.S. jurisdictions, and are already in place in GVRD and FVRD.
- Capitalize on the extensive body of research currently underway and anticipated for this sector, both by agricultural organizations and government agencies.
- Although regulatory programs are not recommended, there are lessons to be learned from some which have been established recently. In jurisdictions such as California and Arizona, where agricultural sources have been identified as priority sources with respect to attainment of PM₁₀ standards, new regulatory programs are being implemented. These programs should be monitored as they will become sources of information on control technologies and associated economics.

Table S-1: Updated LFV Agricultural Emission Inventory for 2000

	emissions (tonnes/year)											
	CO	NO _x	particulate matter			SO _x	VOC	NH ₃	greenhouse gases			
			PM	PM ₁₀	PM _{2.5}				CO ₂	CH ₄	N ₂ O	CO ₂ E
Livestock Animals												
Cattle	0.0	0.0	119.8	76.7	12.0	0.0	2,256.0	0.0	0.0	9,024.0	0.0	189,503.6
Pigs	0.0	0.0	215.9	138.2	21.6	0.0	33.5	0.0	0.0	133.8	0.0	2,810.1
Sheep	0.0	0.0	23.2	14.9	2.3	0.0	21.9	0.0	0.0	87.8	0.0	1,843.6
Poultry	0.0	0.0	6.3	4.0	0.6	0.0	24.9	0.0	0.0	106.9	0.0	2,245.2
Horses	0.0	0.0	153.5	98.2	15.3	0.0	42.1	0.0	0.0	168.6	0.0	3,540.1
Miscellaneous Animals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	92.2	0.0	1,936.9
Subtotal	0.0	0.0	518.7	331.9	51.9	0.0	2,378.4	0.0	0.0	9,613.3	0.0	201,879.5
Manure Management												
Livestock wastes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10,008.6	0.0	5,893.8	127.2	163,196.3
Subtotal	0	0	0	0	0	0	0	10,009	0	5,894	127	163,196
Burning												
Agricultural	1,803.4	62.2	342.0	342.0	342.0	0.0	279.8	0.0	0.0	84.0	0.0	1,763.0
Subtotal	1,803	62	342	342	342	0	280	0	0	84	0	1,763
Chemical & Nutrient Applications												
Synthetic Fertilizers	0.0	0.0	53.6	26.3	7.5	0.0	0.0	891.2	0.0	0.0	115.5	35,790.7
Organic Fertilizers ^a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	146.3	45,361.9
Pesticides	0.0	0.0	106.9	52.5	14.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Limestone/Dolomite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,394.2	0.0	0.0	4,394.2
Subtotal	0	0	160	79	22	0	0	891	4,394	0	262	85,547
Fugitive Dust												
Wind Erosion	0.0	0.0	910.7	455.4	100.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tilling	0.0	0.0	1,220.2	256.3	51.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0	0	2,131	712	152	0	0	0	0	0	0	0
Non-road Engines												
Agricultural Equipment	1,922.3	1,737.1	246.8	246.8	239.4	47.5	306.1	1.1	135,043.7	14.0	54.5	152,219.8
Subtotal	1,922	1,737	247	247	239	47	306	1	135,044	14	54	152,220
LFV Total	3,726	1,799	3,399	1,711	808	47	2,964	10,901	139,438	15,605	443	604,605

^a emissions of NH₃ of organic fertilizers are quantified under manure management

