BIOFILTRO
worm powered wastewater solutions

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Re: Biofiltro's comments on the draft **Analysis of Progress toward Achieving the 2030 Dairy and Livestock Sector Methane Emissions Target**

Biofiltro (www.biofiltro.com) appreciates the opportunity to comment on the California Air Resources Board draft *Analysis of Progress toward Achieving the 2030 Dairy and Livestock Sector Methane Emissions Target.* Biofiltro is a greenhouse gas reduction, water filtration, and nutrient capture vermifiltration system that provides the environmental benefits sought by the dairy industry, CARB and California. Biofiltro U.S. and its complimentary company based in Chile has dozens of installations that achieve the goals set forth in the Alternative Manure Management Program. With adequate incentives, correctly outlined in CARB's draft report, Biofiltro is poised to be an AMMP technology that reduces greenhouse gas emissions (CH_4 and N_2O), captures otherwise fugitive nitrogen, ammonia and phosphorus, eliminates manure and flush water odors and produces clean, reusable water and a highly biologically active product well suited as a fertilizer replacement and soil health amendment.

The CARB report does a good job of describing the current state of affairs and the need for greater incentive funding to achieve the state's livestock emissions reduction goals. We suggest, however, that the conclusions made regarding the AMMP practices should not be described as conclusions or reported as complete, but true only for the practices and technologies included in the incentive programs until now. For CARB's forward-looking strategies, we propose that the analysis of the progress toward achieving the 2030 target include other AMMP practices and technologies, particularly Biofiltro's vermifiltration, a technology/practice that would greatly improve and expedite progress toward achieving the 2030 target.

Vermifilters are filtering systems that contain vermicomposting worms (Baugmanter, 2013; Lourenço and Nunes, 2017) which are highly effective at filtering liquid waste streams. The technique uses earthworms and microorganisms to degrade the wastewater organic load, treating wastewater and manure onsite, producing only reusable water and fertilizer. The system simultaneously cleans water, separates solids, treats separated solids, and removes and recovers manure nutrients. Vermifiltration can be utilized on farms with confined livestock of any size and results in a wider range of environmental benefits relative to anaerobic lagoons and anaerobic digesters.

The environmental benefits of vermifiltration include:

1) reduction of greenhouse gas (GHG) emissions of CH_4 and N_2O,
2) reduction of groundwater and air pollution from nitrogen and ammonia,
3) production of organic fertilizer for enhanced soil health and soil carbon sequestration,

4) recycled use of treated water, including irrigation and flushing, and therefore reducing the reliance on freshly pumped, high-quality water,
5) elimination of odors from fugitive ammonia, and
6) simple technology utilizing minimal energy inputs.

Vermifiltration as an alternative manure management practice (AMMP) acts as a solid separator with an efficiency of 87-90%, far higher than the 15-50% for other separators recommended in the AMMP. Furthermore, compared to standard separators, the vermifilter has the additional ability to avoid clogging (Krishnasamy and Java, 2013) and odors (Baugmanter, 2013), treat separated solids on-site and without producing sludge or anaerobic conditions (Singh et al. 2019; Manyuchi et al. 2013) and it requires low energy inputs (Sinha et al. 2010). Scientific literature demonstrates the ability of the technique to avoid CH_4, N_2O, and NH_3 emissions during treatment (Lai et al., Dore et al., Luth 2011) and reduces the risk of GHG emissions after treatment by removing volatile solids and nitrogen (in particular NH_3) from the wastewater stream. In a pilot study in CA, the technique reduced 84% of N, 84% of phosphorous, and approximately 50% of salts (Lai et al., 2018, Dore et al., 2021).

Commercial scale vermifilters are available and operational in the USA. Currently operational vermifiltration systems in the dairy industry treat 100 to 7,000 cows daily, up to 750,000 gallons of water per day, and work continuously throughout the year. Biofiltro, the company commercializing the dairy vermifilters, has multiple full scale operating systems on dairies, wineries, milk processors, slaughterhouses, sanitary sewage and sludge and other operations with similar waste streams. Within the California dairy community, Biofiltro has installed and is operating a pilot system at the Fanelli Dairy in Merced County, CA. A full scale vermifilter system has been operational at the Royal Dairy in Royal City, WA (https://www.royaldairy.com/; https://www.usatoday.com/story/sponsor-story/innovation-center-for-us-dairy/2019/04/22/earth-day-dairy-farmer-thinking-decades-down-line/3521007002/). That system treats approximately 6,000 milking cows and a total of 15,000 animals. The vermifilter replaced an anaerobic lagoon in spring 2020.

- ***AMMP projects are not eligible to generate revenue from environmental credits*** (page 14)

A methodology to generate revenue from the voluntary carbon market for separators already exists. It is the CDM small-scale methodology Methane avoidance through separation of solids from wastewater or manure treatment systems AMS-III.Y.

A project based on the vermifilter at the Royal dairy in Washington was registered with the independent carbon verifier Verra (www.verra.org) using the CDM methodology for separators. In its first verification the project generated credits corresponding annually to 42,000 MTCO2e. The credits were certified and recently became available on the carbon market.

This proves AMMP technologies can obtain income streams from the voluntary carbon market and that CARB can incentivize this revenue by adopting methodologies for AMMP practices in the compliance market.

In addition to the carbon market, the Royal dairy vermifilter produces a unique and valuable offtake (vermicompost) made up of worms, worm castings and other organic matter rich in nutrients. The nutrient rich soil amendment/fertilizer is extracted from the vermifilter at 18 month intervals. The system

produces approximately 22,500 cubic yards of vermicompost every 18 months. Biofiltro has secured a vermicompost buyer for all of its production for the states of Washington, Idaho and Oregon. Biofiltro has been offered similar offtake arrangements for California.

Adopting the methodology in the compliance market would mean that the annual income from the carbon market and the vermicompost could cover the entire cost of a vermifilter system. Facilitating and incentivizing vermifiltration on dairies can not only avoid dairy CH_4 emissions but have a significant positive impact on decreasing California's use of inorganic fertilizers, increase soil health and carbon sequestration, and increasing the state's crop productivity.

- **the Digesters costs range from approximately $3 million to $17 million** (page 14)

The comparative affordability of a vermifiltration system and the multiple benefits it provides suggests that additional state incentives should be made available for such systems. Biofiltro's installations suggest that securing reliable greenhouse gas credits plus the value of the purchased new product of vermicompost covers the entire operating expenditures and, depending on the value of the carbon credits, a large portion of the capital expenditure. Biofiltro's economic analysis shows that a vermifiltration system's Total Cost Investment would be approximately $20 per MTCO2e. This is significantly less than the total investment costs reported for both DDRDP and AMMP.

Table 3. Estimated Cost Effectiveness of California Dairy and Livestock Methane Emissions Reductions through 2022

Program	State Investment ($/MTCO$_2$e)	Private Investment ($/MTCO$_2$e)	Total Investment ($/MTCO$_2$e)
DDRDP	$9	$20	$29
AMMP	$61	$9	$70

Additionally, vermifilters can be built for dairies of any size and design. They can also be used in conjunction with anaerobic digesters. Anaerobic digesters are not a nutrient pollution control practice (Campos et al., 2019), and they are not suitable for all farms (Lee & Sumner, 2018). Vermifilters can reduce the surplus nutrients in the digestates, the NH_3 emissions caused by anaerobic digesters (Nkoa, 2014), and increase their efficiency in removing volatile solids from wastewater.

- ***Alternative manure management practices have great methane emissions reduction potential but many operational factors can affect their efficiencies, resulting in difficulties to quantify methane emissions reductions benefits*** (page 37)

The vermifiltration system has been proven to show continuous and constant reduction of volatile solids and monthly emissions of CH_4 that averages > 80% reduction. A *methane conversion factor* has been quantified for the practice in California. (Dore et 2021). Therefore, there are no difficulties in quantifying the emission reduction of the practice, and the certification of the emission reductions produced in a real world setting such as at the Royal Dairy in Washington State.

- In reference **to table 7 of the draft Report**,

Table 7. Technical and Market Barriers to Implementing Manure Management and Enteric Fermentation Methane Emissions Reductions Projects

	Technical Barriers	Market Barriers
Manure Management	Alternative manure management projects ✗ Inconsistent reductions ✗ Difficulty quantifying reductions Anaerobic Digesters ✓ Grid and pipeline interconnection ✓ Biomethane quality standards	✓ Project development costs and financing ✓ Environmental credit certainty ✗ Sector economics ✗ Insufficient public funds ✗ Undeveloped markets for value-added manure products
Enteric Fermentation	✗ Transient effect/rumen adaptation ✗ Potential animal health impacts Limited availability ✗ 3-5 years before commercial availability ✗ Seasonal products	? Consumer acceptance ? Cost-effectiveness

✓ = Progress made ✗ = Persistent barrier ? = Currently Unknown

if vermifiltration is included, for the AMMP projects "Inconsistent reduction", "Difficulty quantifying reduction" from Technical Barriers and "Undeveloped market values for added manure products" would improve from *persistent barriers* to *progress made*.

- **Next Steps**

Moving forward… Implemented strategies must not only reduce methane emissions from the sector sufficient to achieve the 2030 target, but should also be consistent (to the extent feasible) with other State objectives. These objectives include reduced impacts to air and water quality, improved soil health, reduced impacts to environmental justice communities, and maximized GHG emissions reductions while minimizing emissions leakage (Pag 44).

Vermifiltration is consistent and feasible to <u>all</u> objectives listed above.

- ***CARB will continue to research additional technology options and management practices that can achieve methane emissions reductions, as well as research the effectiveness of practices used today*** (page 45)

Biofiltro has already communicated and proposed to CARB (and CDFA) its vermifiltration system for tests, demonstration projects and monitoring (unfortunately without success). The company proposed to AMMP to add the technique as an allowable practice, received a pre-approval and is waiting for the final response. A pilot project is operational in Merced County and is available to any scientific study, monitoring, and demonstration project CARB would like to address.

In summary, we believe:

1) Biofiltro's vermifiltration system should be considered as a major tool to reduce CA methane emissions,
2) practices and technologies that produce the kind of greenhouse gas reducing and nutrient capture benefits of vermifiltration should be financially incented to bring such systems to California dairies,
3) practices and technologies that generate these environmental benefits AND produce a valuable new product should be financially incented to develop the markets supporting those new products more fully,
4) alternative manure management practices that generate measurable, quantifiable, and certifiable greenhouse gas reductions should be eligible for credits that rival the value of DDRP greenhouse gas reductions, and
5) practices and technologies that are economically suited to support smaller dairies should also be economically incented to bring such environmental benefits to the entire dairy community.

Biofiltro appreciates the opportunity to comment on the draft Report and looks forward to seeing increased opportunity to bring this simple, but effective practice/technology to California.

Respectfully,

MatiasSjögren, CEO

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