VT Phosphorus Innovation Challenge – Agrilab Technologies Inc.

September 2019 - Final Report and Business Plan

Part 1: Project Overview

Introduction-

Agrilab Technologies Inc. (AGT) of Enosburg Falls, Vermont was the lead entity with Brian Jerose, President acting as the Principal Investigator. VP Engineering Jason McCune-Sanders also made significant contributions to the project. Other AGT staff that played some roles in the project included Ryan Koloski, Todd White and Jaime Tibbits. The company office address, website and phone is: 1662 Pumpkin Village Road, Enosburg Falls, VT 05450; www.agrilabtech.com and (802) 933-8336. The primary contact and email for this report and Stage III is Brian Jerose and brian@agrilabtech.com

Key project partners were from VT Natural Ag Products, the composting enterprise of Foster Brother Farms in Middlebury, VT. President Robert Foster, VP of Finance and Administration Heather Foster-Provencher, and lead site operator Wes Kimball were involved in field prototyping, market assessment and economic assessment aspects of the Stage II tasks. Mark Foster also utilized some dehydrated solids as bedding in their dairy barn. Their primary contact is Robert Foster with email rfmoodoovt@sover.net

Other organizations that had some roles in the project as advisors, material providers, and others providing market feedback include UVM Extension (Heather Darby and Jeff Sanders), Digested Organics (Bobby Levine, Matthew Biette and Sam Bagchi), and farmers Scott Magnan, Guy and Matt Choiniere, Eric Paris, Tom Gilbert, Mark and Marty Magnan, Jennifer Daniels, Rick Fox, Christine Motyka, George VanVlanderen, and Terry Magnan. Friends of Northern Lake Champlain, a watershed protection non-profit, provided venues for presentations and tables of information at both their winter and summer 2019 Farmer Meetings held in St.Albans and Franklin.

This group has only evolved in the extent of involvement from the project as proposed to the project as implemented. Certain individuals have provided greater or smaller roles, but more or less the involved organizations are largely the same and as expected. This collection has been able to provide much of labor and resources necessary to carry out field prototyping and the information related to market and economic assessment.

The involvement of UVM Extension would have ideally been greater, if timing of producing phosphorus (P) containing products, primarily composts, had been completed prior to planting season for corn, hemp, sunflowers and other specialty crops. We would have been able to conduct meaningful field trials in 2019 and provide farmers and other potential buyers greater confidence in the anticipated performance of these products when providing fertility and improving soil organic matter.

This compilation of entities is appropriate to address a portion of the water quality needs including redistributing P to more appropriate locations both within VT watersheds and as exported as products from VT. The group included practical equipment and material handling expertise for efficient creation of new compost blends and dehydrated products. The inclusion of Digested Organics derived P concentrate was valuable as a means to move greater volumes of P with less total volume. The working knowledge and experience of the farmers and UVM Extension provided important feedback on what specific products are needed and useful to VT growers, as well as market assessment of the size and potential value of renewable P products.

The Stage Three proposal is not directly combined but is intended to partner with other VPIC entities. Specifically we seek to support Digested Organics locate and operate an ultrafiltration unit in Franklin County to produce P concentrate, and utilize that concentrate in the production of P-fortified compost as well as develop other solid and liquid fertility products. Further, we seek to conduct field growth trials with new blended fertility products, including biochar from Green State Biochar mixed with compost.

Addressing the concerns about P-

This participant sees numerous issues regarding P management in VT as it impacts water quality. The AGT team has put its effort for VPIC towards improved management of P from manure, primarily from dairy farms, and with an emphasis on providing better distribution options from areas of serious water quality concerns in Franklin and Addison counties.

To summarize the key issues observed, on a watershed scale (using Missisquoi and St.Albans Bay watersheds as examples), there is more P imported in livestock feed, and to a lesser extent in commercial fertilizer, than there is P exported in milk, meat and other farm biomass, thus an accumulation of P in area soils and water bodies has occurred and continues to occur.

Individual farm examples of issues with P vary widely, including among conventional dairies, where the greatest number of cows are found. Some dairies are limited on available land and existing soil P levels relative to their herd size, whereas other dairies have more land than is necessary to meet P-Risk Index levels within a nutrient management plan (NMP).

Even within dairy farms that on paper, via their NMP, have sufficient acreage and equipment to spread manure at an acceptable agronomic basis, weather and other factors can still lead to P runoff and pollution. For example, the VT Agency of Agriculture, Food and Markets (VT AAFM) granted approximately 30 waivers to December 1 spreading ban in 2019. A wet October, followed by early snow cover in much of northern Vermont prevented many farms from lowering their manure lagoon levels and applying manure to corn and hay fields. While a Franklin County farm was cited for direct discharge from field runoff during this period, even those farms that remained fully compliant were at much greater risk of P runoff during subsequent rain and snowmelt events. Thus the need for more storage, distribution and appropriate placement of manure P would have an immediate benefit.

The secondary impact is the failure to utilize the N associated with the manure (slurry or composted) during the crop growing season. There is ample evidence that N runoff also impairs water quality locally and may accelerate algal blooms at certain stages, even though P is recognized as the limiting nutrient in Lake Champlain and most VT water bodies. This is an economic loss to the farmers and is then typically purchased and utilized the following spring or after cuts of hay.

This concern over water quality impacts are currently being addressed by a range of field and farmstead best management practices (BMPs) including but not limited to soil testing and nutrient management planning, ditch and stream buffers, cover crops, manure injection, silage bunker leachate treatment, and barnyard runoff controls. While these practices are effective and may be achieving compliance with current regulations, they are still insufficient to meet the P reduction goals contained in the EPA and VT Total Maximum Daily Load (TMDL) for Lake Champlain and its tributaries.

The AGT team seeks to address gaps in P management related to 1) creating value-added products more suitable for sale in bulk or bagged form, to export P from individual farms, and 2) creating lighter weight and stable P products suitable for longer term storage and better distribution within farm operations and available crop fields. As proposed the team would build out P processing infrastructure in Franklin, Addison, Lamoille, and Caledonia counties. At the first phase items such as physical working pads, electric and data service, storage and related infrastructure work would be cost-share funded via VPIC Stage III on multiple farms. This will facilitate the proper receiving and blending, aerated composting, drying, other processing and storage steps of the supply chain are located on complimentary sites around the region.

Overall Technological Description-

Agrilab Technologies Inc. will provide existing and planned mobile equipment to actively aerate, stabilize and compost a mix of P containing biomass. This includes but is not limited to separated dairy manure solids (SDMS), dewatered digestate, P concentrate (ultrafiltrate), P centrifuge cake, bedded pack manure, wood chips, silage bunk spoilage and other crop residue. The existing equipment is the Compost Heat Wagon, a 20' cargo trailer with on-board positive aeration capacity with a specialized water to air heat exchanger, aeration fans, valved aeration ductwork, and remotely accessible sensors and controls to manage processing. The specialized heat exchanger is designed for utilizing renewable thermal energy from active composting, and can be connected to standard AGT products including the Drum Dragon 200, Hot Skid 250-R, Hot Box 250-R or Hot Box – 8A -250R. The Compost Heat Wagon can also be tied into hydronic systems from solar or geothermal, or to standard propane and heating oil fired boilers. Note the Compost Aeration and Heat Recovery (CAHR) Schematic provides a visual representation of the process flow.

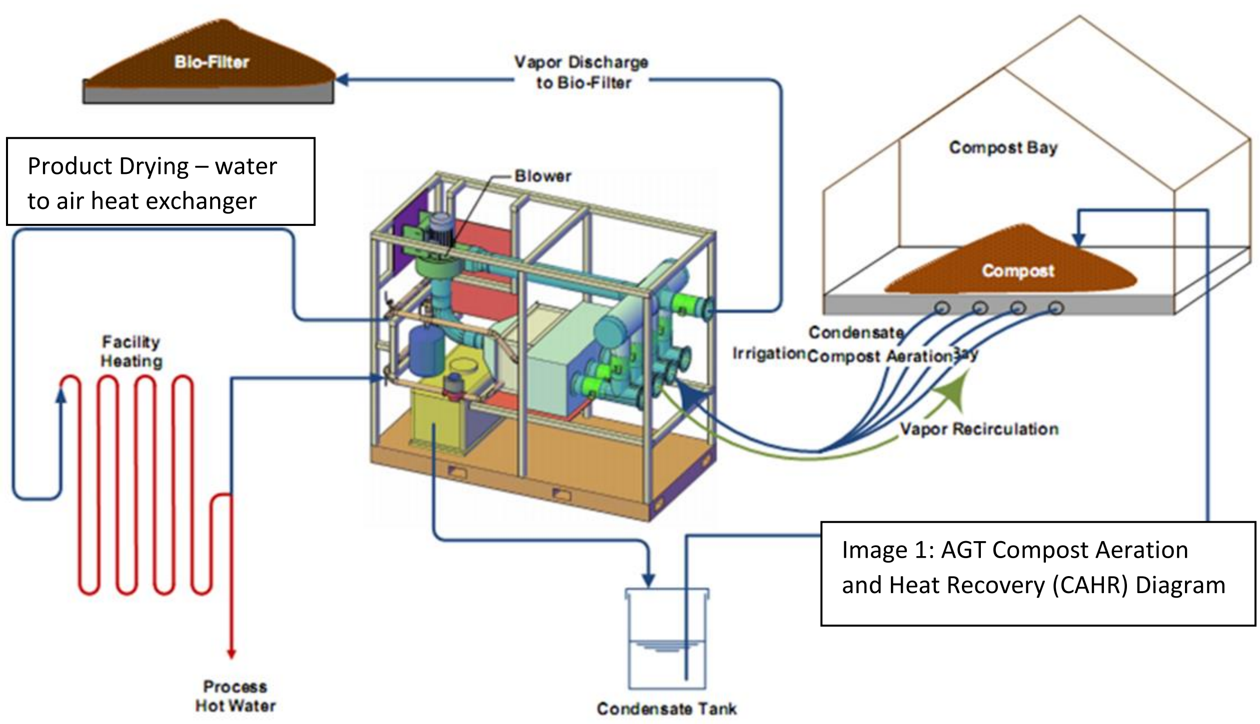

Image 1: AGT Compost Aeration and Heat Recovery (CAHR) Diagram

The CAHR system functions to accelerate and provide more control over the composting process. Oxygen availability is a key limiting factor in the rate of manure and biomass decomposition, so aeration systems are a composting practice to pull and/or push air (negative and positive aeration) through blended feedstocks. Aeration also acts to remove heat from compost batches during thermophilic-stage (120F+) decomposition as not to overheat the biomass and kill-off preferred beneficial microorganisms. This destruction of beneficials typically occurs when temperatures are over 150F and increases up to 180F, when the type of decomposition changes and is no longer considered regular composting. Therefore two concurrent composting management goals are to maintain oxygen and temperature in optimal or near-optimal ranges.

CAHR systems differ from aeration only composting systems in that renewable thermal energy is actively captured via a specialized heat exchanger in to a hydronic system (typically water and glycol loops). This is comparable in some aspects to solar thermal or geothermal systems. In CAHR systems the negative aeration mode brings in hot vapor (typically 110F to 160F) from active compost piles into the ductwork and specialized heat exchanger. The thermal energy is utilized in different ways depending on the site needs and demands of the current compost batches. Heated water and glycol loops are run to buildings, greenhouses or are used to preheat water for washing or other on-site processes. What was conducted in VPIC Stage II and proposed in Stage III is to heat drying air for later –stage stabilization of some P-containing products. Hot vapor can also be recirculated to active compost batches to bring fresh cold mixtures up to desired temperatures during winter or after over-cooling.

The integrated system acts to heat “make-up air” to accelerate batch drying of P-containing materials – primarily compost blends fortified with P, but also SMDS, P centrifuge cake and soil blends with P. Materials after batch drying can be used immediately with reduced weights for trucking, improving transport economics. If there isn’t a match with timing for land application and soil amendment, batch-dried materials are more readily stable for medium and long-term storage.

Image 2: Materials are transferred to the drying zone after two weeks of composting. Note the AGT trailer outside the Coverall barn providing the heated drying aeration during field prototyping.

Image 3: Steam rising from batches of composted manure solids, wood chips and P concentrate indicates moisture being driven off by heated aeration during prototyping at VT Natural Ag Products.

Image 4: Heated aeration drying system technology using CAHR can be wall-mounted as shown here from the Catlin Farmstead in Winchendon, MA

Results VPIC Stage Two

Several lessons have been learned from the prototyping and building process conducted in VPIC Stage Two. First and most importantly, P containing materials were able to be mixed into compost blends or processed exclusively into products that have widespread application both in VT and to markets outside the state. Products were created with technologies and practices that did not require daily on-site management, and used renewable thermal energy that was generated on-site, captured from existing processes – namely aerated composting.

Several different feedstocks and formulations of P concentrate or DAF sludge were handled during field prototyping. For new materials, initial blending was done on a 5-gallon bucket scale, prior to blending with the pay loader. Feedstock sample analyses and typical material values for carbon, nitrogen, moisture content and bulk density were used in a compost formulation spreadsheet to narrow the range of feedstock proportions that needed to be mixed by trial and error. The worksheet formulations and 5-gallon bucket blends prepared in advance, limited the time needed by VNAP staff to develop appropriate mixtures.

Image 5: P Concentrate from Digested Organics is blended with solid feedstocks during prototyping

Image 6: Batches mixed at full scale were sampled for lab analysis at the start, mid-point and end of the aerated composting process.

Prototyping, economic analysis, market research and assessment of others experience developing both sites and new products were all part of Stage Two findings. On a system-wide perspective, all pieces of an alternative P management supply chain must be in place for new products and improved P distribution to occur. While obvious on some levels, in practice it means the value-added processing, product testing, marketing, sales and distribution steps are dependent on P capture, separation and concentration equipment being in place and in regular operation. Prototyping work was not able to be started earlier in part due to P cake from a centrifuge not been available when it had been expected. Operation and maintenance challenges were not overcome to restart regular operation of the centrifuge from March through July. Similarly, an ultrafiltration unit used to produce P concentrate was initially in the timeline to be in Vermont for operation and demonstration in March, but was not operational and capable of generating batches suitable for blending into compost mixtures until late May.

While the AGT team attempted to focus on the value-added processing and subsequent product marketing and sales, it reinforces the need to have more control around the earlier steps of the supply chain. This is important beyond the prototyping process, as having reliable feedstocks are critical to the ultimate production and delivery of fertility products to farms and other end-users. Either being the owner/operator of P concentration equipment or possessing a long-term agreement with a farm generating P products is key to guaranteeing availability of the product to those end-users being marketed to.

The prototyping and building process was able to highlight the differences in labor and process management for different P materials and amendments used in blending. Specifically, materials with higher bulk densities such as DAF solids, required both larger volumes of fiber for blending (forestry and agricultural sources), and more extensive batch blending and turning time and cost. The take away lesson is feedstocks need to be carefully evaluated as although they may contain significant fractions of P and be capable of conversion into fertility products and soil blends, their handling requirements and costs may make achievement of an acceptable margin of revenues over costs unattainable, at least with the technologies and practices deployed in Stage II.

What are still unknown factors from the prototyping and business case development?

There are unknown factors from both the prototyping and business case development tasks of the Stage Two project. The prototyping focused on evaluating the process options, cost and efficiency (labor and energy) and development of value-added products that were of interest to bulk users (growers within VT) and to consumers of bagged products both in and out of state. Given the project timeline and budget, it was anticipated that only some products would be produced and tested in Stage Two, so additional compost blend formulations and dried feedstocks (ex. dehydrated P centrifuge cake) should still be prototyped to develop a wider range of products that could be made available for sale.

Field trials for application of the prototyped products was not possible with the products being generated after the primary planting season of targeted crops for bulk application – corn, hay, and specialty crops such as sunflowers, hemp and vegetables. Beyond the value in quality control, the field trials are an important aspect of market development and making a business case. Providing end-users confidence that new fertility products have comparable or better effects (yield and quality) than current inputs, is key to market acceptance, and garnering higher prices for product sales.

In addition to the business case development being possible for only a partial product line, the market assessment was not as robust as originally intended, particularly for the potential of bagged product. While distribution of samples is still on-going, and products were able to be lab tested for nutrient content, the material was still more immature than desired, as additional curing of compost products after the active decomposition phase would be standard practice on a commercial composting site. As a result, more field trials should be conducted to validate performance of any new formulations before extensive marketing and making specific performance claims.

What knowledge was gained through the development and building process?

Better understanding of the timing and use of P fertility was gained during the business case development process, particularly for specialty crops. One of the promising off-takes (or end use markets) is for hemp growers. This is a new and rapidly growing crop in Vermont, following the changes in the US Farm Bill legalizing hemp cultivation nationally.

To what extent did the Stage Two process confirm any assumptions from Stage One?

The biggest confirmation of assumptions from Stage One is that current P separation technologies and their resulting concentrate products are technically effective at P removal from manure, but do not have widespread and valuable markets for the P concentrate "as-is". Rather further value-added processing consisting of blending, composting and/or drying steps are important to create products that have greater market demand and value.

What are the significant changes that will be made to this proposal based on the results of Stage Two?

Further work is needed to develop cost-effective and efficient drying technologies and practices, especially those that can powered by local renewable energy. Process efficiency is connected to cost-effectiveness through energy and labor expenses. While some materials were successfully dried using the batch process accelerated by heated drying air (in this case using renewable thermal energy from the compost aeration process), other materials required such extensive mixing with amendments in order to achieve sufficient porosity for aeration, that additional feedstock volumes and material handling made that approach unattractive. Other drying methods that employ additional material agitation may be needed. However most commercially available dehydrators and pelletizers are a major capital expense and have high energy costs, are typically powered by fossil fuels and may have high labor operating costs if not significantly automated. This proposal will as a result include less drying equipment than earlier conceptual approaches, but rather employ a mixture of traditional and greenhouse enhanced lower-cost drying approaches, while continuing to research higher capacity drying options for subsequent development and growth phases after Stage Three.

The scale of next stage processing of P materials will be smaller than previously intended in order to give more time for further product line development, field trials and deployment of concentration equipment at dairy farm sources. There are significant gaps in the development of the supply chain in counties outside Addison, which could also be enhanced. Building out elements of the material handling network allows for a measured growth plan and co-development of other compatible enterprises.

Specifically, P containing materials can be categorized as have relative levels of P concentrations, low, medium and high for simplicity. Low P would be much of the fibrous biomass – bedding, separated dairy manure solids, leaves, wood chips and other agricultural and forestry residues. Medium P would be standard manures, though covering the range from solid bedded manures, slurried manures, most food processing residuals, source-separated food scraps, as well as digestate (liquid or dewatered) that may contain multiple feedstocks and/or manure. High P materials would be limited to P centrifuge cake, Dissolved Air Flotation (DAF) solids, Ultrafiltrate (P concentrate) and certain rendering and food processing residuals.

The approach in this proposal will be capable of building out capacity first for low and medium P containing materials, largely around aerated composting infrastructure on multiple farm sites, and be better positioned to handle P concentrate, P centrifuge cake and other high P feedstocks. As time of this proposal, those concentrated sources cannot be reliability obtained on a regular basis, but they are anticipated to be deployed in Franklin, Addison and/or Orleans counties over the next 18 months.

Stage Two results included finding that high P feedstocks may be available seasonally or be subject to significant equipment downtime. Therefore any business model and plan needs to have service and product revenues that can be viable independent of high P feedstock availability. With regards to impact on P redistribution on farm and watershed mass balance scales, it will take higher volumes of materials and products to achieve significant P tonnage without a consistent high P source. However, having the feedstock amendments available for blending into P-fortified composts and development of additional end-use markets, will allow the pace of P distribution to scale more rapidly once new P concentration equipment is deployed.

Part Two: Full Implementation

VPIC Stage Three

AGT proposes to fund, build and utilize a Hot Box – 8A- 250R, a 20' containerized compost aeration and heat recovery (CAHR) unit. The modular equipment functions to aerate up to 8 zones of fresh compost feedstocks, consisting of up to 200 CY batches (1600 CY peak capacity). While batch residence times can range from as little as two weeks to up to 12 weeks, typical residence time is 28 days (effectively one month). 1600 x 12 months equals 19, 200 CY annual capacity. Given the unit may be moved between three or more farms in the initial years of operation, 60 days of break-down, transport and set-up time are projected and reduce annual production capacity projection to 16,000 CY of incoming feedstocks. Average volume reduction during active composting is nearly 50% so annual finished compost production is estimated to be 8,000 CY by 2021. These volumes assume that network farm sites will be capable of aggregating 1600 CY or more of feedstocks to fully utilize the aeration capacity.

Participating farms along with Agrilab Technologies Inc. intend to utilize the Vermont Capital Equipment Assistance Program (CEAP) to acquire the phosphorus processing equipment, specifically the Hot Box 250 – 8A – 250R and the Digested Organics Ultrafilter. As described above, the Compost Heat Wagon adds to positive aeration and drying capacity. The pieces of equipment address needs of P separation and concentration, pathogen destruction and volume reduction via composting of manure based P products, and further stabilization through aerated drying.

Image 7: AGT CAHR equipment is provided in shipping containers or on skid frames for semi-mobile modular deployment of mechanical components including aeration fans, valved ductwork, heat exchanger, pumps, and remotely accessible sensors and controls. Note steam exhausted from container is from negative aeration of adjacent compost windrows.

Business Description

The business plan for this proposal relies on a combination of product revenues, service revenues and cost savings to justify an entrepreneurial opportunity. There is an existing market for these technologies, products and services, with potential to grow in scale and impact. The plan will address each of the market opportunities and summarize the combination of these elements.

Compare to values of prototyping phase.

Unit economics analysis by the project team tracked the actual costs of the research and development conducted during VPIC Stage Two prototyping. Tracking all costs of materials, labor, equipment use, facility usage and other expenses, and divided by the 668 cubic yards (CY) of feedstocks processed, a per

CY cost of $70.99 was measured. For VPIC Stage Three, at the proposed implemented scale, per CY processing costs range from $4.74 to $9.48 depending on the amount of volumes composted, composted and dried, or exclusively dried, with the combination of composting and drying resulting in the highest unit cost.

Compare to full scale implementation (in planned phases)

VPIC Stage Three goal is 16000 CY materials processed – estimate 8000-10000 CY finished product or 4000-5000 tons of product. At average 1% P concentration, 40-50 tons of P are a reasonable projection of total P to be redistributed. While not a massive volume, this does represent a 25X increase over the 640 CY processed in VPIC Stage Three.

The volume and weight of P processed and redistributed could grow significantly if one or more P separation or concentration system is deployed in northern VT. Having the composting and drying infrastructure in place first should lead to improved utilization of any installed P separation equipment.

Compare new P products to competitor prices and values and distinguish offerings from competition (competition analysis) -

Raw liquid manure is commonly available in VT and is the primary source of P fertility for forage crops grown for dairy livestock. Manure can be stored in several ways and applied in various forms, but the largest fraction is in liquid slurry manure, stored in lagoons. While P content varies depending on the farm, the characteristics of the ration (feed formulation), moisture levels and more, commonly manure is applied to meet some of the nitrogen (N) demands of corn silage and hay. Typically P demands are often being met or exceeded, if manure was applied to meet all agronomic recommendations for N. As a result, manure is applied at reduced rates to not exceed P Risk Index thresholds in a farm nutrient management plan (NMP). Generally considered the lowest cost approach for dairies, typical custom manure application costs range from 1 to 2 cents/gallon.

Commercial fertilizer can be considered competition for a new renewable P product. Statewide N fertilizer is the largest tonnage purchased and applied to farm fields. Combined N-P-K formulations are often used as starter for corn crops, incorporated at the time of seeding to promote early stage plant growth. Minimal P fertilizer is applied after this time in most VT cropping scenarios. Rather the bulk of commercial fertilizer use in VT if for N demands. This comes in the form of side-dressed N on corn silage prior to the plants achieving full canopy over the soil, as well as on grass fields after harvests of chopped haylage or cuts of baled hay.

See Appendix A: 2018 Fertilizer and Nutrient Tonnage by Type - VT Agency of Agriculture Food and Markets, Agricultural Resource Management Division

Raw Giroux poultry manure is another source of P fertility used in northern VT, provided by the large egg producer in Chazy, NY. Most farms use this manure as a source of N and it is typically applied in solid form by truck-mounted spreaders. This product is relatively affordable as it comes at a low price and trucking is understood to be subsidized by Giroux in order for their farm to distribute its nutrients and avoid overloading on their own crop land closer to the farmstead in NY. The material is used by organic dairy farms for fertility as while it is raw manure and cannot be used on human consumption crops without a 90-day waiting period, it can be applied to livestock feed forages with a 30-day waiting period prior to harvest. The potential downsides to use of this product are not as much related to fertility but rather the generation of odors (ammonia from the high N content) and other sulfur-related compounds if the material becomes anaerobic. This may limit its use on fields with more sensitive neighbors. Some anecdotal concerns regarding antibiotic residues, salts and other constituents have been expressed, but no testing was found at this time to validate or eliminate that issue.

Commercial compost is available around the state, with reports of its use mostly on hemp and vegetable crops, with very little used in corn and hay production. There are some farm-made composts used on the same farm as part of a manure management program. Commercial compost from Vermont Natural Ag Products, Green Mountain Compost, Vermont Compost Company and Grow Compost have been reported to be used in farming through personal interviews, but no volumes have been tracked or estimated for this report. Most commercial compost in VT is sold to home owners and landscapers, and not for farm crop production.

ProHemp 5-3-9 from North Country Organics, based in Brandon, VT is a new product targeted for commercial hemp growers. This fertilizer blend is understood to be applied at the time of planting, to trigger vigorous growth after transplanting seedlings to fields. Pricing is variable depending on volumes and distance. Where renewable P products (as compost, dried materials or liquid extracts) could be valuable is at the late stages of hemp growth during flower development, where primarily P fertility is needed by the crop, and minimal or no N and K. This informs future product development opportunities for the coming two years. Foliar applications, fertigation and irrigation of top dressed compost are delivery methods that should be investigated for cost-effectiveness and plant response.

Soluble Organic Phosphorus – Boucher Fertilizer, Highgate. At least one organic dairy has selected a soluble organic phosphorus (SOP) as its preferred fertility input that is approved for organic use. It does not have the odor, salt or antibiotic residue concerns of poultry manure, and had good response with crop growth. The product is derived from seaweed and other fish residuals.

Other information

THE FOLLOWING SECTION IS MARKED AS CONFIDENTIAL FOR PROPRIETARY INFORMATION

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RETURN TO NON-CONFIDENTIAL CONTENT

How would the sale of these products benefit and compensate Vermont farmers and taxpayers?

Vermont farmers are intended to benefit through improving options for P distribution off the farm, while creating new revenues. Any viable expansion of P processing through P concentration equipment, composting, blending and drying will need to pay farmers for their materials used as inputs. Current models are structured to pay farms $2 to $8 per cubic yard for materials, such as P concentrate, separated dairy manure solids, solid bedded pack manure or other biomass.

Vermont taxpayers should benefit through reductions in P runoff to Lake Champlain and other waterbodies. A range of water quality BMPs are needed to reduce impacts such as algae blooms and help the state meet TMDL goals. By treating farm manures and other residuals as valuable products, and providing more options to create workable NMP's, this P-processing and composting network should accelerate achievement of P loading reductions. Vermont taxpayers are already making significant investments in water quality, and they should expect results. Regulatory compliance by farms, businesses, municipalities and other land managers is very unlikely to achieve the TMDL targets on their own, so stimulation of markets to accelerate P reductions is a worthy endeavor.

Clearly show how this business would be profitable at scale and how that profit would be generated –

Unfortunately this business cannot clearly show how it will be profitable at scale, given the uncertainty about market demand and willingness to pay prices that exceed the cost of production. Other sources of fertility including commercial fertilizer and Giroux poultry manure are known quantities that are considered cost-effective. Without incentives to use renewable P sources as an alternative, and/or capital incentives for P processing and composting infrastructure and equipment that can substantially reduce the cost of production, it may be challenging to offer a competitive line of products to farmers and other end-users.

Budget for VPIC Stage Three

The budget reflects the infrastructure and integration needs at a network of composting and P processing sites in four Vermont counties. There are additional budget items that reflect the estimated costs of implementing improvements and initial management and administration of the network.

Estimated costs are based on historical experience in conducting final planning and design tasks, installing equipment and related infrastructure, commissioning the systems and providing start-up, initial operating and documentation support.

The summary of the financial status can be characterized as focused on site infrastructure development in the first two operating years, while limited revenues are projected. The biggest uncertainty is timing for initial product sales revenues, which are dependent the speed of deploying equipment and start-up to processing feedstocks.

Generally product sales for fertility are very seasonal, with the largest volumes of compost and commercial fertilizer purchased and applied from late April through mid-June. This corresponds with direct seeding and transplanting of both forages such as corn silage, as well as specialty crops such as hemp and vegetables. If sites cannot effectively produce materials for sale by spring 2020, then the ability to conduct larger scale field trials and creation of new product blends may not occur at significant scale until 2021. It is assumed that meaningful product sales and revenues will occur in the year following field trials, so in a worst case scenario, this could be pushed back to 2022. While some revenues for services are forecast, and some sales can be made for later season top dressing, or as components into bagged products, it can make the horizon for investors and granting agencies to see an acceptable ROI more challenging. Likewise, the risk increases to an operating entity, such as AGT proposes to serve in that role, as revenues could be delayed and are not guaranteed in any scenario.

Funding request

Agrilab Technologies Inc. requests **$167,191** for VPIC Stage Three Investments.

Match (cash and in-kind) from individual farms and from AGT totals **$167,200**.

Details, itemized cost estimates and match by farm and business entities are provided in the attached Appendix B: CAHR Budget – AGT Stage III VPIC 190928

The AGT team and other partners intend to pursue other private, federal and state funding for complimentary equipment, inventory, labor expenses and assets that will support the larger effort. These funds are not secured at this time due to both funding cycles and uncertainty that the current business plan is worthy of private investment. Therefore these potential sources are not included as match at the time of this Stage Three proposal.

Timeline for business launch

The business will be formally launched in December 2019 depending on award of funds and completion of all required agreements. In order to have at least some products ready sale and use in field trials for spring 2020, an aggressive construction timeline for site development at the Magnan Brothers Maquam Shore Dairy is proposed. The timeline could be delayed by weather, fabrication schedules of equipment, labor availability and other factors.

Infrastructure improvements at other proposed sites in the network can occur on a less aggressive timeline. Further, the proposed infrastructure at the Choiniere, Paris, and Meristem Farm sites is more basic and largely consists of modest pad improvements and utility connections of 220V/30A electric service and internet. Timing for drying improvements at VNAP/Foster Brothers Farms can follow the improvements at other sites, as in part the drying will be utilized to stabilize and add value to materials produced at Magnan Brothers and other sites.

Permitting requirements

No new state permitting is required at any of the sites surrounding ANR compost site certification, Act 250 development and land use, or VT AAFM LFO or MFO regulations. All activities will be on-farm, and represent recognized farming activities and do not cross any thresholds for importation, use or sale of off-farm feedstocks in the processes. Each site will comply with local municipal requirements for building permits for greenhouses and other structures if needed, as well as for new electrical service connections, if required.

AGT recognizes that if the network of sites does grow successfully, there will likely be a need for multiple permits or regulatory approvals. While this is not included in the Stage Three proposal, phased growth could reasonably lead to compost certification required to accept off-farm inputs such as food processing residuals, source-separated food scraps, rendering residuals or other regulated biomass. Act 250 permits may be required if a separate material blending and product sales facility is developed in coordination with the on-farm processing. VT AAFM fertilizer registration and licensure may be needed for some products making fertility claims and guarantees. An Act 248 permit/certificate of public good will be needed if Magnan Brothers proceed with anaerobic digester facility implementation. Other permits may be required and will be researched as planning proceeds on those future developments.

To summarize, the key hurdles to address are locating permanent, reliably operating P separation and concentration equipment on farms and watersheds with excess P loading. The network of proposed P processing and composting sites should be well-positioned to handle traditional and existing sources of low and medium P materials, and incorporate high P materials as they become available. Minimizing transportation distances between sources, processors and end-users is key to reducing trucking costs, as products may at least initially have low profit margins.

Expanding and refining product lines to multiple end-users, both in state for bulk products and predominantly out-of-state for bagged products, is key to maximizing value and achieving higher price points. Additional field trials of composted, dried and other blended materials will be part of market development, which may require multiple years to fully implement. The investments in infrastructure and network coordination proposed for VPIC Stage Three should make meaningful progress toward addressing these hurdles and helping to meet state TMDL P reduction targets.

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Custom Hot Box 250-8R
Compost Aeration and Heat Recovery Unit
Equipment Quotation

The following quotation is for the purchase of one Agrilab Technologies "AGT Custom Hot Box 250-8R compost aeration and heat recovery (CAHR) unit modular compost aeration and heat recovery equipment". A specification sheet describing the standard Hot Box 250-R components of the system is attached to this document. An additional fresh air intake and second heat exchanger are additional components as part of this 8 zone unit as compared to the standard 4 zone unit shown in the specifications. This purchase agreement includes manufacturing and coordination of delivery of the unit to the site location specified below. Also included in the system price is "startup support" as described here:

- Prior to startup, the system must be properly installed by the customer, customer's agents, or Agrilab Technologies (AGT) staff per a separate services agreement. Specifically, electrical, network and plumbing connections must be functional to perform startup testing.
- Confirm that all mechanical components operate as designed.
- Confirm that controls and data logging operate as designed.
- Confirm that control and data systems are accessible remotely through the internet.
- Instruct the customer on initial operation of the unit and default settings.
- Provide technical assistance regarding operation, remote or in person, for up to an additional 8 hours following startup.

Fifty percent (50%) of the system cost is due upon signature of this document and is required to initiate fabrication of the unit. Forty-five percent (45%) of the system cost payment is due to AGT upon AGT notifying buyer that system is ready for delivery. The final balance of five percent (5%) is due upon delivery and approved commissioning of the system. Unpaid amounts due will incur ten percent (10%) monthly interest.

Buyer acknowledges that each system is custom built by AGT specifically for the buyer's application which may entail modifications or attributes specific to their individual project requirements.

Down payment on fabrication is a non-refundable, binding agreement for purchase of the below described system. Should purchaser default on completion of the system purchase, "said system" will become property of AGT to use, sell or lease in any capacity it deems most appropriate.

802 933 8336 | info@AgrilabTech.com | www.AgrilabTech.com
1662 Pumpkin Village Rd. Enosburg Falls, VT 05450

Buyer recognizes that additional expenses incurred on behalf of purchaser for site design, system installation and operational training, provided by AGT personnel in excess of the funds paid to AGT under the "Technical Services Agreement" or "Purchase Agreement" for on-site services and related travel after system installation, will be the financial responsibility of purchaser. These incurred expenses will be invoiced monthly and payable within thirty days of receipt by purchaser.

The completed unit will be delivered to Magnan Brothers Maquam Shore Dairy LLC, on Route 36 (Maquam Shore Road), St.Albans, VT.

Agreed upon price:	$ 138,000
Equipment Total	**$ 138,000**
System Deposit (50%):	**$ 69,000**

agrilab TECHNOLOGIES
Compost Powered Heat

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1662 Pumpkin Village Road, Enosburg Falls, VT 05450.

The Compost Hot Box 250R™

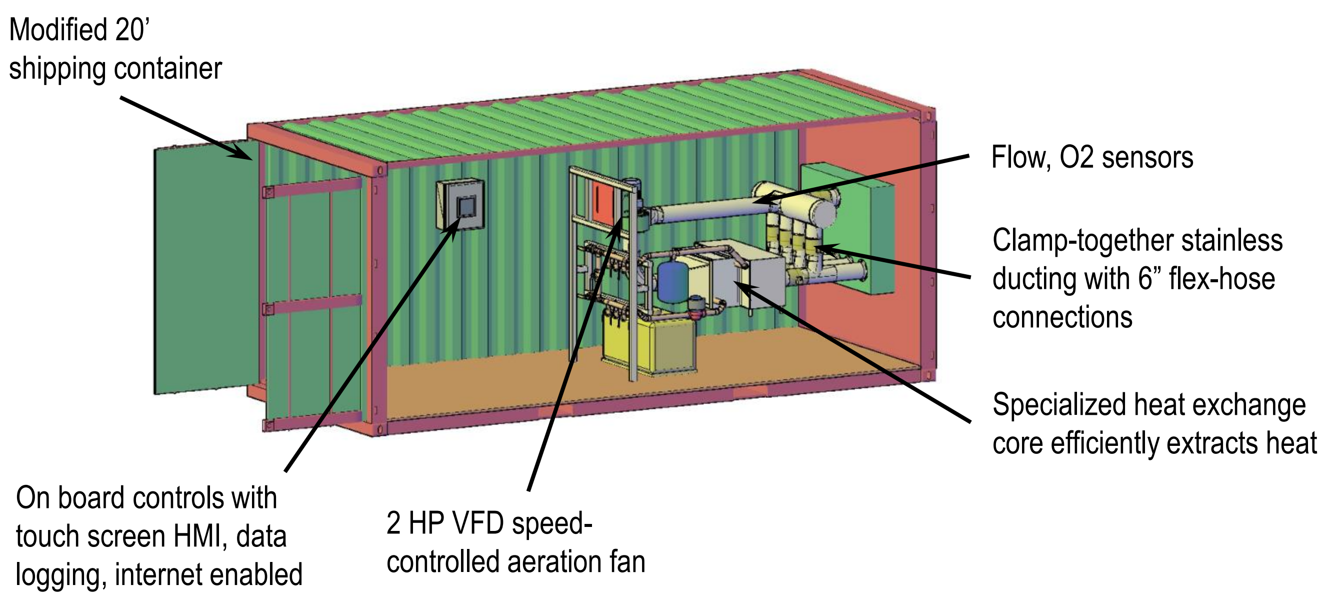
The Compost Hot Box 250R™ is a mobile plug and play compost aeration and heat recovery system with recirculation capability, featuring Agrilab Inside™ technology designed for negatively aerated or enclosed composting systems on medium to large scale farms and commercial/municipal compost operations.

Aerated Static Pile processing means minimal mechanical tumbling of material is required to aerate and break down the material into stable compost.

It includes remote data monitoring, computerized controls, hot water, and condensate recirculation systems. Aeration exhaust can be automatically vented back into the compost for moisture and heat retention, or directly into a bio-filter for odor control. Everything is assembled in a standard 20ft intermodal cargo container for easy setup alongside existing structures or other enclosures. Data captured is used to optimize compost production efficiency and quality. System documents temperature and oxygen level tracking to meet Process for Further Reduction of Pathogens (PFRP) quality standards, and maximize renewable thermal energy captured.

Annual Maximum Compost Volume Processing Capacity: 700 CY/month or 8,400 CY/year

Annual Maximum Energy ROI when heating water to 120F based on $15 per million Btu energy prices: $30,000+



What is Agrilab Inside™?

- The patented Agrilab Inside™ process takes aerated compost systems to the most advanced level with the ability to modulate air flow rates relative to oxygen and temperature levels, capturing useful heat and moisture, and recirculating compost vapor or fresh air into the compost to optimize heat and moisture levels.
- Renewable thermal energy captured as moist hot compost vapor is run through specialized heat exchangers where water is heated and condensate water is reclaimed. Aeration exhaust can be automatically sent back into the compost for moisture and energy optimization. Cooled aeration vapor can be vented directly into a bio-filter for odor control.
- This process is the first and most advanced compost heat recovery system available and saves time and money compared to turned windrow composting. Agrilab Inside™ optimizes the overall composting process and enables effective bio-filter odor control, fast compost production and predictable heat and water recovery.

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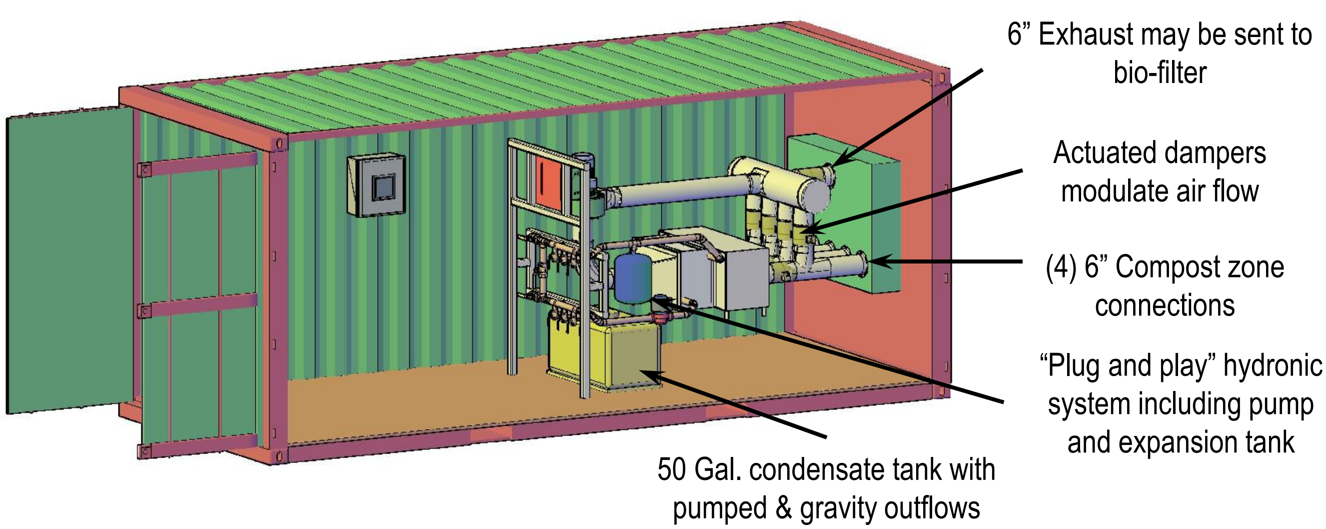
1662 Pumpkin Village Road, Enosburg Falls, VT 05450.

Compost Hot Box 250R™

The Compost Hot Box 250R™ is an integrated, plug and play system that contains the core mechanical and control equipment for aerated composting with heat recovery - the "brains, lungs and heart" of the system. The Hot Box 250R™ is designed for aeration flow of 100 to 350 cubic feet per minute, with 4 compost batch zones and the ability to recirculate into any zone for additional heat recovery. All pumps, blowers and valves are controlled by an on board SCADA system with touch screen interface, data logging and remote monitoring software.

Specifications:	
Dimensions, Installation:	Customized metal shipping container; 8' wide by 20' long by 8' high, ~6,000 lbs. 6" hoses for compost aeration and exhaust connections.
Aeration:	3 Horsepower blower, speed controlled, 100 to 350 CFM range adjusted manually or with feedback controls. Four compost and exhaust zones with fresh air intake.
Recirculation:	Exhaust from any compost zone can be injected into another zone. This conserves heat and moisture, and can jump-start cold or frozen material.
Sample Heating Output:	**With 250 CFM of saturated 140F compost exhaust**: • 124,000 Btu heating loop: 9 GPM heated from 100F to 128 F • 160,000 Btu water pre-heating: 5 GPM heated from 55 to 120 F **With 350 CFM of saturated 140F compost exhaust**: • 151,000 Btu heating loop: 12 GPM heated from 100 to 125 F • 237,000 Btu water pre-heating: 8.75 GPM heated from 55 to 110 F
Monitoring:	Parameters can be used to optimize composting and heat recovery, linked to SCADA system: • Oxygen level of compost vapor • Temperatures at all critical points • Air and water flow rates
Control:	• Touch screen with web server for intuitive operator control • Full control and monitoring via internet. Remote support available by contract. • Expandable to control auxiliary systems (i.e. greenhouse climate control)
Delivery, Purchase or Lease:	Delivery/shipping to be paid for directly by buyer with logistics support from AGT. Purchase includes 8 hours of remote startup support during the first week of operation. Site preparation, Hot Box installation and on going technical support packages available under separate agreement. No $ down lease-to-own financing is available.



Vermont Agency Of Agriculture, Food, & Markets
Agricultural Resource Management Division

Fertilizer and Nutrients Tonnage By Type

From: Jan 2018 - Dec 2018 (Annual)

To: Jan 2018 - Dec 2018 (Annual)

		CONTAINER			USE	
	TOTAL	BAG	BULK	LIQUID	FARM	NONFARM
MULTI-NUTRIENT						
NITROGEN	2510.888	231.167	1947.333	332.388	2370.746	140.142
PHOSPHATE	2431.277	72.740	1886.611	471.926	2410.677	20.600
POTASH	2554.272	155.269	2279.179	119.824	2501.555	52.717
SINGLE-NUTRIENT						
NITROGEN	9984.593	19.919	8691.283	1273.391	9983.837	0.756
PHOSPHATE	14.754	1.284	13.460	0.010	14.468	0.286
POTASH	2379.208	6.379	2372.780	0.049	2376.427	2.781
TOTAL NUTRIENT						
NITROGEN	12495.481	251.086	10638.616	1605.779	12354.583	140.898
PHOSPHATE	2446.031	74.024	1900.071	471.936	2425.145	20.886
POTASH	4933.480	161.648	4651.959	119.873	4877.982	55.498

***Excludes Lime, Gypsum, and Peat**

September 26, 2019

Black Dirt Farm
393 Stannard Mountain Road
Greensboro Bend, VT 05842

Kaitlyn Hayes and Terry Smith
Office of the Governor and VT Agency of Agriculture Food and Markets
109 State Street, Pavilion
Montpelier, VT 05609

Re: Letter of Interest/Support for Agrilab Technologies Inc.

Dear VPIC Stage Three Review Committee-

This is to express our interest and support of Agrilab Technologies Inc. (AGT) Stage Three proposal for the VT Phosphorus Innovation Challenge (VPIC). Our diversified organic farm is both an end-user of compost and other approved fertility products, and a compost producer, with a focus on worm castings or vermicompost. Our farm also raises hens for egg production and grow crops.

We are interested to participate in grow trials for both solid and liquid compost and extracts for greenhouse and field crops, including greens, vegetables and hemp. We anticipate all manures will need to be composted first to address concerns about antibiotic residues.

Some feedstocks may also be applied to the vermicomposting beds, to see if P centrifuge cake, P fortified compost and other inputs will be beneficial for worms and generate new value-added products.

We hope to support a network of composting and P processing sites that can create useful soil building materials, while improving nutrient management in VT watersheds.

Please contact us if you have any questions.

Sincerely,

Tom Gilbert, Owner/Operator, Black Dirt Farm

September 26, 2019

Choiniere Family Farm
2465 Gore Road
Highgate Center, VT 05459

Kaitlyn Hayes and Terry Smith
Office of the Governor and VT Agency of Agriculture Food and Markets
109 State Street, Pavilion
Montpelier, VT 05609

Re: Letter of Interest/Support for Agrilab Technologies Inc.

Dear VPIC Stage Three Review Committee-

This is to express our farm's interest and support of Agrilab Technologies Inc. Stage Three proposal for the VT Phosphorus Innovation Challenge (VPIC). Specifically our farm is interested to be an end-use and buyer of compost and phosphorus fertility products for use on our hayfields and pastures. This would begin by conducting trials of different treatments on targeted plots and paddocks.

As our dairy is certified organic, inputs such as soil amendments, fertilizers and similar materials must be approved for organic production. Our 300 acres of hay fields and pastures, according to our soil sampling and nutrient management planning, are deficient of some minerals and nutrients, including phosphorus (P). This has become more the case for P since our dairy transitioned to grass-only production for Organic Valley. The P contained in farm-raised corn silage or grain, or in purchased concentrates for animal feed, is no longer fed to dairy cows and youngstock. As a result, manure P levels as well as soil P levels are dropping.

Our farm has acquired raw manure from an adjacent conventional dairy as well as organic fertilizer from seaweed, in order to address the agronomic needs. Other farms also apply chicken manure from Giroux Poultry to supply N and P. We are interested to apply composted manure, fortified with P for several reasons.

Beyond the straight P concentrations, applying this fertility as compost has the additional benefit of delivering carbon to increase soil organic matter. In a composted form, there are the advantages on hayfields of not inadvertently harvesting some amount of raw manure applied after a previous cut, and potentially spreading pathogens through the herd via fed forages.

For pastures, most manure and nutrient applications are made in the fall at the end of the grazing season. Composted manures (potentially fortified with P) have the benefit of not carrying manure "flavor" that comes with raw manure, and leads to pasture rejection by grazing animals due to lack of palatability, and a corresponding loss of forage intake, and likely decreased milk production. This enables applications during the active grazing season, and improved uptake of any N contained along with the compost and P, and typical increases in pasture productivity.

Beyond using the product, we are interested to host the seasonal processing and storage of P fortified compost and similar amendments, as transportation and timing advantages may occur, both seasonally and as off-farm sources that are suitable for blending and inclusion are available. Using the mobile equipment and operating support of Agrilab Technologies Inc., we avoid the capital expense of a permanent year-round facility.

Please contact us if you have any questions.

Sincerely,

Guy Choinière Mathieu Choiniere

Guy and Mathieu Choiniere

Choiniere Family Farm

Does' Leap
1703 Rt. 108 South
East Fairfield, VT 05448

Kaitlyn Hayes and Terry Smith
Office of the Governor and VT Agency of Agriculture Food and Markets
109 State Street, Pavilion
Montpelier, VT 05609

Re: Letter of Interest/Support for Agrilab Technologies Inc.

Dear VPIC Stage Three Review Committee-

This is to express our interest and support of Agrilab Technologies Inc. (AGT) Stage Three proposal for the VT Phosphorus Innovation Challenge (VPIC). We are the only certified organic goat dairy in Vermont, and also raise pigs, chickens, other crops and make organic goat cheese and dairy products. Our pastures and hay fields can only have fertility and soil amendments applied that are approved for organic use.

We would like to apply additional fertility if it is cost effective and does not have negative effects on the palatability for the grazing animals. Composting the manure and P concentrates should stabilize some nutrients in the manures, kill pathogens and weed seeds, and reduce off flavors and odors of manure that can lead to pasture rejection, reduced forage intake and reduced milk production.
We hope to be able to utilize P products generated from the VPIC efforts and support a network of compost sites and P processors in VT, particularly if products can be approved for organic use.

Please contact us if you have any questions.

Sincerely,

George VanVlanderen and Kristan Doolan, Owners, Does Leap Farm

802.827.3046 doesleap@myfairpoint.net

September 26, 2019

Magnan Brothers Maquam Shore Dairy LLC
Maquam Shore Road
St.Albans Bay, VT 05481

Kaitlyn Hayes and Terry Smith
Office of the Governor and VT Agency of Agriculture Food and Markets
109 State Street, Pavilion
Montpelier, VT 05609

Re: Letter of Interest/Support for Agrilab Technologies Inc.

Dear VPIC Stage Three Review Committee-

This is to express our interest and support of Agrilab Technologies Inc. (AGT) Stage Three proposal for the VT Phosphorus Innovation Challenge (VPIC). Our farm operation consists of several farmsteads in Fairfield and St.Albans towns, including two dairies. The Magnan Brothers Maquam Shore Dairy is interested to site a composting and phosphorus (P) processing facility on the farm, to manage both on-farm and off-farm residuals. This includes concentrated P from other farms, food processing residuals and other suitable feedstocks.

Our farm is planning to install other related facilities over the next two years, including a screw-press solids separator and an aerobic digester. For this proposal, beyond a working pad and utilities for connecting to mobile modular composting equipment, a multi-use greenhouse that would be used for drying down P fortified compost and other high P materials during summer and winter seasons. The greenhouse will be used for plant growth and drying during spring and fall.

The approach of using AGT mobile equipment and operating support, and a facility design that facilitates expansion in phases, helps manage capital and operating costs during a time of economic stress on many dairy operations. Once operational, the facilities should both reduce farm operating costs as well as generate new revenues separate from fluid milk sales.

Please contact us if you have any questions.

Sincerely,

Mark Magnan, Marty Magnan, Peter Magnan, owner/operators

Martin J. Magnan

Mark W. Magnan

September 26, 2019

Meristem Farms
2127 Cady’s Falls Road
Morristown, VT 05661

KaitlIn Hayes and Terry Smith
Office of the Governor and VT Agency of Agriculture Food and Markets
109 State Street, Pavilion
Montpelier, VT 05609

Re: Letter of Interest/Support for Agrilab Technologies Inc.

Dear VPIC Stage Three Review Committee-

This is to express our interest and support of Agrilab Technologies Inc. (AGT) Stage Three proposal for the VT Phosphorus Innovation Challenge (VPIC). Specifically our hemp farm and business is a consumer of compost and P fertility products during the indoor seedling stage, transplanting to fields and for late stage top dressing. All fertility inputs must be approved for organic use as we are a certified organic farm.

Working with the AGT team to utilize their equipment and operating support provides Meristem Farms with three worthwhile benefits. First, to produce and blend our own compost and fertility products, including liquid extracts, in order to match our crops needs at different stages of their growth cycle. Second, we have abundant high-lignin biomass residue in the form of stems and leaves. Combining them in formulations of other manure and high P feedstocks on site, will avoid transportation and disposal costs and be a means to recycle and return organic matter to the farm soils. Third, by using a model of mobile equipment and temporary connections, we can minimize the capital and operating costs of a composting site on our farm.

Please contact us if you have any questions.

Sincerely,

Jennifer Daniels, President

September 26, 2019

VT Natural Ag Products, Inc.
297 Lower Foote Street
Middlebury, VT 05753

Kaitlyn Hayes and Terry Smith
Office of the Governor and VT Agency of Agriculture Food and Markets
109 State Street, Pavilion
Montpelier, VT 05609

Re: Letter of Interest/Support for Agrilab Technologies Inc.

Dear VPIC Stage Three Review Committee-

This is to express our interest and support of Agrilab Technologies Inc. (AGT) Stage Three proposal for the VT Phosphorus Innovation Challenge (VPIC). Specifically our compost business is interested to be a buyer of compost and phosphorus fertility products for use in our bulk and bagged product lines. Further, we seek to compost and dry down other high phosphorus feedstocks as additional P concentration and removal equipment comes on line in VT.

VT Natural Ag Products (VNAP) has been in business since 1992 and sells compost, soil blends, mulch and other products in bags and bulk form around the Northeast U.S. During VPIC Stage Two we provided facility space and worked with the AGT team to evaluate equipment and material handling practices for blends of high P feedstocks and other manure solids. Tasks included on-site material blending and loading task, working through unit economics of products and the beginning stages of evaluating market opportunities.

Some of the prototyped products, including P-fortified compost, will be eligible for approval for organic use, similar to a number of products offered in our line. We are interested in doing additional market analysis and seeing where the products could fit in our existing line and/or as additional products.

We are hopeful this proposal will increase our drying capacity for products that require lower moisture contents prior to screening, bagging and distribution.

Please contact us if you have any questions.

Sincerely,

Heather Foster-Provencher

Heather Foster-Provencher, VP of Finance and Administration

Robert Foster, President

VT Phosphorus Innovation Challenge

Integrating Technologies to Achieve Economical Phosphorus Removal and Redistribution

FNLC/UVM Extension Summer Farmer Meeting, August 2019

Brian Jerose, President

Agrilab Technologies Inc.

Barriers The VPIC Project Seeks to Address

- P removal and concentration is technically feasible – examples in VT and beyond but not widely adopted
- P cake/concentrates are currently expensive to produce with few incentives for dairy farmers to install systems
- Marketplace has minimal awareness and demand for these products
- Materials are dense with high moisture, and have high trucking costs
- New supply chains must be created from source production, value-added processing, transportation/distribution to consumer end-use
- Bulk commodity outlets as well as bagged retail channels need development, from end-use demonstrations to determining price points

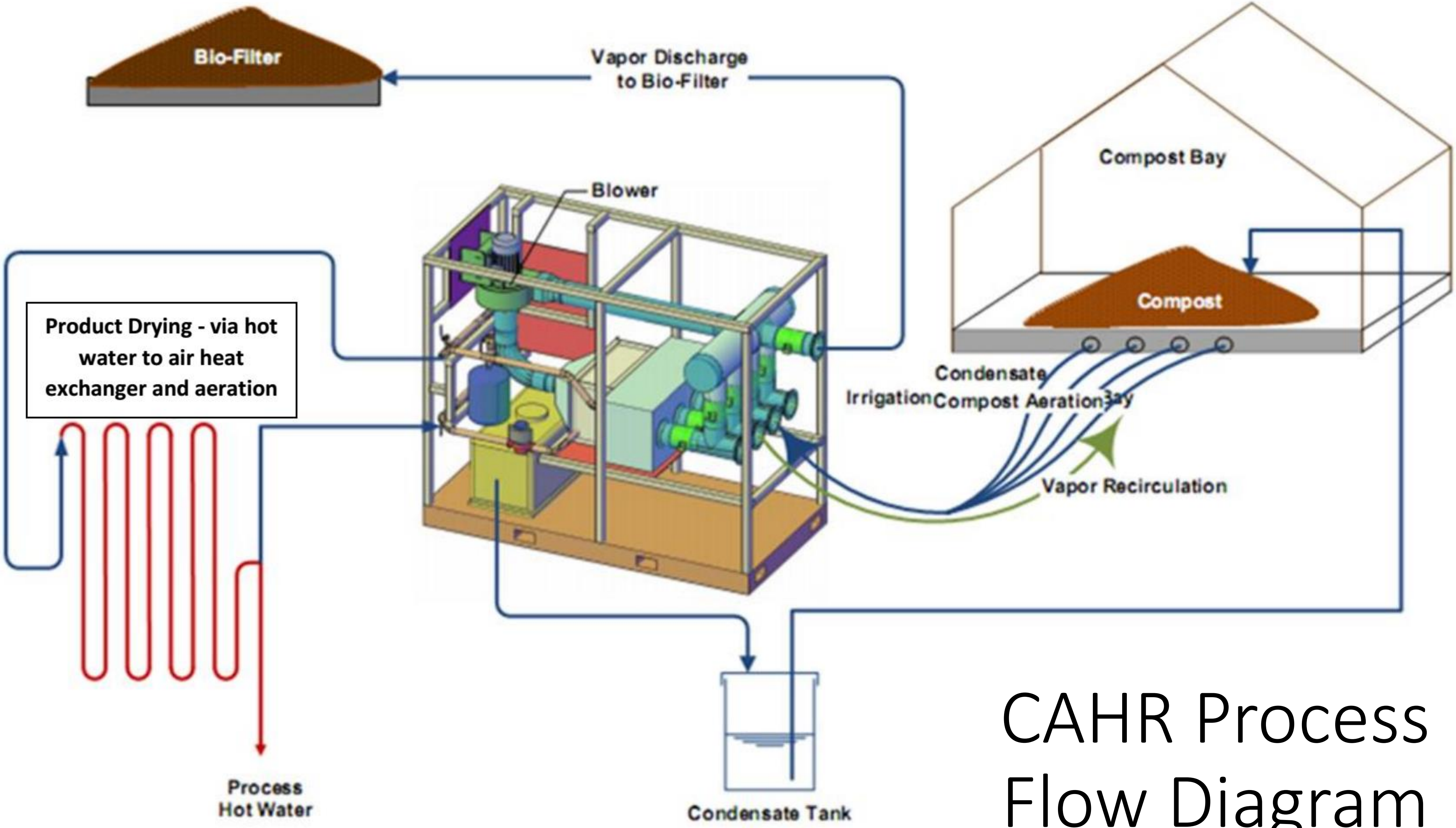
Agrilab Technologies Inc. (AGT)
Stage II Project Summary

- Conduct composting and drying batch demonstrations of concentrated phosphorus (P) materials, separated dairy manure solids and blends with other agricultural and forestry biomass
- Build on the existing compost aeration and heat recovery (CAHR) process for value-adding and stabilization including utilization of renewable thermal energy for drying P cake, filtered concentrate and similar residuals
- Conduct parallel market evaluation for bulk products within VT and for bagged products in conjunction with VT Natural Ag Products (VNAP)
- Prototyping and other proposed tasks chosen to determine both technical and economic feasibility of multiple P-products and pathways to scale operations in Franklin County and all of VT

- Vermont Natural Ag Products Inc. (VNAP)
- Location for Stage II Prototyping in Middlebury, Vermont
- 10 acre certified composting facility with stormwater collection

- Makers of MooDoo and other compost/mulch/soil products sold in 12 northeastern states

AGT Hot Box 250-R connected to aeration vapor pipes, plumbing, electrical and data



CAHR Process Flow Diagram

Active compost windrows releasing moisture, CO2 and thermal energy

This vapor stream is pulled into the compost aeration and heat recovery (CAHR) systems, thermal energy is captured and used to heat drying air for other process steps. For VPIC the heated drying stabilizes and reduces weight of P residuals and compost blends

P Concentrate from Digested Organics is mixed with amendments for compost blend

Dissolved Air Flotation (DAF) Sludge as Received

Residuals Not Processed

- Centrifuge solids (cake) from Machia and Sons Dairy
- Another option for concentrating P in dairy manure by secondary separation of fine particulate solids that typically carrying largest fraction of P
- Current moisture and density limits economical transportation range

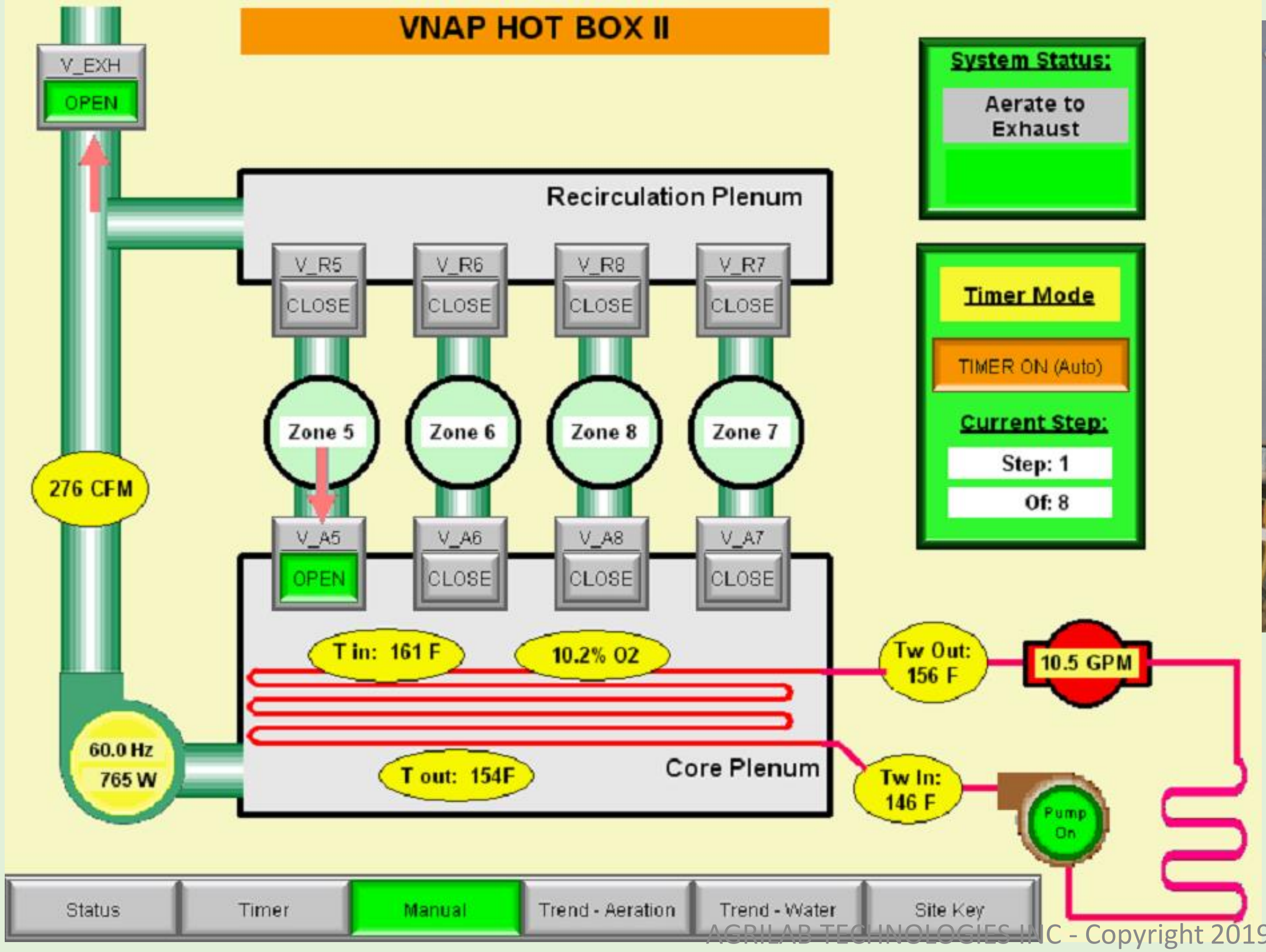
Aeration pipes (on grade) spaced to match loader wheel base

Moisture released via heated aeration

Batches of compost, separated dairy manure solids and phosphorus (P) concentrate are aerated and dried during field trials April to August 2019

Separated dairy manure solids transferred from active composting bay to drying zone

On-site and remote data collection and control enable efficient operation and tracking



Next Steps for VPIC

- Complete unit economics of P – products tracking material, labor and other inputs
- Complete market assessment for revenue potential from bulk and bagged products
- Identify potential phases of growth to expand processing capacity including capital and operating costs at on-farm and centralized sites
- Identify other needs for field trials, gaps in supply chain and potential impact on P-loading to Lake Champlain and other water bodies
- Final report due September 30 including application for Stage III funds

How Does This Lead Towards Reducing P Pollution at Meaningful Scale in VT?

- Stage II tasks have been selected to find most cost-effective practices to add value and stabilize P-cake and P containing residuals
- P-fortified composts, dehydrated P-cake and other blends will be selected from larger potential suite of bulk and bagged products
- Economic feasibility and market assessment will provide detail for product pricing, crop field trials and other market development needs
- Information is intended to identify equipment, infrastructure, labor and other needs to plan and develop Franklin County farm-based and commercial P-processing facilities to compliment VNAP capacity

Reducing P Transport

- Timing and Placement of Manure Applications
- Reducing or Eliminating Tillage in Flow Areas
- Maintaining Vegetative Cover and Buffers
- Building Soil Organic Matter levels and increasing soil moisture infiltration and storage capacities
- Addressing P mass balance via feed, manure, fertilizer, soil loss and other sources
- Planning for the “rainy day” – in most years THE MAJORITY OF PHOSPHORUS IS TRANSPORTED TO THE LAKE IN ONLY 10 TO 15 DAYS.

Thank You!

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