Final Business Plan and Report

Vermont Phosphorus Innovation Challenge

DVO, Inc.

Section 1 – VPIC Stage 2 Results

Introduction

This document has been developed to report the results of successful prototype testing in the Stage 2 Vermont Phosphorus Innovation Challenge (VPIC) program and to describe a business plan for full-scale implementation associated with Stage 3 of the VPIC program.

To this date, the program participants have consisted of:

1. Vermont state agencies,
2. DVO, Inc – Chilton, WI,
3. University of Vermont (UVM), Rubenstein School of Environment and Natural Resources, Burlington, VT, and
4. Magic Dirt (Cenergy) – Little Rock, AR.

Going forward and proposed in Stage 3 development, additional Vermont participants will be identified.

We propose to establish a new VT LLC, centered in (likely) SW , VT. This LLC will initially be headed by Dr. Michael Curtis but will transition in the near term to a Vermont professional who will be identified and introduced as this project evolves. To date, we have had several discussions with UVM and various Vermont entrepreneurs concerning this undertaking.

We are developing this program and business as a **Vermont company**-specific to the economic development goals associated with this program. The principal players previously identified comprise one of the more effective dairy manure phosphorus control groups ever established in the United States. We will augment this with in-state entrepreneurial expertise in development of a final product or multiple products that will garner a strong place in the market similar to products developed by the project team in other venues. The in-state addition to the program will make this a more localized event and potentially result in **the hiring of 10 (plus or minus) individuals to manage the various media associated with this effort and to staff the proposed facility development in the state of Vermont**. This proposal does not combine our VPIC related group with another but does 'lean' upon various Vermont groups in development of the final business plan and goals.

The Phosphorus Concern

As detailed in previous submittals, dairy manure–related phosphorus loadings to VT surface waters, due to surface runoff and subsurface transport phenomena, are contributing to eutrophication and associated harmful algal blooms in Vermont lakes, including Lake Champlain. The VPIC Stage 2 project team of DVO, Inc, Magic Dirt, and UVM has developed a to-be-patented solution to phosphorus control in dairy systems in which the manure is digested. This patented system consists of:

1. anaerobic digestion using proprietary Two-Stage Linear Vortex digester technology,
2. primary solid separation using screw press technology,
3. secondary solid generation using dissolved air flotation, and
4. development of prescribed nutrient-rich plant foods/specialty fertilizers (the "formulated materials"), the basis of this business plan.

Under full implementation, approximately 1.5 million pounds of phosphorus fertilizer/plant food could be generated for product implementation from Vermont dairy anaerobic digesters. We have shown in Stage 2 testing that the formulated materials are highly effective in facilitating both germination and growth of vegetables and flowers. While further optimization of the formulated 'mixes' will be performed in Stage 3, a strong conclusion from Stage 2 efforts is that this phosphorus-laden solid source is the basis for a high-value plant food which can be sold in bulk on a regional basis or in a bagged solution to various retailers throughout the region and nation. The developed products will contain measurable and significant recycled nutrients AND contain many / most of the micronutrients that are simply not present in manufactured fertilizer products.

Thus, we have the potential to successfully 'capture' a large percentage of dairy–related phosphorus and convert this material into high-value plant foods and specialty fertilizers. This will result in an **export of phosphorus from the state of Vermont to various places that use phosphorus as plant food or specialty fertilizer in residential or larger commercial systems**.

Overall Technology Description

As detailed above, the technology consists of the following key steps.

1. DVO Two-Stage Mixed Plug flow digester – This modern digester is highly desirable in this effort in that the technical nature of the digester system itself results in near-complete exhaustion of biodegradable materials such that the digestate (solids from the digester) are far less biologically active then a complete mixed/vertical tank system. This exhaustion of

'biodegradability' is important in the ultimate retail aspect of the product. Simply, bags don't explode on shelves.

2. Solid Separation – The digestate from 21 days of manure digestion is pumped to a primary separation system. This is typically (but not exclusively) screw-press technology. The screw-press exudes a high-fiber solids source that is immediately reusable for onsite bedding and the remainder of which has been shown to comprise a highly valuable plant-based product, Magic Dirt™. The Magic Dirt company has developed Magic Dirt™ products to the point where they have been sold in thousands of Walmart stores nationwide. Magic Dirt is a key partner in Stage 2 and Stage 3 efforts.

The material that is discharged from the side of the press, is treated further in a customized **dissolved air flotation device**, which has been specially modified by DVO, Inc to remove the vast majority of fine solids which are part of the liquid mix. The successful removal of these solids has resulted in a nutrient-rich solid source that is the basis of our VPIC project. In total, **80 to 90%** of the phosphorus from dairy manure is consistently removed in the two solid separation steps.

Testing at the University of Vermont (UVM) has shown that this nutrient–rich fine solid material, when dried, processed and mixed with the appropriate substrate, has resulted in accelerated growth and germination of various cultivars. Grow–testing, performed at a UVM greenhouse, has shown optimal mixes of this material used in both flower and vegetable germination and growth. A brief summary of Stage 2 findings appears below while the full UVM Final report is contained in Attachments.

The technological gap that exists, and is the focus of full-scale implementation in the following sections, is the **cost-effective drying of the secondary solids**. We have evaluated various drying alternatives. These run the gamut of high capital/low operational costs to low(er) capital/high(er) operational costs. We strive to find a solution that is low enough capital to meet business Pro-forma requirements, resulting in profitability and offers a very low operational cost in developing a meaningfully drier solid. This is discussed in further detail in the following sections.

When the secondary solid source has been dried and turned into a friable solid source, it can be mixed into appropriate substrates and bagged and sold as a plant food in 'menus' consistent with grow testing. This development of a friable secondary solids source is the key technological challenge of the Stage 3 effort. Full-scale pilot testing will be performed as part of the product development.

VPIC Stage 2 Results

Technical Drying Evaluations

Technical evaluations have consisted of:

1. Choice of drier technology,

2. Location of secondary solids dryer(s) and
3. Nearness to proposed, re-located mixing and bagging facility.

If economically viable, Magic Dirt is prepared to relocate its current regional mixing and bagging operation to a TBD Vermont locale. The finale location of this mixing and bagging facility could be at or near a mixing / processing plant as recalled by the process flow diagram shown in the preparation of final solids 'products'. Drying of secondary solids is required prior to blending with appropriate materials and subsequent bagging.

Dissolved Air Flotation (DAF) units separate secondary solids from digestate. Secondary Solids moisture content is approximately 80% (20% solid content). Processing of these solids includes drying to 30 to 60% solids and mechanical agitation to preclude caking of the material. In order to process these into a blend-able material, we have evaluated four drier technology choices. These were:

1. Thermal / Solar Dryer Systems (https://www.thermo-system.com/en/tradition-and-progress),
2. High Rate – Composting Drying Sludge Systems (https://www.bdpindustries.com/wp-content/uploads/2015/03/ICS_CompostingBrochure.pdf),
3. Various Rotary Drum Dryer Systems, and
4. Quick Lime / Lime Aided Drying

Each of these technologies has advantages and disadvantages. The final technical choice will balance capital cost and operational expenses, integrating potential grants and external investments. The goal is to maximize overall system productivity and minimize per-ton unit sludge drying costs.

In every case, we have assessed the use of waste heat associated with the digester exhaust and digester heating. It is possible that the project will employ digester waste heat in the final, chosen technology. Use of waste heat could potentially reduce operational costs.

After extended product research, we are pursuing use of **Quicklime and on-farm drying**. This choice reflects:

1) Manageable on-farm capital costs,
2) Inexpensive Chemical Addition – Possible Use of Large In-state Waste Product, (no chemical addition to Magic Dirt products)
3) Minimization of Trucking Costs resulting from On-Farm Drying Application, and
4) Simplistic Technology; easily managed on-farm by farm personnel.

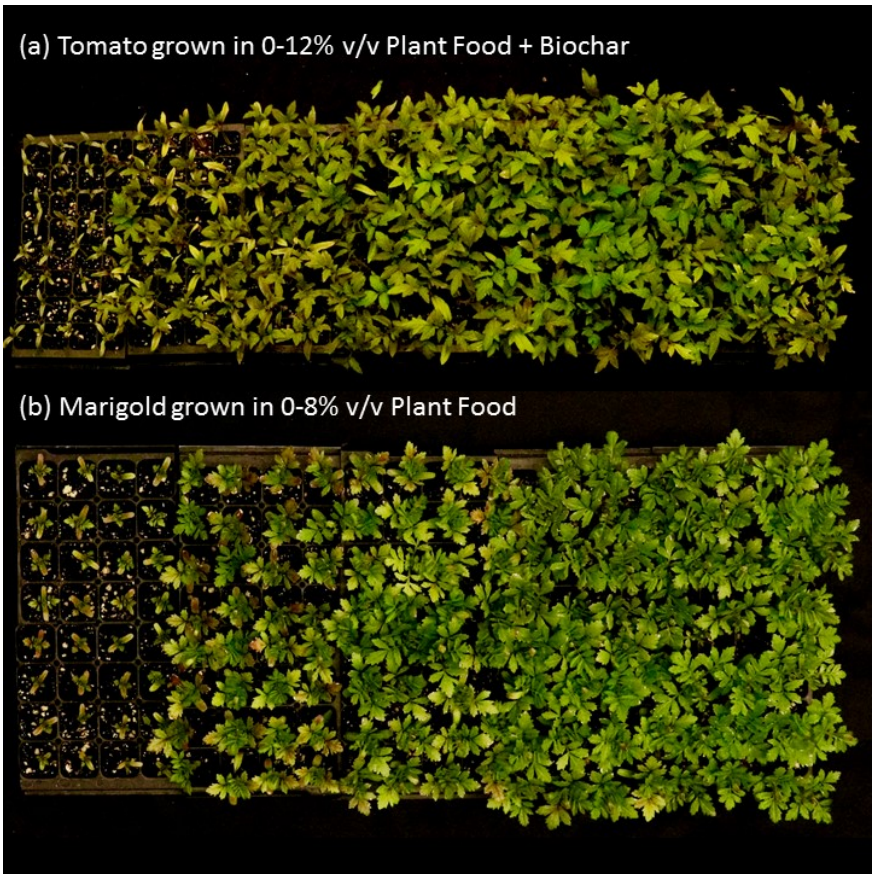
We present a proposal for **Full-Scale Pilot Testing** of this chosen alternative in the second section of this report.

Summary of UVM Grow Testing

Note: A detailed description of the UVM research is included as an Appendix.

In this study, we conducted a series of bioassays at UVM to assess the fertilization and disease suppression potential of novel recovered P fertilizers ("plant foods") consisting of fine secondary solids captured by DAF ("P-cake", 18% total solids) blended with Magic Dirt proprietary products derived from other agricultural wastes. Seedlings of tomato, pepper, petunia, and marigold were grown for five weeks in a soilless (?) substrate amended with 0 – 12% v/v of two recovered P fertilizer recipes—one containing Magic Dirt's patented manure-derived biochar product and the other without biochar. In a subsequent bioassay, tomato and marigold seedlings were grown for five weeks in a soilless(?) substrate amended with 0 – 12% v/v of two refined Magic Dirt proprietary formulations using drier P-cake (dried to 45% total solids). For both bioassays, seedlings were also grown in an organic market alternative as a positive control. Additionally, a plate competition assay was conducted to assess potential of recovered P fertilizers to suppress *Rhizoctonia solani*, one of the most prevalent soil-borne plant pathogens.

Recovered P fertilizers did not inhibit germination at any application rate tested in the preliminary bioassay using plant foods containing raw P-cake (18% total solids) collected from Blue Spruce Dairy. However, we observed surface crust formation in some cells, which likely caused the observed increased rate of post-germination mortality. Despite this factor, the preliminary bioassay clearly indicated a positive fertilization effect, suggesting that undried P-cake can be used in on-farm applications (e.g., spreading on fields in need of P further from barnyard). A drier product will be needed for off-farm transportation and marketing. The refined recovered P fertilizers using P-cake dried to 45% total solids did not inhibit germination at any application rate for either tomato or marigold. Mean dry biomass was six times greater than the unamended control (see figure), and not significantly different from the market alternative group at 6% v/v. Material



characterization work confirmed that the majority of P contained in recovered P fertilizers will become available to plants over time, much of it in a slow-release fashion.

The recovered P fertilizers and raw P-cake exhibited negligible potential to suppress *R. solani*. In parallel work separate from this VPIC project, we have determined that screw-press separated coarse primary solids do have substantial capacity to suppress *R. solani*, indicating a potential new marketing angle for that material.

In summary, the DAF-separated secondary fine solids ("P-cake") captured from post-screw press liquid dairy farm digestates can be upcycled into an agronomically valuable form, providing clear fertilization benefits without compromising germination in seedling production. This research will serve as the foundation for designing novel Vermont products containing P-cake from DAF systems tailored for use in the production of vegetables and flowers.

VPIC Stage 2 Conclusions

In conclusion, in Stage 2 of the VPIC effort, we were able to demonstrate that:

1. Use of Secondary Solids as Plant Foods and Specialty Fertilizers resulted in highly successful grow-testing of various plant species in controlled testing.
2. The formulated materials perform as expected; accelerating growth of the plant species tested without compromising germination.
3. Further Solids drying and processing must be cost-effectively achieved to successfully develop this exciting new product, and
4. A feasible on-farm drying technology appears to be quicklime (or other inorganic compound) addition and mechanical agitation.

Section 2 – VPIC Stage 3 Business Plan

Business Plan Overview

Introduction

To this point in the project, a customized "phosphorous recovery" dissolved air flotation (DAF) unit has been installed at Blue Spruce Farm in Bridport, VT. This DAF has and does generate significant masses of fine solids, separated from the post-primary pressate at the farm. These fine solids, upon drying and maceration, have been shown to be a high-quality plant fertilizer. Various mixtures of the secondary solids material (hereinafter "P-Cake") have been shown to enhance flower and vegetable growth in a series of controlled experiments at the University of Vermont. We have established that the separated P-Cake is a high-quality fertilizer but that its secondary 'processing' is still a technical challenge which must be overcome to bring this fertilizer to market.

As a result, much of the next stage of this effort will concentrate on creating a blend-able, friable material at the farm or at a central processing system potentially located in southwest Vermont. It is a difficult technical challenge to cost-effectively develop a drying and agitation/maceration installation at Blue Spruce Farm that can then be replicated at the numerous digesters throughout the state. Notwithstanding, we have developed a business plan which projects solution at the 'farm – level' and development of a solution to a statewide phosphorus issue. Necessarily, there are numerous unknowns and assumptions that are made in long-term business projections. These are detailed herein with general responsibilities of each participating party detailed as part of the plan.

Final solutions at the farm level and at the state level are simply unknown at this date although a great deal of work has been done to focus on certain key solution methodologies. Below is the VPIC Stage 3 business plan as requested by from Agency of Agriculture, Food and Market and an ongoing proposal for participation in the Stage 3 grant program by the project team.

The project team, currently consisting of professionals from DVO and Magic Dirt, with research support from UVM, are proposing to create a New Vermont – based company (NEWCO) to:

1. *With DVO as lead,*
    a. Facilitate the installation, operation and maintenance of secondary solid removal processes at various farms with (and potentially without) DVO digesters.
    b. Refine secondary solids handling and drying techniques to create the substrate for a salable plant food / fertilizer product. This technical challenge is detailed further below.

2. *With NEWCO as lead,*
    a. In a 'Bulk to Bag' strategy, facilitate an expanding secondary solids generation and collection network, resulting in a supply of secondary solids that should / could

exceed the ability of Magic Dirt to sell these products to various consumer outlets in the region. Additionally, a bulk product solution will result from this operation.

b. Develop markets and outlets for bulk, mixed solids addressing a non-dairy, cash crop marketplace found in Vermont and the region.

3. *With Magic Dirt as Lead,*
    a. Establish a Solids Processing Facility, Relocating / Creating Processing and Bagging Operations to manufacture as many as seven (7) discrete products at a site in Southwest VT.
    b. Relocate certain NY-based Magic Dirt product processing operations to SW VT.
    c. Produce a number of bagged, plant food products seasonally (fall and winter).
    d. Produce a bulk plant-food product in late winter spring and summer sold to NEWCO for re-sale to cash-crop farms as a recycled natural plant food/fertilizer.

Business Plan

Product and New Product Development

One of the more significant project engineering challenges is successful implementation of a cost-effective **drying process** (detailed in previous sections). The current technical application under consideration as the final solution in drying is employing Quicklime or other inorganic material dosing to the secondary solids and subsequent mixture agitation such that ample drying occurs. DVO laboratories in Chilton, WI, will perform preliminary testing. Several assays of secondary solids and chemical addition will take place in increasing dose mixtures.

Grow testing of the refined material will be performed at UVM for vegetables on a limited basis. It will not constitute the exhaustive testing of Stage 2 efforts for vegetables, but simply confirm that minor additions of Quicklime (or similar) with associated drying result in a repeat of the observed results of Stage 2.

Lastly, it is our intent to develop additional specialized products using the secondary solids proposed mixtures. We wish to develop, *at a minimum*, a second plant-food product in collaboration with UVM. This and other potential high-value mixtures could result in manufacturing an increasing array of products at the proposed Southwest Vermont facility.

Timelines for this and all others steps appear in attachments. Dryer testing and development will take place using solids generated at Blue Spruce Farms and occur in the 2020 calendar year.

Drier Trials and Development

As detailed in prior sections, there is need to refine and develop a cost-effective dryer system that will:

1. Further remove moisture from the P-cake secondary solids to an acceptable level (i.e. 35-50% solids) and,
2. Agitate or otherwise break up these solids to a point where they are both able to be broadcast and are 'blend-able' into a mixture of solids to make a final product.

Evaluations of solids drying have been ongoing through the course of Stage 2 effort and to the present. We will continue to develop a cost-effective solution to the solids drying and management aspects of the P-Cake product. The P-cake solids, upon discharge from the DAF is approximately 20 to 25% solids and upon delivery from the DAF conveyer belt, solidify in a short period of time (5 to 10 days) into a near hardpan, becoming more difficult to manage. A crust layer is found as the first sign of solidification and this must be broken down and the materials 'worked' to create a friable material which can be used for processing, blending and/or field application.

Numerous highly energy-intensive systems exist on the market. All are either not economical in an agricultural application, and or are not feasible (due to the lack of heat energy or fuel available). Therefore, we must find a means to dry these solids, at the farm locale, which does not overwhelm project finances at an individual project/solids generation site or compromise environmental sustainability. It must also be simple enough to be reliably operated and maintained on a daily basis by trained farm personnel.

To date, we have assessed:

1. Thermal/solar drying
2. Rotary drum drying (various systems)
3. Drying in a mobile dewatering unit,
4. Quicklime addition and solids agitation.

The last alternative appears to be an ideal one as its energy requirements are low, compared to other alternatives, and calcium represents at worst, a benign additive to the sludge to perform drying. If done properly, quicklime addition will both hydrate and generate heat, result in water evaporation and produce a product that has ample 'free' phosphorus and (after blending) is at appropriate pH values for an applied fertilizer.

While quicklime testing is ongoing, we will refine this testing under the future grant effort. Additionally, it is envisioned that grant monies will fund the lime dosing and other hardware purchase for the system proposed to be developed, designed and installed at Blue Spruce Farms. The Drier/Agitator will be specified on or about the time of grant receipt and will be purchased under VPIC monies. On-farm testing and refinement of lime addition and agitation will be undertaken as a principle part of the VPIC Stage 3 grant. Input from various external groups (see Supreme Industries below) will be highly valuable as there is expertise outside of the sludge – handling arena which may be very valuable in development of the final solution.

DAF Unit Sales and Installation

Commencing in the second half of 2020, DVO and Newco will make concerted efforts to place DAF units at DVO-digester farms. The first phase of this effort will develop secondary solids from DVO Two-Stage Mixed Plug flow digesters. The lack of biological activity in these soils make them prime candidates for product development. Later efforts may include assessing digestate from complete-mixed systems.

Each installation will result in a sizable 'new' mass of secondary solids generated daily. Newco will coordinate the solids collection effort, consisting of trucking from individual farms to a central processing facility after drying. It is highly possible that installation of DAF/drier system will generate more solids than the retail product demands.

The seasonal demand for bulk verses bagged product are markedly different. Bagged products processing must occur in fall and winter of a given year in order to reach a retail locale in the spring of the coming year. Bulk products processing must happen in the spring and summer in order to be applied to a working field that year. With appropriate planning, it is likely that an **uninterrupted** flow of secondary solids from facilities to the processing facility will be undertaken.

It is likely and desirable that the market for bagged product will grow. This is consistent with what should be a fast-growing demand from retail establishments currently working with Magic Dirt. Notwithstanding, the mass of materials being generated in a single DAF installation will produce enough material that it is also likely that **storage** of excess processed material, waiting for sale and delivery to a site, will be a necessity at the farm or processing site.

Preliminary conversations have begun with the Bennington Waste Water Treatment facility and town. There is ample land at the site and as well as solids processing hardware possibly useful in processing solids into a final mixture. The facility has room for hoop tents and these will likely be installed to store excess processed solids such that they can be conveyed to the marketplace at an appropriate time in seasonal sales.

Business Mechanics and Process Flow Diagram

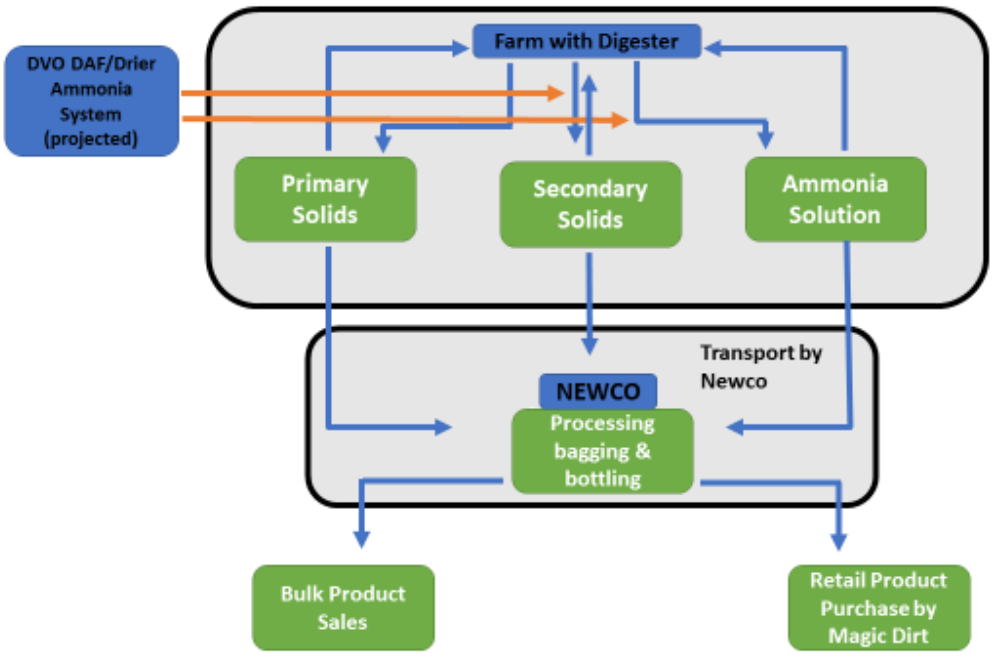
The following figure shows the detailed process flow of soils generated at farms/digesters site to the market. Each participating firm has its own set of responsibilities towards project success. These are as follows:

1. DVO will take prime responsibility for the sales, installation, training and ongoing support and maintenance (when needed) of the DAF + dryer systems. This will generate vast quantities of solids that will require processing at a separate facility.
2. Newco will be responsible for transporting these solids from the generating farm to a processing facility to be located in Southwest Vermont. There, Newco will maintain and operate a solid fertilizer processing facility which will generate a bulk product (to be sold by a Newco in the region) and acquire product packaging equipment for sales and regional

distribution. The business goal of the operation is to expand the facility production over time when market forces pull more materials into more stores.

3. Magic Dirt will purchase bagged and bottled products for distribution. Additionally, they will facilitate and manage the build-out in Southwest Vermont given their previous project experience in similar matters.

VT NEW PRODUCT DEVELOPMENT PROCESS FLOW



Marketing Plan

From 2017 to 2026, Reuter's (www.reuters.com/brandfeatures/venture-capital/article?id=29370) predicts the organic fertilizer market size to increase at a compound annual growth rate (CAGR) of nearly 13%. The market is projected to expand to nearly 20 billion by 2026. The Magic Dirt products, when entering this market, could gain notable market share in a booming section of an agriculture retail market. While some competitors already offer eco-friendly alternatives to traditional fertilizer, we believe our product will be perhaps the most environmentally friendly option in the market today. Our belief is based upon the 100% recycled nutrient content in the containment of a vast array of important micro-nutrients found in the recycled product. We also see a great opportunity in market and brand image development.

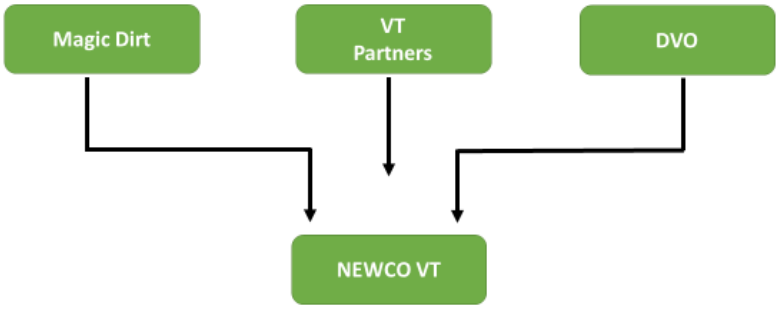
A Vermont – based wholesale brand will also strengthen the success potential of the fertilizer product. As eco-friendly fertilizer alternatives are relatively new to the market place, the market is inherently not over-saturated.

While there are various companies in the marketplace today that offer organic fertilizer, we believe that few or none tells a compelling story. This is where our product has the opportunity to differentiate itself and earn customer dollars and loyalty. While other companies claim that their product is organic and benefiting the environment, they fail to craft a complete story that communicates a commitment to sustainable farming. Our product will tell this story and further explain its important benefit to regional dairy sustainability. We hope that our marketing communications will make the difference between commodity and trailblazing.

The bulk product marketing and sales effort will be aimed at groups ranging from eco-sensitive farmers to towns and municipalities who would preferentially buy a sustainable fertilizer product at comparable market prices to conventional products. While our fertilizer could be a great value add to anyone looking to grow plants, farmers and other large users stand to gain the most from our product. More developed marketing plans and budgets will be developed in the near-term after project initiation and will ramp up as product development is completed and product is 'on the street' for sale.

Company Organization

Newco will be composed of a minimum of three partners. These are DVO, Inc of Chilton Wisconsin, Magic Dirt of Little Rock Arkansas, and a Vermont-based group of New England partners / individuals. The following figure shows certain roles and responsibility of these proposed partners. This is a very strong project team. DVO is the largest producer of agricultural anaerobic digester systems in the United States. Magic Dirt has successfully taken a sustainable and organic series of products to the marketplace. The Vermont partners will be sought from numerous applicants that have approached us to date and others. The project requires a true entrepreneur -- this person will need to have the ability to relate to a wide array of professionals ranging from farm owners to regulatory agencies to finance/investor groups.



Proposal

The combined project team of DVO and Magic Dirt, comprising the proposed 2/3 of Newco, are pursuing a grant of at least $500,000 from the Vermont Agency of Agriculture, Food and

Market. In exchange for this grant, we envision the following very positive economic outcomes in the state of Vermont:

1. Establishment of a 10,000 to 20,000 sf soils processing facility in Southwestern Vermont.
2. Addition of 10 (+) new jobs transporting, processing solids and developing manufactured organic soils for resale to the marketplace.
3. Annual capture and beneficial reuse of as much as 1 million pounds of manure-based phosphorus,
4. Possible external investment of $500K (+) at participating farms, and/or grant development to fund DAF / dryerr installations,
5. A new, significant top-line profitable revenue brought to participating VT farms resulting from expanding DAF / drier deployment, and
6. Development of new higher-value bulk product(s) in collaboration with UVM .

The Potential Project Match - Financial Commitments

The requirement for matching farms will be more than amply met. The following is envisioned as a source of matching farms to the proposed VPIC plant. These are:

1. NEWCO – bagging operation relocation and facility development – Bennington Vermont	$400,000
2. On-Farm Building / Infrastructure Upgrade	$50,000-75,000
3. Magic Dirt - Ancillary Investment – Startup	$100,000
4. EQUIP Grant Funding – NRCS	$450,000
5. Vermont Agency of Economic Development Grant Funding	$50-100,000
6. In-Kind Services (DVO and Magic Dirt)	$50-100,000
Total	**$1,100,000 – 1,225,000**

We will utilize every grant opportunity that is available to us and will work with the Vermont Agency of Agriculture, Economic Development and other agencies to minimize the capital, to the extent feasible, to achieve this very important **water quality goal**.

All commitments detailed above are 'soft' and based upon further discussions and negotiations between the state of Vermont, Agency of Agriculture and the entities listed above. Additional investment by various groups will necessarily rely on concurrent commitments from Vermont. This will be a negotiated process requiring several meetings and will ultimately result in a tremendous success for the state of Vermont and the project team. We are able and willing to undertake the preliminary conversations related to these proposed expenditures in the very

near-term following submittal and review of this report by the Vermont Agency of Agriculture Food and Markets.

Timeline

The project timing is driven by the need to bring bagged product to market in January 2021. This is the latest timeframe that will allow on-shelf sales in the spring retail season. Resulting from this deadline, we have developed the following projects tasking and schedule.

1) **P-Cake drying and processing analysis** – We envision a 1-2 month time-frame (Jan – February, 2020) to refine our drying / processing efforts. As detailed, our current technical choice is Quicklime addition and mechanical agitation. This process will be refined at a bench-scale and will subsequently jump to a full-scale install at Blue Spruce Farm.
2) **Equipment Purchase, Install and Commissioning –** In the beginning portion of 2020, Installations at Blue Spruce Farm and (later) the proposed SW VT site will take place. Solids processing of P-Cake at Blue Spruce Farm will include purchase of required equipment, a necessary upgrade of the system controls at the farm and on-farm building modifications. We will also develop facility design for ultimate purchase & installation of bagging and other equipment for a leased facility at the SW VT site.
3) **Field-testing and New Product Development** – With the product coming from the Blue Spruce installation, field testing of a developed **bulk** solid will **possibly** take place at UVM In the mid/late spring. Additionally, new Magic Dirt product 'recipes' will be developed and tested at UVM for incorporation into retail products to be blended and bagged at the proposed SW VT facility. This will necessarily take place in the spring / early summer of 2020. The stated goal is an aggressive development of the retail product(s) at the onset of 2021. Additionally, bulk product development for P-Cake not used in retail product will be ready for spring 2021 sale. The timing of this proposal is important to meet 2021 retail goals and will be discussed at length with VT officials over the course of proposal review.

Strategic Partner Acquisition

Quantum Biopower (Southington, CT) and its partner company Supreme Forest Products (https://www.supremeforestproducts.com/), is aggressively advancing wholesale and retail soil sales of an expanding array of soils. This expansion could include the vast quantity of soils generated under the DAF / drier systems program proposed at various Vermont dairies. Supreme Industries is perhaps the largest organic products recycler in the northeast, with a throughput of approximately 400,000 tons of material a year. Their product mix ranges from wood chips to mulch and other products.

Strategic planning at the firm has resulted in a path towards higher value-added bulk soil sales. The proposed time duration of DAF rollout and new soils generation may merge quite elegantly with Supremes' advancement into this market. The firm, with 350 New England employees,

operates up and down the eastern seaboard and has the mechanical and logistical capability to handle the mass of soils to be created in VT systems.

Ongoing conversations with Mr. Brian Paganini, the managing member of Quantum Biopower and in charge of strategic development at Supreme Forest Products, has resulted in his commitment to this project as shown in the attached letter of interest in report appendixes. Supreme also has 'brute force' capabilities in solids handling and brings an approach to blending and solids mixing which is outside of the realm of biosolids processing which the project team is highly expert in. We will utilize their resources and ingenuity in drying technology development as well.

Fertilizer Companies – Through the course of this effort, we have reached various fertilizer sales teams who service the dairy industry. These groups have shown keen interest in working with the project team when the product comes to market. One group in particular, The Farmer's Cow™ (http://www.thefarmerscow.com/) has just 'gone national' with their branding. While not a fertilizer company, their brand is important. They are willing to make introductions to a number of regional fertilizer companies and more.

Pursuit of a strategic fertilizer company partner with regional distribution of bulk product has been ongoing. Success could result in a seamless delivery of final bulk Vermont product to a large regional market, supplanting fossil fuel based fertilizer products at the regional level.

Native Energy – Native Energy of Burlington, VT leverages proposed carbon / greenhouse gas savings for sale to interested parties. These buyers purchase these credits on the open market and thereby subsidize projects. We will bring this opportunity for massive carbon savings to the group in the hope that they can re-sale these credits on the open market. This possible strategic partnership would take advantage of carbon savings achieved through the elimination of fossil fuel-based fertilizer development. Native Energy has had tremendous success in the region delivering these credits. They could comprise a key strategic partner in subsidizing short-term development of the product.

Other – Other concepts discussed have included 'Phosphorus credits'; with application similar to Renewable Energy Credits used to develop Alternate Energy Projects. These could conceivably be developed at the Vermont level and subsidization of our product could be undertaken at some nominal per-pound fee. UVM collaborator Eric Roy has recently co-authored a Gund Institute white paper focused on a proposed voluntary "payments for ecosystem services" program for Vermont farms. The proposed program would include payments for improvements in whole-farm phosphorus mass balance, which our system can achieve.

In conclusion, we will pursue other concepts, but the long-term success of this project will result from market development and sales of a high-value recycled nutrient product. Collaborating with larger groups could accelerate success, as could new nutrient management efforts/policy in the state (e.g., a payment for ecosystem services program).

Long-Term Economic Impact

As detailed, the near-term focus of this project is in development of an on-farm solution to create a blend-able P-Cake material that can be processed at an off-site facility. Much of the focus of upcoming efforts relates to development of this on-farm solution. A break-even calculation, showing potential project profitability is shown below. Numerous, well thought out and valid assumptions have been made in developing this calculation. Basic assumptions which have been made to develop this analysis include the following:

1. Approximately 15,000 dry tons per year of secondary solids can be created from DVO digesters in the state of Vermont. Where certain farms do not participate, other farms with other digesters could fill this void and actually surpass the proposed tonnage seen herein.
2. A farm payment of $25 per wet ton was used as payment for farmers for the development of a processed wet, friable P-Cake solid. Projected operating cost at the farm is less than $10 a ton and therefore new topline profitability for participating farms is projected.
3. The sale of this bulk material is projected at approximately $65 a ton. This is a very representative value for fossil-fuel-based materials. Given the numerous intangibles associated with the micronutrient and carbon-based fertilizer, it is possible that this sales price and margin could be surpassed.
4. If the Bennington facility is developed, the ability to develop higher value-blends will increase this sales value with a commensurate increase in product cost per unit. These are projected as net zero increments.
5. The processing cost per wet ton is projected at $10 per ton is likely to be lower as much/all of the processing has been done at the on-farm level and only dry storage and removal will take place at the facility.

Given these assumptions, a break-even quantity of approximately 35,000 tons has been developed. This is less than the total amount of tons that can be produced and projects rather conservative values in development and detail of the assumptions above. This projection has enough uncertainty that further development of more ‘granular’ data has not been performed as part of this effort. A final product Pro-forma is a necessary development but cannot be done until much of the work related to the Stage 3 proposal has been completed.

P-CAKE NEW PRODUCT DEVELOPMENT
BREAK EVEN CALCULATION

A. Annual Fixed Costs	$	300,000	Salaries - 5 @ $60K all in
(Expenses that do not vary with level	$	240,000	Rent and Utilities - $20 K per month
of production or sales)	$	12,000	Office Supplies and Other Misc Expenses
	$	400,000	Trucking
	$	1,000,000	Purchase from Farmer
Total fixed costs	$	1,952,000	
B. Product selling price per unit	$	65.00	Amount you are paid for each product or hour of service
C. Product cost per unit **	$	10.00	Materials, supplies, and variable factory labor cost to make one ton of product.
D. Gross profit margin per unit	$	55.00	Gross margin on sale of one product
Break-Even Point			
E. In number of units		35,491	A ÷ D. This is the number of units you will need to sell per year to break even.
F. In dollar sales	$	2,306,909	B x E

Total Production Possible	55	TPD
	20075	TPY
Assume 50% Moisture	40150	TPY

Trucking	40150	TPY
	30	Tons per Load
	1338	Loads Per Year
	$300	Per Load
	$401,500	Per Year

Farm Payment	40150	TPY
	$10	Per Wet Ton
	$401,500	Per Year

Conclusion

We are optimistic that this represents a viable and profitable project. While it does not solve the entire state's massive phosphorus problem*, it represents control of as much as 1.5 million lbs of phosphorus annually.* This plan also develops a new top-line profitable revenue line item for the participating farm(s), and creates 10 to 15 new jobs in the state of Vermont in development of this very important VT – based natural fertilizer product.

QUANTUM
BIOPOWER
49 DePaolo Drive · Southington, CT · 06489

Dr. Michael Curtis. P.E.
CDT Tech, Inc
75 Hennequin Road
Columbia, CT 06237

September 17, 2019

Dear Dr. Curtis;

I am writing this letter to express our high level of interest in the Vermont Phosphorus Innovation Challenge (VPIC) program that you continue to pursue with DVO, Inc. and Magic Dirt. As you have related to us, there exists a large 'value-added' soils opportunity associated with this project. We have keen interest in collaborating with the project team to process and develop the market for these soils. We are interested in this and other possible solutions related to phosphorus-rich soils which you are proposing to generate from a number of Vermont dairy manure digesters.

We would hope to more fully understand the possible size of this offering and begin to understand the rate at which the level of soil production will increase with digester upgrades over the coming years. As you are aware, we have the capability to enter this market and this possible entre' is very consistent with our strategic planning. We truly look forward to discussing this with you in the near future.

Sincerely,

Brian Paganini
Managing Member – Quantum Biopower
Supreme Industries

September 20, 2019

Michael Curtis, Ph.D., P.E.
CDT Tech, Inc.
75 Hennequin Road
Columbia, CT 06237

Dear Dr. Curtis,

We are writing this letter of support in your pursuit of grant funding for the Vermont Phosphorus Innovation Challenge (VPIC) program. We understand that you have had very successful completion of your most recent efforts and we have had preliminary discussions relative to the potential greenhouse gas savings related to the successful product development in the next stage of the assessment.

Per our understanding, you are developing a natural fertilizer, consisting of recycled nitrogen phosphorus, and potassium which contains appreciable plant-based carbon in its makeup. If successfully developed, this would represent a superior substitute to fossil fuel-based fertilizers on the market today. We wholeheartedly support this effort. With this letter, we hope to undertake preliminary and ongoing discussions related to NativeEnergy's possible participation in certain aspects of this project.

Any participation, if achieved, is to be determined later but we are hopeful that you are successful in your coming efforts and wish to show our support of this project.

Sincerely,

Brian KillKelley

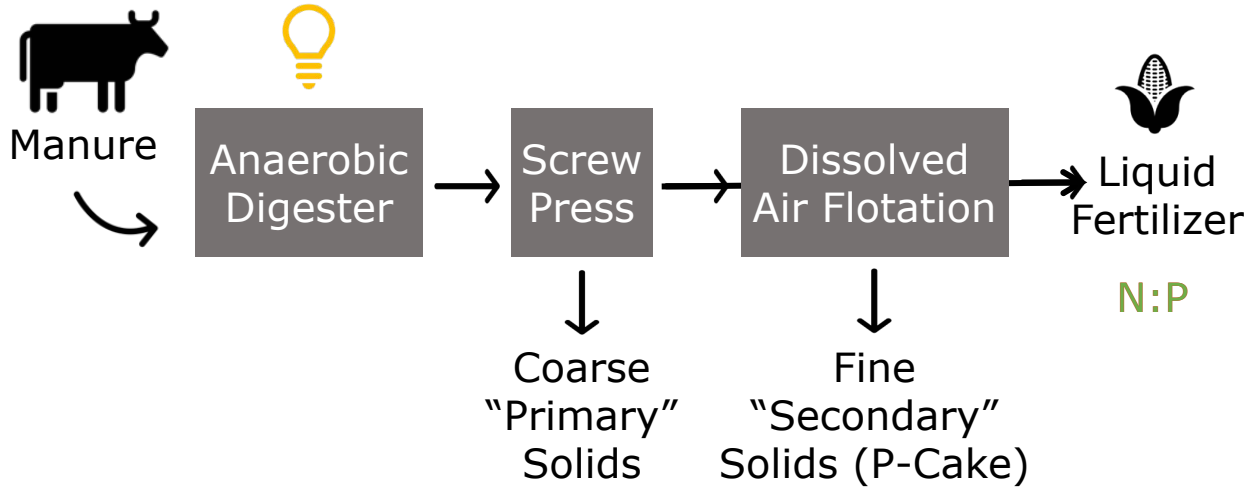
Brian KillKelley
Director of Project Development, NativeEnergy

Recovery and Reuse of Phosphorus from Digested Dairy Manure

Kate Porterfield[1], Deb Neher[2], Mike Curtis[3], Steve Dvorak[3], Bob Joblin[4], and Eric Roy[1]*

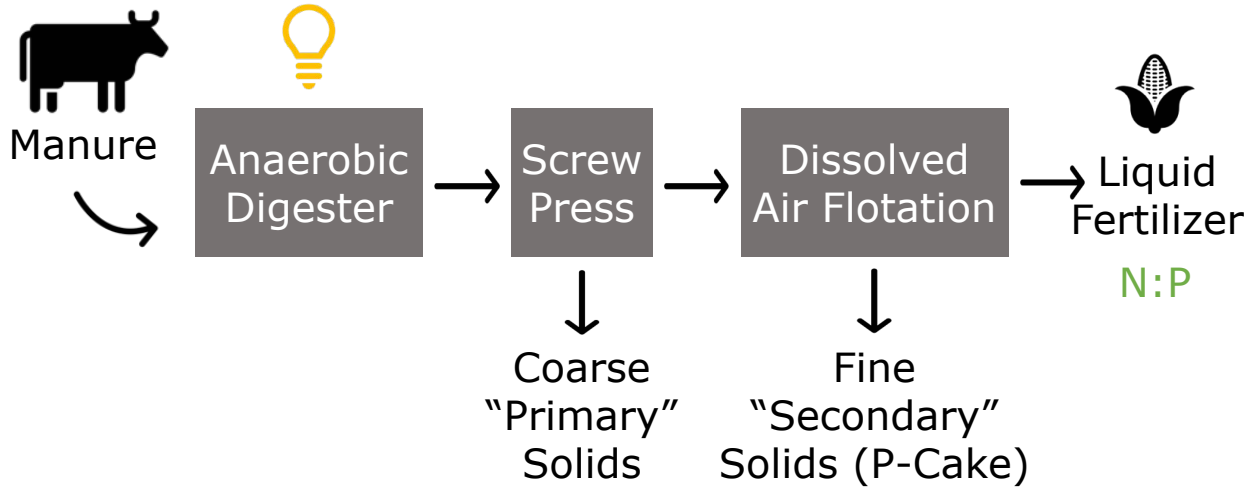
[1]Nutrient Cycling and Ecological Design Lab, Rubenstein School of Environment and Natural Resources, University of Vermont, [2]Department of Plant & Soil Science, University of Vermont, [3]DVO, Inc., [4]Cenergy USA, Inc.
*Corresponding author: Dr. Eric Roy, eroy4@uvm.edu

On-farm Anaerobic Digestion

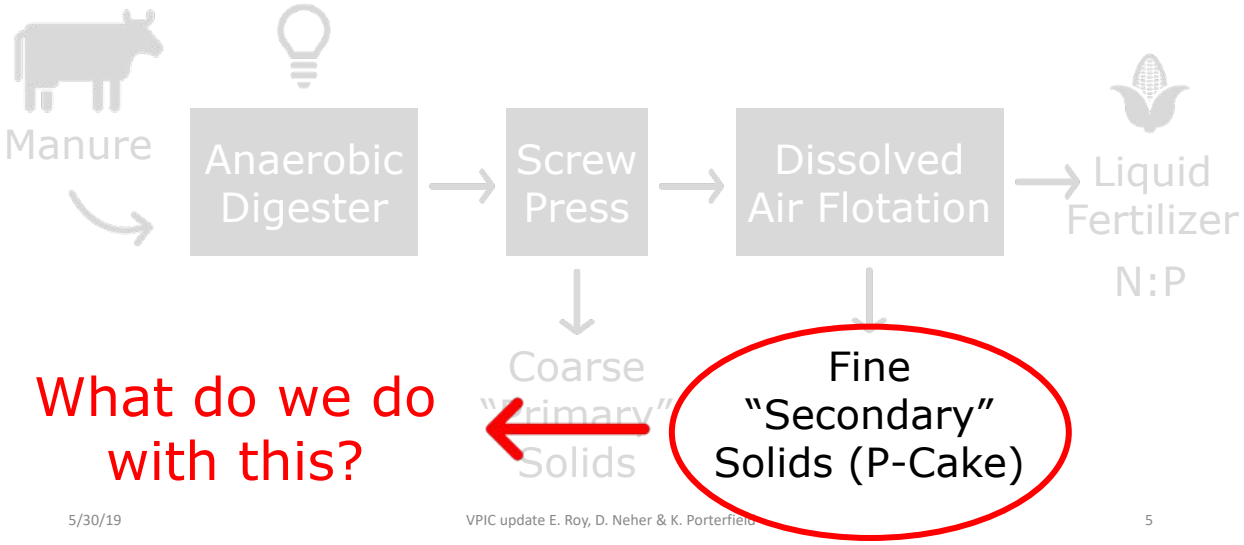


What do we do with all this P-cake?

On-farm Anaerobic Digestion



On-farm Anaerobic Digestion



What do we do with this?

Objectives

Develop a recovered phosphorus ("P-cake") plant food product with verifiable market value

- P-Cake Grow Trials

The University of Vermont

cenergy
Clean energy solutions

DVO | ANAEROBIC DIGESTERS

QUANTUM BIOPOWER

Guiding Questions

Does P-cake inhibit germination?

Germination %

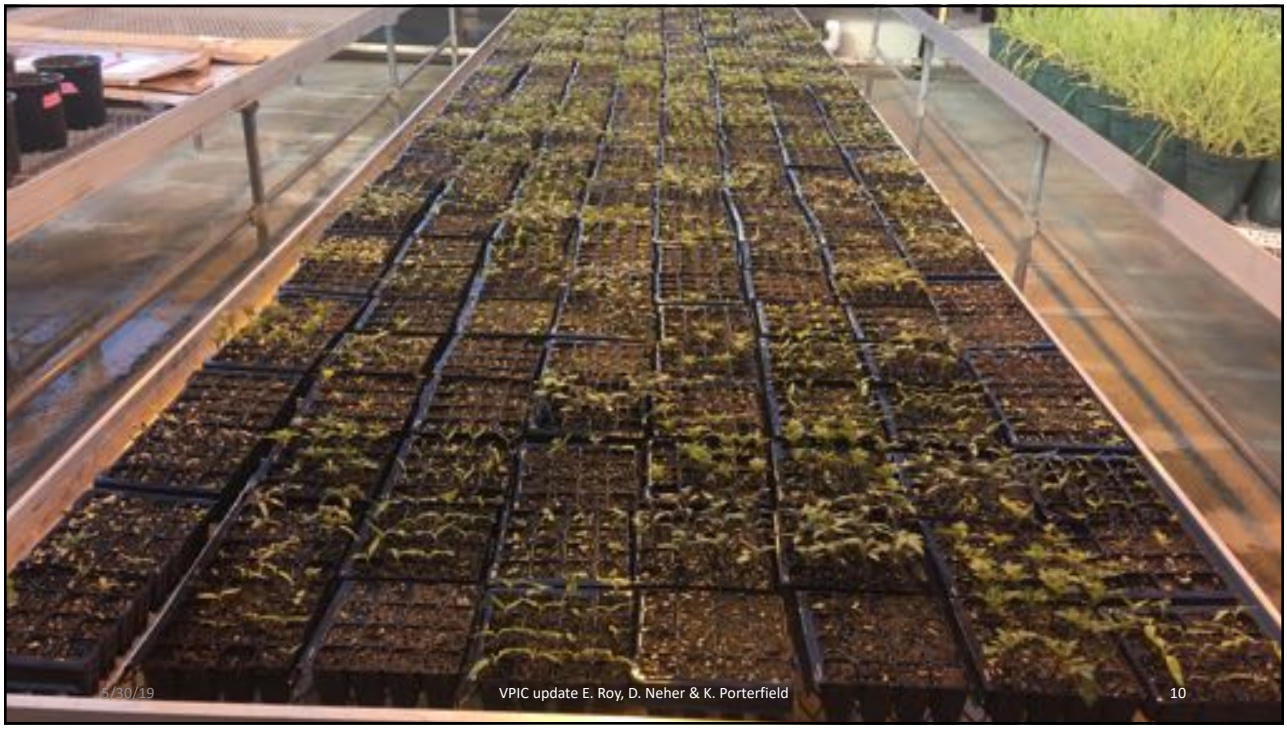
Does it provide a fertilization effect?

Biomass

What plant food recipes work best for flowers and vegetables?

Methods

- 0 – 12 % v/v
- Tomato, Pepper, Marigold, Petunia
- Biomass, Germination



Results

Does P-cake inhibit germination?

Vegetables: No

Flowers: No

Does P-cake provide a fertilization effect?

Vegetables: Yes

Flowers: Yes

Results

Does P-cake inhibit germination?

Vegetables: No

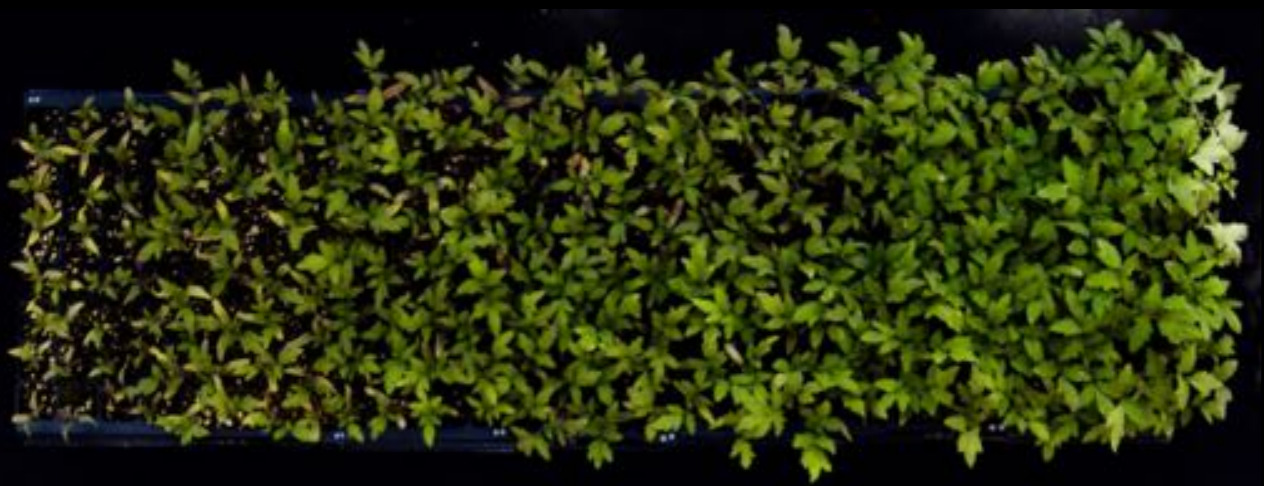
Flowers: No

Does P-cake provide a fertilization effect?

Vegetables: Yes

Flowers: Yes

No Germination Inhibition



Tomato, 0-12% v/v Plant Food + Biochar

Results

Does P-cake inhibit germination?

Vegetables: No

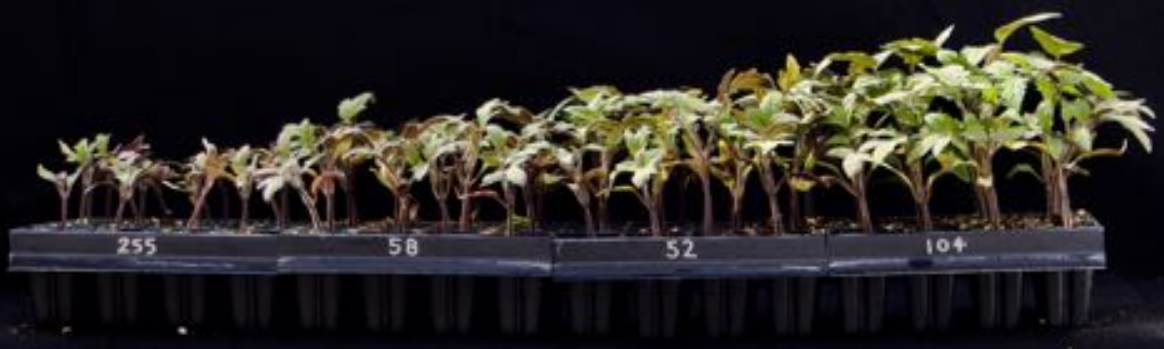
Flowers: No

Does P-cake provide a fertilization effect?

Vegetables: Yes

Flowers: Yes

P-cake Increased Plant Biomass



Tomato, 0-12% v/v Plant Food + Biochar

Tomato

0-12% v/v Plant Food

Pepper

0-12% v/v Plant Food

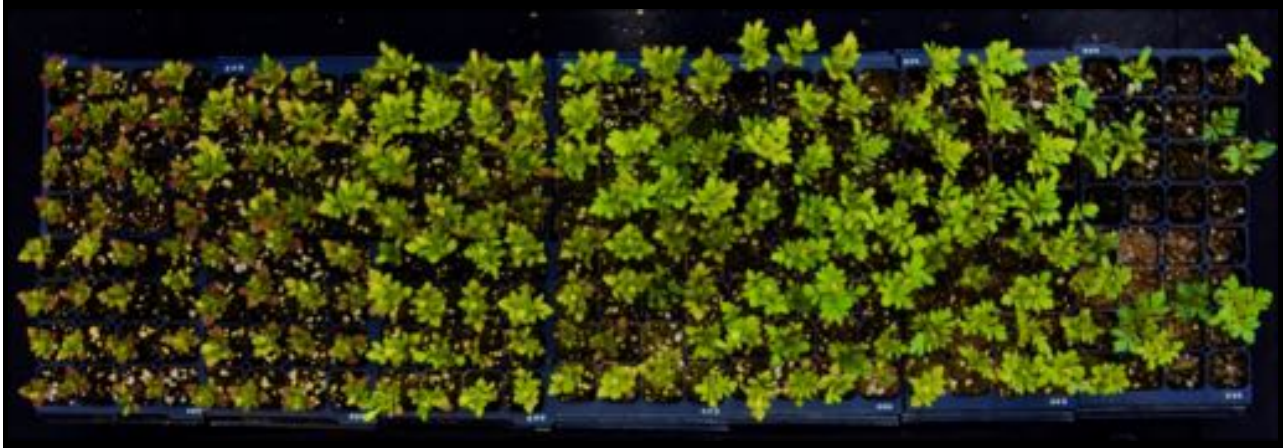
Pepper

0-12% v/v Plant Food + Biochar

Marigold

0-12% v/v Plant Food

Marigold



0-12% v/v Plant Food + Biochar

Guiding Questions

Does P-cake inhibit germination?

Germination %

Does it provide a fertilization effect?

Biomass

What plant food recipes work best for flowers and vegetables? Product Development

Methods

- 0 – 12 % v/v
- Tomato, Marigold
- Biomass, Germination

No Germination Inhibition

0-12% v/v Dried P-cake Plant Food + Biochar

Tomato

0-12% v/v Plant Food + Biochar

Marigold

0-8% v/v Plant Food

Guiding Questions

Does P-cake inhibit germination?

Germination %

Does it provide a fertilization effect?

Biomass

What plant food recipes work best for flowers and vegetables? Product Development

Marigold

0% v/v | 6% v/v Plant Food | 6% v/v Plant Food A | 6% v/v Plant Food B | Market Alternative

Disease Suppression Potential

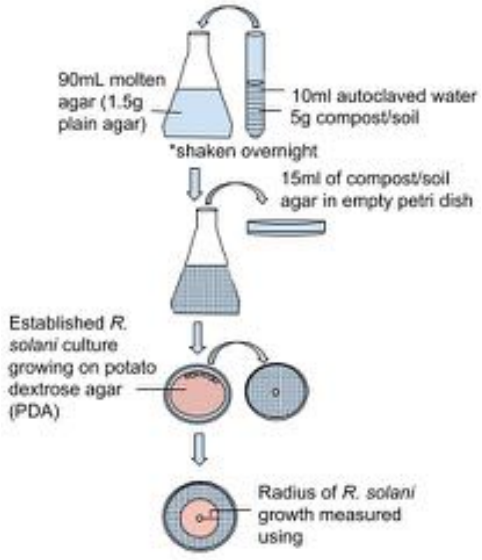
Lead Researcher: Dr. Deborah Neher

Does PR-cake and derived plant foods suppress ***Rhizoctonia solani*** ?

Rhizoctonia solani is a plant pathogenic fungus with a wide host range and worldwide distribution. Disease suppression can add value to a plant food.

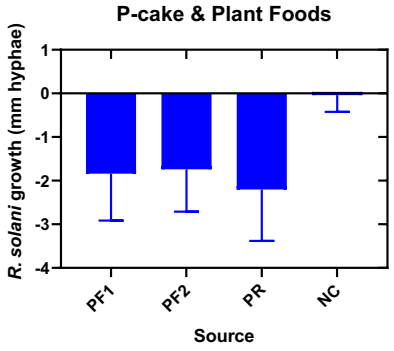
Bottom rot on lettuce

Methods

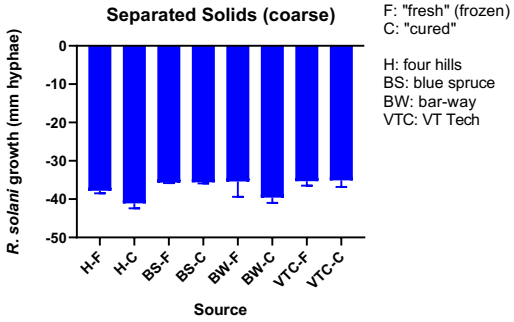


Neher et al. 2017, 2018

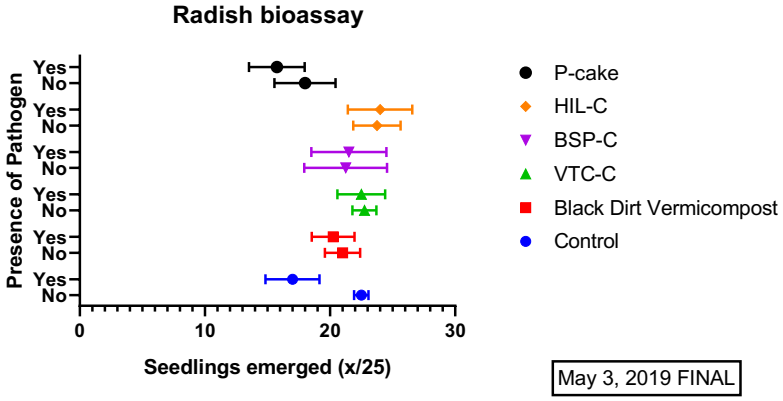
PR-cake (secondary fine solids) and derived plant foods showed only negligible suppression of *Rhizoctonia*



However, digester primary course solids (from screw press) showed far more substantial suppression



Radish Bioassays in greenhouse confirmed the results of lab testing



May 3, 2019 FINAL

Acknowledgements

Project Team

Steve Dvorak (DVO)

Robert Joblin (Cenergy)

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Deborah Neher (UVM)

Thomas Weicht (UVM)

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The University of Vermont

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Quantum Biopower

Cenergy