

## Executive Summary

1. Project Title: TRAPI - Truffle Research and Production Initiative
2. Project Type: Planning
3. Requesting consideration for Center of Excellence? (~~Yes~~ or No)
4. Legislatively Mandated Focus Areas

Focus area	Percentage addressed in this proposal
Plant Breeding and Genetics	25%
Pest Management	0%
Plant Production and Production Efficiency	50%
Technology	25%
Food Safety	0%

### 5. Program Staff

Role	Name	Title	Institution	City, State	Email
Project Director	Mark Coleman	Professor	University of Idaho	Moscow, ID	mcoleman@uidaho.edu

### 6. Critical stakeholder needs and long-term goals

Truffle industry stakeholders primarily need to improve yields and to understand the position and potential of the North American (NA) truffle market. Improved yields will not only increase profitability of growers but will also involve a whole system of truffière service providers, consumers, marketing and distribution, and expand the economic impact well beyond the market value of fresh truffles. While we understand the importance of these other primary sectors of the truffle industry, here we focus on four areas of critical need: 1) agronomic practices, 2) genetic monitoring tools, 3) economic decisions support information, and 4) quality assurance standards.

Agronomic practices are largely influenced by the truffière location. Growers need realistic soil and climate requirements for locating optimal sites and to evaluate the best truffle species for prospective truffières. Some truffle species have narrow site specification, while others have more robust requirements. Translation of these requirements into optimal ranges would support grower decisions on which species to manage for their location.

Irrigation and soil amendments will expand viable areas for trufficulture. Irrigation will be necessary to produce truffles in many NA locations. Various irrigation scheduling approaches need to be evaluated based on reliability and effectiveness. Optimal soil moisture to maximize truffle yields should be developed for each truffle species. Research is also needed on effective amendments to create alkaline soil reactions and increase calcium. Alternatives to agricultural lime (e.g., calcareous shells, biochar, etc.) should be evaluated for effects on long-term stability of soil reaction, fungal mycelium and ascocarp formation.

Agronomic information is needed on maintaining the tree structure through pruning. Pruning is known to help maintain truffière production. Practical French truffière management prescriptions describe the need to suppress the trees. Management of natural truffle forests suggest that thinning restores ascocarp formation. Studies are needed to determine the effects of pruning intensity and timing on fungal hyphae, host roots, and ascocarp formation.

Spore inoculation is an agronomic practice unique to trufficulture. Spore inoculations can enhance truffle production by assuring paternal mating types are present to fertilize maternal mating types on mycorrhizal root tips and initiate ascocarp formation. This practice has

demonstrated potential to improve yields, but rigorous controlled trials are needed to understand how, where and when to apply spores for greatest effect.

Growers need genetic tools to monitor mycorrhizal colonization and symbiont responses to management interventions. Traditional approaches for tracking progression of the ectomycorrhizal (ECM) symbiosis involves sampling roots and counting ECM root tips. However, these approaches are costly and imprecise. Modern DNA tools have revolutionized mycology and are now routinely available for monitoring truffle abundance in soil. Growers have strong interest in the use and development of such approaches. These methods need to be further developed to create affordable commercially available analytical services with consistent standards for interpreting results.

Economic information to support business decisions is needed by investors and growers. The NA truffle industry needs practical, empirical, fact-based, information on trufficulture that is up-to-date, available, and easily understood by growers and investors. Fundamental economic information is needed to support investment decisions including domestic and international commodity supply, prices, growth potential, and risks. Much of the truffle economic information is available for Europe and there have been global overviews, but similar analysis still needs to be adapted for NA market analysis.

Quality assurance standards must be established for seedlings and spore amendments to minimize risk. Seedling quality standards assure growers that planting stock has optimum opportunity for success through abundant mycorrhization with target species and no unwanted, low-value truffles. Post-planting spore amendments must also consist purely of the target truffle without any contaminants. Thus, standardized assessment approaches must be developed to not only protect individual growers, but also the regional industry.

The primary goals of the TRAPI project are to enhance production of truffles in NA and develop domestic and international markets for fresh NA truffles and truffle products. An ambitious, yet realistic long-term goal is to double yields of *T. melanosporum* in NA every year for 10 years. This exponential increase is consistent with projections for other non-European nations that have supported the development of *T. melanosporum* truffières and largely represents expansion of acreage. Reaching such a goal would bring NA production on par with other non-European nations. The increase in truffle production will proportionally increase demand for support services such as truffle seedlings, agronomic supplies, truffle hunting dogs, food services, etc. This industry expansion will result in not just substantial economic impact but also social enrichment by increasing appreciation and availability of truffles. The TRAPI project intends to review current knowledge of global and regional truffle markets and apply that knowledge to information needs for analysis of NA market growth within an international context.

#### 7. Outreach plan summary

During the TRAPI planning project we will engage our main stakeholder group – truffle growers – in the development of an SCRI proposal and improve the knowledge base to support their demand for information on how to establish and manage truffières to maximize yields. We will gauge growers research priorities by conducting a member survey of North American Truffle Growers Association (NATGA). Our objective for the fall 2022-member survey is to receive 75 responses, which would almost double the number of respondents from fall 2021. TRAPI research and extension scientists will review current knowledge on priority research topics and present online seminars to NATGA members. Our objective for TRAPI online seminar series is to generate over 400 contact hours. This target is based on past NATGA

webinars that typically receive over 40 participants and we expect to make eight one-hour presentations for the series. These seminars and a review manuscript on the current knowledge of trufficulture as it applies to NA will also provide information for preparing extension programs and bulletins. Preparation of those material will be included as objectives in the SCRI proposal planned for submission in 2024.

#### 8. Potential benefits

The TRAPI project is intended to have both long term and immediate benefits on the NA truffle industry. A doubling of annual production for 10 years would also benefit the other main sectors of the truffle industry; namely, the processing and distribution system, and consumer and marketing system. Currently, NA growers are distributing their own products through personal connections or online. More available truffles would motivate establishment of distribution centers concentrating truffles from many truffières. Greater truffle availability will also allow promotion and marketing efforts and encourage restaurants and consumers to explore culinary possibilities. To achieve these long-term, system-wide goals, the immediate focus of TRAPI is on truffle production and market analysis of the NA truffle industry.

One immediate benefit of the TRAPI planning project will be to strengthen ties between truffle growers, researchers and extension specialists. These ties are needed because now growers are individually seeking pragmatic information on how to establish truffières and increase truffle yields by reading sparse European management guidelines, interpreting scientific literature, and contacting the few known individual research and extension scientists. Research scientist cannot always assist growers due to proximity and availability. Few extension specialists are familiar with trufficulture information. Therefore, an immediate benefit of the TRAPI planning project is the building of a network of scientists who will collaborate on synthesizing available information and sharing comprehensive and practical insights with growers. Developing a collaborative research network will ultimately create more rapid scientific advances that are relevant to NA truffle production. We are especially focused on collaborating with extension scientists to advance communication between scientists and practitioners. Inclusion of extension scientists in information synthesis will facilitate technology transfer during the planning process and assure integration of outreach in the resulting SCRI proposal. We will involve and develop research and extension scientists with essential levels of expertise that are geographically distributed across North America. Our intention is to forge lasting ties among research and extension scientists to contribute to long-term profitability and sustainability of the truffle industry. Once established, the TRAPI network is expected to expand collaboration by encouraging other colleagues and training students.

Another immediate benefit of the TRAPI planning project are products spawned from literature research on priority topics. TRAPI scientists will research, synthesize and present current knowledge about priority truffle production topics to growers and focus on practical applications. Scientists will also collaborate to prepare a manuscript reviewing current knowledge on priority research topics. The review manuscript will be shared with and evaluated by growers.

The final benefit of the TRAPI planning project will be the development of an SCRI proposal to request support for top priority research. TRAPI scientists will develop the proposal in collaboration NATGA. Research questions will address approaches to increase yields while outreach objectives will develop programs and extension bulletins describing trufficulture best practices.