



SUSTAINABILITY REPORT





SUSTAINABILITY IN ACTION:



**CAN A SOIL FUMIGANT BE
USED AS A BIOSTIMULANT
IN AGRICULTURE?**



**LIPHATECH AND CARDINAL
PROFESSIONAL PRODUCTS**



**KEEP IT GOINS FOUNDATION
AND CARDINAL
PROFESSIONAL PRODUCTS**



OVERVIEW

- » **04** Letter from the CEO, Welcome Message
- » **05** Mission, Vision, Values
- » **07** Business Overview
- » **11** Sustainability Strategy
- » **16** Pillar 1: Providing Growers a Path Towards Functional Sustainability
- » **25** Pillar 2: Moving Toward Resource Efficient Operations within the TriCal Group
- » **31** Pillar 3: Helping to Build Sustainable Ag for the Future
- » **36** Closing Statement
- » **37** Appendix



WELCOME MESSAGE

TriCal was founded in 1961 to help growers be more productive. The co-founders Richard Storkan, Jerry Hanes and Robert McCaslin had complementary backgrounds in entomology, plant pathology and chemical engineering. They combined these branches of science to develop new methods for soil health and land preservation. The goal was to help farmers save land from crop destroying pests and pathogens. They offered solutions for farmers to maximize harvest while employing good stewardship, safety and compliance with environmental guidelines.

Sustainability has been a part of our practices from the start. We are one of the leaders in our industry in stewardship and research. We are committed to providing practical solutions to growers to enable them to continue to feed an expanding global population. While TriCal is now multiple companies within the TriCal Group they are all dedicated to promoting a beneficial soil environment for farmers around the world. The result is they provide more bountiful and healthy food.

TriCal is a third generation family business. We provide growers with functional solutions that they need to be sustainable in their operations. To us, that means growing more food on less land with less topical pesticides, fertilizer, water or other inputs. Growers can continue this year after year and leave something better for future generations.

Sincerely,

Dean Storkan
TriCal Group, President and CEO



CORE VALUES

HEALTHY FIELDS. HEALTHY YIELDS.

The Vision of the TriCal Group is to promote the most beneficial soil environment for growers to produce healthy, bountiful crops that feed the world.

WE ALWAYS START WITH SAFETY

From the beginning, we've teamed entomology and plant pathology with chemical science to find safe, effective solutions. Today, we work closely with EPA, USDA, State Departments of Pesticide Regulations, individual county ag commissioners, farmers and customers to make sure we preserve land, health, and the environment.

INNOVATION AND R&D SET US APART

We register, defend, manufacture, package, distribute, apply custom fumigant blends, specialized treatment applications, and other cutting-edge growing solutions, such as precision irrigation, fertigation, and plant-grafting.

TRUST KEEPS US IN BUSINESS

Close, personal relationships are the backbone of our company and how we do business; as a private, family-owned company, we are in it for the long-haul—success for our growers and customers means success for us.



BUSINESS OVERVIEW

The TriCal Group is a privately-held family of companies with a global presence, including business in North America, Central America, South America, Western Europe & the Mediterranean, Australia, New Zealand, and Africa, as well as developments in Japan, China, and Southeast Asia.





The TriCal Group was one of the first companies to commercially mechanize soil fumigation to help farmers save land from crop-destroying pests and pathogens. From the start, TriCal has understood the importance of ensuring a stable, global food supply by empowering growers to maximize yields to feed an ever-growing population using fewer inputs and less land. Today, the TriCal Group continues to lead with innovative solutions for growers from pre-plant through post-harvest.



THE TRICAL GROUP OFFERS A WIDE-RANGE OF TARGETED SOLUTIONS FOR GROWERS, FROM PRE-PLANT THROUGH POST-HARVEST, INCLUDING:

- Plant & Soil Disease Diagnostics
- Soil Health & Pest Management Recommendations


DIAGNOSING THE PROBLEM

- Soil Conditioning & Fumigation
- Plant Nutrition & Liquid Fertilizers
- Custom Agriculture Irrigation
- Grafted Plants/Nurseries

PREPPING FOR THE GROWING SEASON

- Custom Agriculture Equipment
- Safety Supplies
- Structural & Food Pest Management

ONGOING MANAGEMENT



THE TRICAL GROUP'S COMMITMENT TO PROVIDING GROWERS WITH TARGETED, CUSTOM SOLUTIONS STEMS FROM THE UNDERSTANDING THAT OUR GLOBAL FOOD SUPPLY IS INTERCONNECTED—WHAT GETS GROWN IN ONE COUNTRY IS OFTEN EXPORTED, SO ENSURING HIGH STANDARDS ACROSS THE BOARD HELPS TO ELEVATE THE ENTIRE SYSTEM.

When growers have solutions for managing soil borne pests and diseases, they can increase output and quality, while also ensuring global biosecurity. Managing pests and maintaining global quarantine zones/import & export standards, helps ensure food supply while guarding against the spread of harmful plant pests.

BUSINESS HIGHLIGHTS:

Operations In More Than

15

Countries



1,600+
Employees

86,116

Acres Treated Annually



13
Affiliate Companies
In The USA &

11

Internationally

166

Product Registrations
(Country-Level),
Globally



5,300

Soil Diagnostics
Tested Annually

7.5 million

Grafted Plants
Grown Annually



30+

crops treated

Strawberries

Tree Fruit

Tree Nuts

Potatoes

Peppers

Nurseries

Flowers

Wine & Table Grapes

Squash

Tomatoes

Melons

Cucumbers

and more...



300+

Research Field
Demonstrations



288+

Published Literature

13

PhD's
on staff



116

Qualified
Applicators Licenses
(QAL)

100,000+

Structures Saved
From Wood Termite
Damage Annually



1,500

Acres Annually of Fumigated Conifer
Seedlings Planted for Reforestation, this
equates to 1,083,000 re-forested acres.

131

Commercial
Class A Drivers

SUSTAINABILITY STRATEGY

As defined by UCLA, “sustainability is the integration of environmental health, social equity and economic vitality in order to create thriving, healthy, diverse and resilient communities for this generation and generations to come. The practice of sustainability recognizes how these **issues are interconnected** and requires a systems approach and an acknowledgement of complexity.

Sustainable practices support ecological, human, and economic health and vitality. Sustainability presumes that resources are finite, and should be used conservatively and wisely with a view to long-term priorities and consequences of the ways in which resources are used. In simplest terms, sustainability is about our children and our grandchildren, and the world we will leave them.”¹

Today, more than ever, growers are under immense pressures to grow more food for a growing world population, all while balancing increasing regulations, rising costs, and less resources like water and land. **The TriCal Group empowers growers to be more sustainable in their operations by providing thoughtful solutions to their problems** through efficacy, plant health, pest management and soil diagnostics.

USING OUR RESOURCES WISELY

We would use more land, more fertilizer, more pesticides, and more water without crop protectants. **With total food demand expected to increase 70 percent by 2050 – and food prices expected to rise as much as 100 percent during that same time period**—sustainable agriculture will not just be instrumental, but critical, to increase productivity in the face of significant environmental constraints and challenges.²

BALANCING ACT. FEEDING THE GROWING POPULATION WITH RESPONSIBLE USE OF ALL OUR RESOURCES

The world population is expected to peak at 8.5 billion people in 2035, from today's 6 billion. The world must produce as much food in the next 40-80 years as the past 12,000 years - and on less land.⁴ Only 7% of Earth's surface is available for farming.

1930

1 farmer fed 10 people.



1970

1 farmer, 73 people.



TODAY

Today's farmer has to feed more than 150 people.





THANKFULLY, AS AGRICULTURAL PRODUCTIVITY HAS IMPROVED, SO HAVE TECHNIQUES FOR SUSTAINING ALL OF OUR RESOURCES.

Soil fumigation plays a key role in helping us to use our resources wisely. Pest-free and productive soil is crucial to efficient use of land, water, and energy resources for crops such as nuts, berries, strawberries, squash, melons, tree fruit, peppers, grapes, cucumbers, tomatoes, potatoes, eggplants, flowers and nurseries.

SUSTAINABILITY IN ACTION

Productive, healthy plants require less fertilizer, less pesticides, and less water. This is due to a healthy root system; healthy root systems get their start in clean soil. Plant diseases such as wilt are a sign that the roots and/or the vascular system have stopped functioning properly and can't take in water. At that point, much of the water used, is wasted. We don't have water to waste.

The TriCal Group supplies growers with custom drip irrigation systems to help reduce and maximize water efficiency. Did you know? Drip irrigation can reduce a farm's water consumption by as much as 60 percent and increase crop yield by 90 percent, compared with conventional irrigation methods.⁵





OUR SUSTAINABILITY EFFORTS ARE TWOFOLD; WE PROVIDE PRODUCTS AND SOLUTIONS THAT ALLOW GROWERS TO BE MORE SUSTAINABLE IN THEIR OPERATIONS BY MAXIMIZING CROP OUTPUT WHILE REDUCING WATER, LAND, AND INPUT USAGE. ADDITIONALLY, WE ARE COMMITTED TO IMPROVING OUR CIRCULAR PRODUCT LIFE-CYCLE BY WORKING WITH OUR SUPPLIERS ON RECYCLING SOLUTIONS, EXPLORING ENERGY EFFICIENT OPERATIONS, AND ADVOCATING FOR SAFE PRODUCT STEWARDSHIP THROUGHOUT THE SUPPLY CHAIN.

We view sustainability as a practical balance of maximizing grower operations today, with targeted solutions that provide benefits today, while keeping an eye towards the future.



3 PILLARS OF SUSTAINABILITY:

PILLAR 1: FUNCTIONAL SUSTAINABILITY (EXTERNAL-FACING)

Providing growers a path towards functional sustainability with practical, targeted solutions

PILLAR 2: RESOURCE EFFICIENT OPERATIONS (INTERNAL-FACING)

Moving Towards Resource Efficient Operations within the TriCal Group by creating company best-practices

PILLAR 3: AG FOR THE FUTURE (INTERNAL/EXTERNAL FACING)

Helping to Build Sustainable Ag for the Future through ag leadership, R&D, and advocacy

PILLAR 1

FUNCTIONAL SUSTAINABILITY

Providing growers a path towards functional sustainability with practical, targeted solutions.

We are passionate about building sustainability throughout the grower chain. That's why we offer a path to sustainability through targeted solutions customized for each growers' needs. Farmers are at the forefront of feeding the world, and we provide the tools to help them grow healthy plants, with higher yields, and improved quality.

By prepping the soil with fumigation, growers are able to level the playing field against destructive plant parasitic nematodes and soil-borne diseases, essentially creating a clean slate from which to plant. If left untreated, soil with high nematode pressure and soil borne pathogens can wreak havoc on crops, leading to significant yield reductions and negative impacts on quality leading to unsellable product.

This point cannot be stressed enough because while alternatives to fumigation exist, none are as effective.



New research suggests that in the United States, half of all produce is thrown away; globally, about one-third of food is wasted. This equates to 1.6 billion tons of produce annually, at the economic value of approximately \$1 trillion dollars.⁶ One farmer who ships fresh fruit and vegetables from North Carolina and Central Florida says, "It's all about blemish-free produce... What happens in our business today is that it is either perfect, or it gets rejected. It is perfect to them, or they turn it down. And then you are stuck." We give growers the tools they need to avoid being stuck, by producing more quality crops in the same or less footprint.

As climate change continues to worsen, the pest problem will only worsen.

Recent studies show that climate change threatens the ability to meet the crucial 70% yield increase needed to feed the growing global population.⁷ And with warming temperatures and increased rainfall, this number is expected to accelerate as the abundance and geographical distribution of nematodes and plant pathogens rise.⁸ **Growers understand that healthy soil is the foundation for a sustainable farm. That's where we come in.**

Soil health is achieved through the suppression of disease and also managing the physical chemical/biological components of the soil through things like water/nitrogen/carbon cycling—all while growing crops and managing real-world economic pressures.

PART OF THE SOLUTION: REFORESTATION & MAXIMIZING AGRICULTURAL LAND

Did you know? Urban sprawl is encroaching on farmland each year at an unsustainable rate? A report written by environmental planner, Leon Kolankiewicz, states “that between 2002 and 2017 the federal Natural Resources Conservation Service identified around 17,800 square miles of new sprawl.⁹ That means 17,800 square miles of natural and agricultural land were converted during that 15-year period into developed land for residential, commercial, industrial, transportation, and other purposes.” According to Kolankiewicz, “The average destruction of 1,200 square miles of farmland and habitat per year would be unsustainable for a country that desires the continued capability of food independence within its borders.” In other words, it is more important than ever for growers to maximize food production on the same—or less—agricultural land as populations increase and the demand for both food and space continue to grow. The TriCal Group helps growers manage pests and plant diseases in order to maximize efficiencies and crop output for a growing global population.



GROWER TESTIMONIALS

“

The first thing about sustainability is profitability. The farm operation must remain viable. Since we've been using Chloropicrin we've been able to grow less acres and get the same amount of potatoes.”

————— Jay Savage, Savage Farms —————

“

Soil fumigation is key to preparing our soil for optimal crop health and growth and to comply with phytosanitary requirements. The increase in marketable yield is unmatched and we could not sell our plants without them being pest free. I feel good being able to supply strawberry plants to farmers, so that they can produce berries at a price that everyone can afford.”

————— Elizabeth Ponce, Lassen Canyon Nursery —————

“

I had been growing tree crops in the Santa Clara Valley for 40 years and did not know about the importance of soil fumigation until I lost a cherry orchard to Phytophthora. Thanks to TriCal, I learned how soil fumigation could control this disease. They fumigated the land for me and the replanted cherry orchard became a very successful orchard.”

————— George Rajkovich, Fairhaven Orchards —————

WHY SOIL FUMIGATION

SUPPORTING THE USDA'S AGRICULTURE QUARANTINE INSPECTION

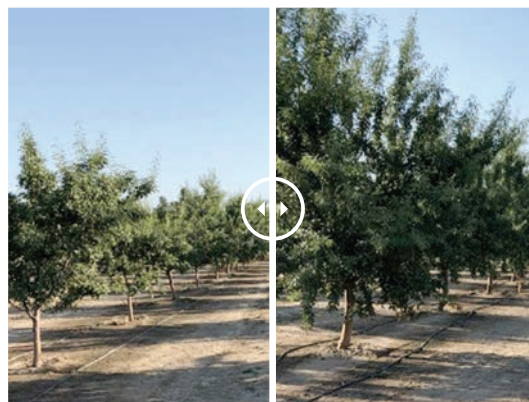
Did you know? According to the USDA “Every year, invasive insects and plant diseases cost the United States about \$40 billion in lost crop and forest production. That figure does not include the significant cost to Federal, State, and local government agencies—and farmers and industry—to combat these threats once they have entered our country. Invasive pest and disease incursions can also result in foreign export markets closing to U.S. agricultural products that could be infested or infected. In calendar year 2021, U.S. agricultural exports were worth a record-breaking \$177 billion.”¹⁰ The TriCal Group cooperates with local, state and federal agencies to stop the movement of agricultural pests at the source—in the field.



STRAWBERRY UNTREATED VS. TREATED



TOMATO UNTREATED VS. TREATED



ALMOND UNTREATED VS. TREATED

Destructive pests such as nematodes, fungi, insects, weeds, and other pathogens can be devastating to a crop. Many common soil-borne issues can be managed with soil fumigation.

Food crops must compete with 30,000 species of weeds, 3,000 species of nematodes and 10,000 species of plant-eating insects. We would spend 30 - 40% more of our income on food without crop protectants.¹¹

NO RESIDUES IN THE SOIL OR IN YOUR FOOD

The TriCal Group's soil fumigants are applied before planting and that after degradation, there are no residuals remaining in the soil. Therefore, nothing comes in contact with seeds, plants, or food—all that is left behind post-fumigation is prepped soil, ready for planting.



UNDERSTANDING SOIL HEALTH

1

Until very recently, determining a fumigant's impact on soil was guesswork: 95% of soil organisms couldn't be isolated and grown in the laboratory – and therefore couldn't be quantified. Now, however, genetic sequencing technology can isolate and analyze ribosomal RNA, allowing a clear and more complete description of a soil sample's biological profile.¹²

“We can finally stop guessing at what's in our soil. **For roughly \$250 per sample, anyone who is interested can determine exactly what's in their soil to a level of precision that was never possible before,**” says Dr. John Washington, a plant pathologist and director of research and development at TriCal Group.¹³ “It's a kind of genetic barcoding: the technology can identify every organism group and their relative amounts.”

2

3

Each fumigant has distinct effects. For example, 2021 trials showed *Trichoderma*, a well-known group of beneficial fungi, increased 20-100-fold in plots treated with Chloropicrin.¹⁴ Population benefits lasted the entire season, and even extended into the next season in some settings, since *Trichoderma* overwinters in northern tree crop soils.

“When we fumigate, we reset the table, creating competition for different organisms and shifts in the biome. We create biome shifts, not decimation.”

Research relating to Chloropicrin and 1,3-D’s impacts on soil’s microbial populations contradicts mainstream dogma and misunderstandings about the soil health effects of fumigants.¹⁵

Saprophytic bacteria and fungi, which live off non-living, decaying organic matter, also increase after fumigation. Saprophytes play major roles in soil nutrient cycles, and also support soil structure, promote plant growth and are involved in natural, biological control of some soil-borne pathogens.

4

5

Building from a more accurate understanding of what is actually happening in the soil, we’ll be positioned to make further gains in agronomy, sustainability and profitability. We’re now ready for much more productive and interesting conversations because we better understand the true dynamics of biological soil health and how to improve it further,” says Washington.¹⁶

In 2019, Phytobiomes Journal published research by Colorado and Oregon State researchers showing that **fumigation with 1,3-D increased the population of Enterobacteriaceae, a family of bacteria that include species that specialize in nutrient cycling, while simultaneously decreasing the population of pathogenic fungi such as Pythium and Verticillium.¹⁷** The impact of beneficial microbes can be significant, with visible plant health noted inside of a single season and long-term benefits achieved over multiple applications of 1,3-D.

6

7

Fungal and bacterial diseases can have a major impact on crop marketability and profitability. For example, in potatoes, common scab (brown lesions on a potato's skin) can reduce the quality of the crop by as much as 20 to 50%.¹⁸ Because crop production utilizes resources like water and fertilizer, significant disease-induced crop losses translate in effect to poor ecological stewardship, and bite deeply into both sustainability and a farm business' total returns. **Ultimately, better managing loss is exactly why growers turn to chloropicrin and 1,3-D, as they are the only tools available that decrease soil pests and diseases without compromising other aspects of soil health.**



Over 50 years of use have proven Chloropicrin's track record of suppressing disease and improving sustainable crop production. Studies with Michigan State University, Oregon State University, and the Research and Development Institute for the Agri-Environment in Quebec have confirmed that Chloropicrin acts as a selective agent, supporting the repopulation of native, beneficial microbes.

8



WHILE OUR PRIMARY BUSINESS IS SOIL FUMIGATION, WE OFFER A FULL SUITE OF TARGETED SOLUTIONS BASED ON GROWERS' NEEDS.

We are proud to offer the right products, at the right time, with the right treatment. We take a prescriptive approach, using precision agriculture practices to create variable rate inputs, optimized for the situation, using no more product than is needed—just enough to be effective for the grower. No more, no less. By maximizing input efficiencies/production efficiencies, we can keep more land in its natural state because we are optimizing our current farmland. Doing more with less allows more native land to stay native.

That's sustainability.

Solutions we offer include:

- Pre-plant soil fumigation
- Crop health & nutrition
- Fertigation
- Precision manufacturing
- Precision agricultural irrigation
- Grafted plants
- Post-harvest & structural fumigation
- Fertilizer
- Soil & plant diagnostics
- Custom equipment
- Stewardship
- Safety equipment
- New product discovery

PILLAR 2

RESOURCE EFFICIENT OPERATIONS

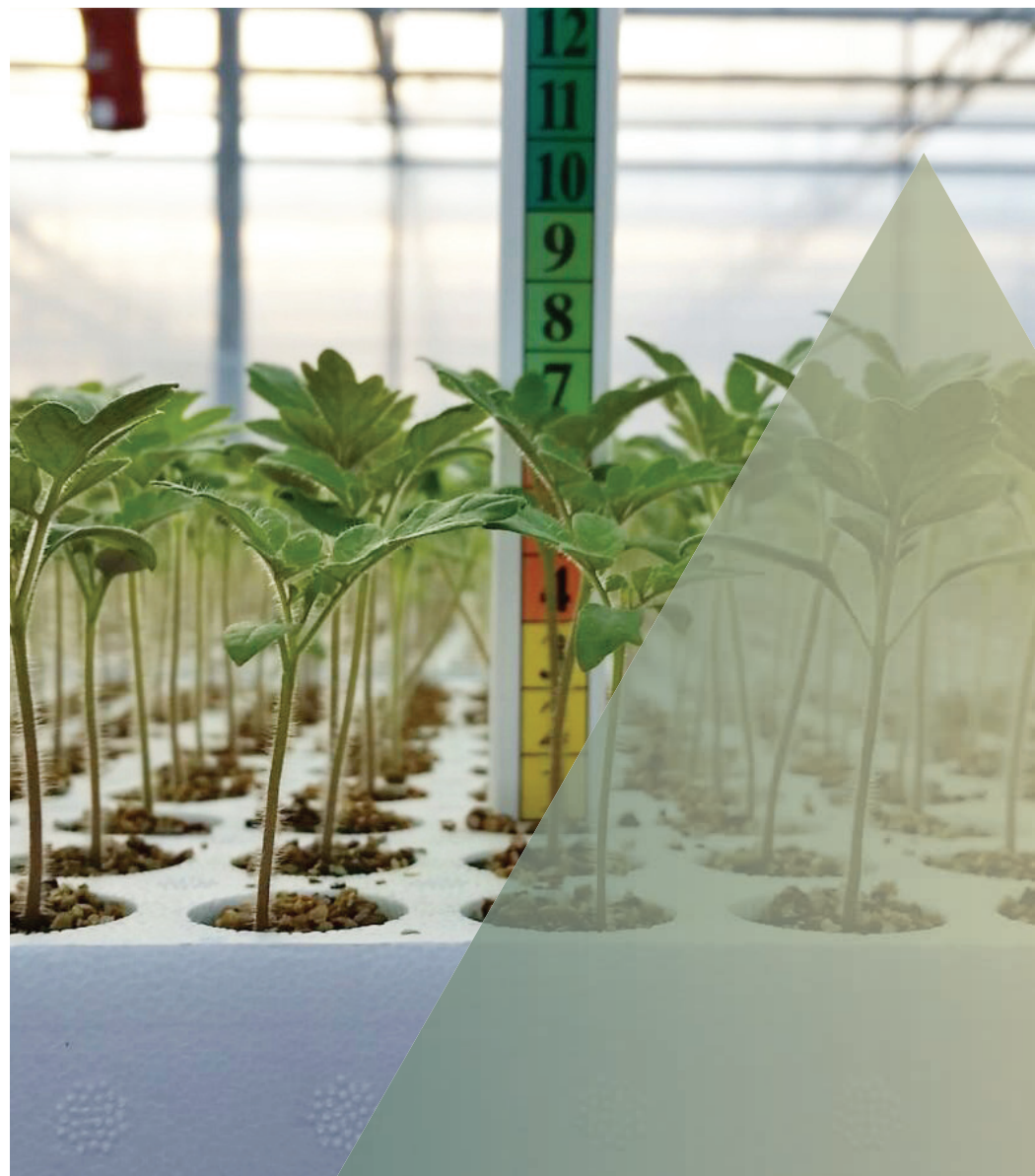
Moving towards resource efficient operations within the TriCal Group by creating company best-practices.

From its inception, the TriCal Group has challenged the status quo, creating new solutions to old problems. Internally, the company has a longstanding history of creating powerful soil solutions/products & technologies to help growers overcome crop-destroying pests, while simultaneously promoting community and environmental health and safety. Since that is what the outcome of these crops – life-sustaining food – is for in the first place.

Today, the company is committed to working across its affiliate network to maximize energy efficiencies and reduce carbon emissions.

From the start, the TriCal Group has invested in the newest technologies and safety equipment, with a company ethos of always evolving and improving.

The company is dedicated to advancing sustainable initiatives, with the appointment of a new Director of Sustainability (Beth Mineau) and a pledge to implement sustainable practices where applicable, in all new endeavors.





SUSTAINABILITY PROJECTS IN PRACTICE

STEWARDSHIP

Stewardship is of paramount importance and includes everything from material safe handling, proper storage, application, and product management.

At the TriCal Group, each affiliate company has a robust stewardship program for internal and external training.

Each year, our more than 30 Pest Control Advisors (PCA's), complete a combined 1,000+ hours of continuing education to maintain their certification and current stewardship best practices.

TriCal Group PCA's lead more than 100+ external stewardship trainings for customers around the world. The TriCal Group has a near perfect/above industry standard safety record across its affiliate network of companies.

OPERATIONS

The TriCal Group is taking action throughout its affiliate network to improve operational sustainability. These actions include changes to infrastructure, operational efficiencies, and sustainability programs aimed at **reducing carbon emissions, optimizing energy use, and recycling improvements.**



SUSTAINABILITY PROJECTS IN PRACTICE



Amy Thompson

Safety & Compliance Director

TriCal, Inc:

In anticipation of new California regulations, Amy is exploring how to **replace existing on-road heavy duty diesel engine vehicles with zero-emission options.** She is currently researching options for electric forklifts and tractors that fit our operations. She is also exploring partners for recycling of plastics.

Todd Barnes

Director of Support Services

Trinity Manufacturing, Inc.:

“We consume approximately 80 55-gallon drums of raw materials per day. Rather than discarding these drums as waste, we sell them to a **drum recycling company who cleans and sells them to be used for other purposes.**”

FACILITIES

The TriCal Group has made sustainable site improvements over the past few years, with additional upgrades planned for the future.

Jason Nowakowski

Director Global Engineering Support

TriCal Group:

“The company sized the retention areas at our new Kingman, AZ facility to accomplish 100% runoff containment (zero storm water discharge).”

Darren Wilhelm

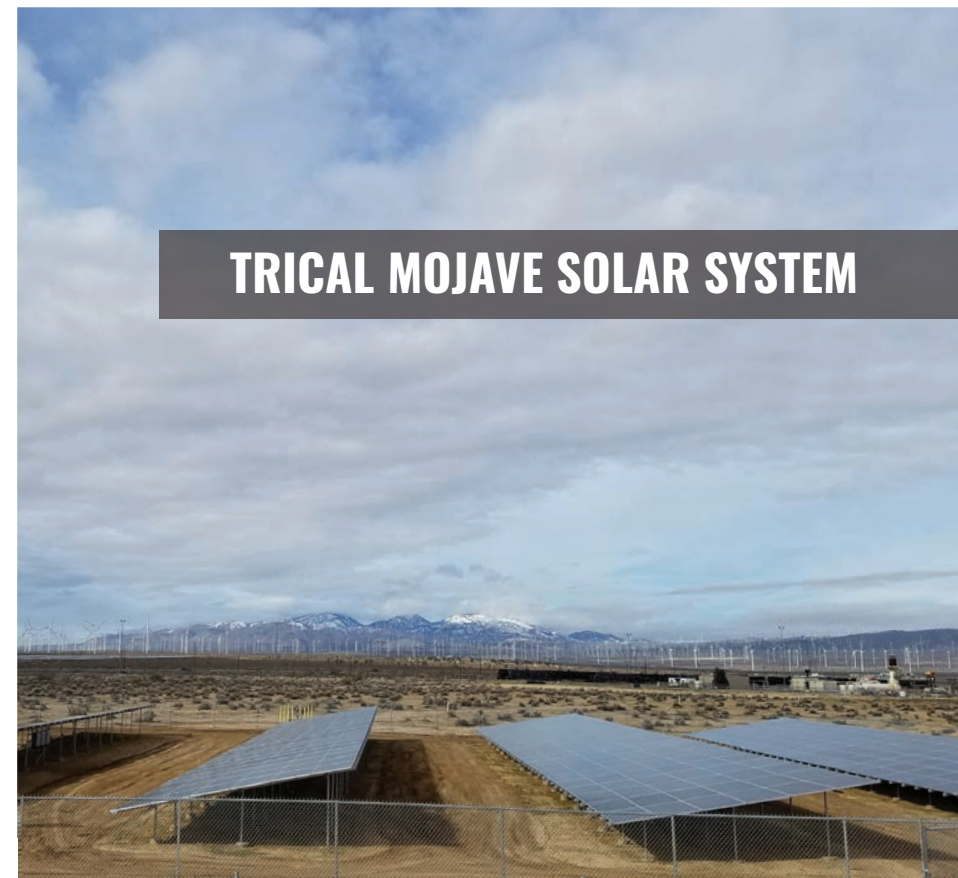
Facilities Project Manager

TriCal, Inc.:

“Our TriCal Mojave facility is solar-powered. The 162.8 KW system was commissioned in October 2017. The system produces anywhere from 245,000 to 260,000 Kwh per year. On average, the facility uses approximately 240,000 Kwh per year, with us crediting anywhere from 5,000-15,000 Kwh back to the grid, annually.”



SUSTAINABILITY PROJECTS IN PRACTICE



TRICAL MOJAVE SOLAR SYSTEM

Todd Barnes

Director of Support Services

Trinity Manufacturing, Inc.

1. “In an effort to create a closed-system manufacturing plant, we took our previously vented hydrogen gas produced by our ChlorAlkali process as a fuel for our boiler to generate steam for the plant processes. Prior to installing the hydrogen fuel boiler, we produced steam using a boiler fueled solely by propane. Installing the hydrogen fuel boiler reduces our propane consumption by 80-90%. We developed and installed a salt water recycling process to reclaim the salt water waste from the Chloropicrin process to be used in the ChlorAlkali process. Prior to installing the salt water recycling process, we had to dispose of this as waste.”



2. “The Carbon Adsorbers on our Chloropicrin processes are of the type that can be regenerated when the carbon is spent. Our process regenerates the carbon using steam to strip the Chloropicrin vapors trapped in the carbon. The steam condensate with the stripped Chloropicrin is returned to the process and not wasted. This greatly extends the life of the carbon. We only need to change the carbon in these Carbon Adsorbers approximately every 3 years. When we do discard this carbon as waste it is non-hazardous.”
3. “We implemented a project to use the reject water (waste water) from our Reverse Osmosis water treatment process as make up water for our cooling tower.”
4. “We take any Chloropicrin we pump out of railcars and ISO containers we are prepping for cleaning and inspections and return it to the process instead of disposing of it as waste.”

TECHNOLOGY & PRODUCT DEVELOPMENT

The TriCal Group is committed to exploring new technologies to further advance its operations and product development. The company invests significant monetary and human resources to achieve advances in ag technology.

Mike Stanghellini, PhD
Chief Science Officer

TriCal Group:

1. “We have active research on microbial inoculants and their secondary metabolites for soil pest control, enhanced crop root development, and other agronomic benefits. We also recently completed an evaluation of a commercially-available bio-nematicide to work in conjunction with our soil fumigation practices.”
2. “The company is exploring several new sustainable products, including biodegradable row mulch, potentially deterring plastic row mulch and plastic from landfills.”
3. “Another project we are exploring on the East Coast is the use of pine tree needles for substrate growing as an alternative to fumigation.”

Ziad Tadros, PhD

R&D Manager

Trinity Manufacturing Inc.:

“We have developed the bio-pesticide broad spectrum bio-pesticide that was found to have bactericide and nematicidal activity. The active ingredients and most of the inert ingredients are environmentally friendly. There is on-going research based on phytochemistry to develop new eco-friendly pesticides, bactericides/nematicides and adjuvants to promote plant health and crop protection as well as turf treatment.”



NEMATODE

PILLAR 3

AG FOR THE FUTURE

Helping to build sustainable Ag for the future through ag leadership, R&D, and advocacy.

As we look to the future, the TriCal Group seeks to develop the next generation of ag leadership by supporting student research as well as continuing to forge ahead with academic R&D and external advocacy support via industry trade associations.

PHILANTHROPY

Founded in 1987, the Storkan-Hanes-McCaslin Foundation was created in honor of the three TriCal founders: Richard Storkan, Jerry Hanes and Bob McCaslin. Their spirit lives on today, as the Foundation continues to support the next generation of researchers in the soil health space.

The Foundation's primary goal is to encourage research in soil health by offering financial assistance to students who are working to understand soil-borne diseases, as well as research to provide farmers with new methods for control. Grants are awarded on a yearly basis – as of 2022, the Foundation has awarded a total of \$618,500 to 91 students across the United States and Canada.

The Foundation provides winners travel to the annual American Phytopathological Society (APS) plant health meetings where members come together to share significant breakthroughs, for both plant science and society.

Previous winners' research includes a wide range of

topics, including: root lesion nematodes in Montana winter wheat; root rot and wilting complex issues for red raspberry in British Columbia, including pathogen characterization, exploiting host-resistance, as well as sustainable management options; genetic structure and virulence of *plasmodiophora brassicae* single-spore isolates and field populations from western Canada; and modeling *phytophthora cinnamomi* distribution in eastern Kentucky.

Previous winners have gone on to work for USDA, UC System, and other key industry positions.



AG LEADERSHIP, R&D, & ADVOCACY

ADVOCACY

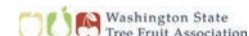
In order to support growers by ensuring the long-term regulatory viability of our products, the TriCal Group is very active in supporting key agricultural trade associations. These groups work tirelessly to ensure growers have the regulatory support at the local, state and federal level.

We actively listen and engage with growers to understand the challenges they face. We leverage our participation in key trade associations and offer support with financial donations, time, product, and equipment.

As a business with operations in California, we are held to some of the strictest regulations for operating soil fumigations. We have taken these best-practices to other geographies where we operate, thereby elevating the operating standards around the world even when regulations are not stipulated.

We are champions of field performance, public safety and environmental stewardship and seek to elevate these standards and practices wherever we operate.

The TriCal Group supports more than 30 trade associations across diverse crop segments. A few key groups include: _____



RESEARCH & DEVELOPMENT



From the start, TriCal has been committed to science and research. The first partnership was between co-founder and then president, Dick Storkan, and Dr. Stephen Wilhelm, Plant Pathologist, University of California, Berkeley. Dick and Stephen are credited with the advancement of mechanical methods of fumigation with plastic sheeting to achieve chemical efficacy and to safely retain the fumigants, allowing for the growth of commercial use.

We continue to develop university and research partnerships to improve efficacy and sustainability. Experts we work with include:

Dr. Jim Adaskaveg, UC Riverside

TriCal and Dr. Adaskaveg have evaluated methyl bromide soil treatment alternatives for suppression of Armillaria Root Rot in almonds over several years and throughout multiple research trials.

Dr. Husein Ajwa, UC Davis (emeritus)

TriCal and Dr. Ajwa have conducted numerous soil fumigant trials and studies on fumigant emissions reduction, including evaluations on totally impermeable film (TIF). These studies demonstrated that, while in place and intact in the field, TIF was successful at effectively retaining soil fumigants under the tarp.



Dr. Steve Fennimore, UC Davis

TriCal and Dr. Fennimore have evaluated a few new soil fumigant candidates on strawberry and ornamental crops, and also collaborated on a multi-year soil disinfestation project using steam.

Dr. Brad Hanson, UC Davis

TriCal and Dr. Hanson have conducted several soil fumigant trials on orchard crops, and more recently on fumigants and fumigant alternatives to control a noxious, parasitic weed (broomrape).

continued on page 33

continued from page 32

Dr. Amanda Hodson, UC Davis

TriCal and Dr. Hodson have collaborated on nematode control projects involving soil fumigants and novel contact nematicides. These studies showed that soil fumigation effectively reduced plant-parasitic nematodes and that some novel contact nematicides have promise in an integrated management program for nematode control.

Dr. Shashika Hewavitharana & Dr. Gerald Holmes, Cal Poly

TriCal, Dr. Hewavitharana, and Dr. Holmes have evaluated several soil fumigant treatments for control of strawberry diseases, their positive impact on soil microbial diversity, and the utility of crop termination after final harvest.



Dr. Joji Muramoto, UC Santa Cruz

TriCal and Dr. Muramoto have collaborated over many years on Anaerobic Soil Disinfestation (ASD) trials, culminating in TriCal having the only broadcast ASD rig in commercial service in California.

Dr. Andreas Westphal, UC Riverside

TriCal and Dr. Westphal have conducted research on walnut orchard and

perennial crop nursery trials, with a focus on nematode control. The goal of this research is to increase grower profitability and sustainability of walnut production by mitigating the devastating impacts of plant-parasitic nematodes in these orchards.

Dr. Daniel Ashworth, USDA

TriCal and Dr. Ashworth have worked together on environmental fate studies, showing that the soil degradation rate of chloropicrin is dependent on the initial application rate. These results continue the joint effort to provide tools to growers while protecting public health and the environment.

Dr. Greg Browne, USDA

TriCal and Dr. Browne have installed numerous, multi-year soil fumigation and Anaerobic Soil Disinfestation (ASD) trials on almonds.

Dr. Peter Henry, USDA

TriCal and Dr. Henry are currently working on a multi-year soil fumigation trial that is evaluating different fumigants and fumigant application methods on their ability to control strawberry pathogens harbored inside residual crown tissue, as these are believed to be a possible source of field reinoculation after fumigation.

Dr. Dan Kluepfel, USDA

TriCal and Dr. Kluepfel have collaborated on soil fumigant studies that evaluated control or suppression of Crown Gall (*Agrobacterium*), as well as on various Anaerobic Soil Disinfestation (ASD) trials in walnuts and perennial crop orchards.

continued on page 34



Dr. Suduan Gao, USDA

TriCal and Dr. Gao collaborated on multiple studies that evaluated the effect of different soil fumigants, fumigant application rates, and environmental safety technology such as impermeable tarps and reactive boundary layers, with a focus on orchard crops.

Dr. Frank Martin, USDA

TriCal and Dr. Martin have collaborated on precision soil fumigation tactics, where portions of fields are ‘heat-mapped’ for disease pressure using state-of-the-art diagnostics tools, and variable fumigation rates are applied based on the disease pressure in any given portion of a field. The objective of this work is to optimize fumigant use to develop a more precise strategy for management of soil-borne pests based on disease risk.

Dr. Becky Westerdahl, UC Davis

TriCal and Dr. Westerdahl collaborated on several research projects that evaluated novel fumigant practices, non-fumigant biopesticide candidates, and organic soil pest control treatments for their effectiveness at suppress-

ing plant parasitic nematodes in field-scale crop trials (e.g., strawberry and deciduous tree nurseries), as well as greenhouse and lab-scale bioassays.

Dr. Steve Culman, Washington State University

Dr. Culman is the Distinguished Endowed Chair of Soil Health in Potato Cropping Systems, Department of Crop and Soil Sciences, WSU. The TriCal Group has contributed to the more-than-\$3 million fund created by potato growers, processors, and suppliers to support Dr. Culman’s research program that will address priorities in irrigated agriculture, including the need to better understand and protect the soil.

We conduct dozens of field trials every year. Many have been documented in peer reviewed journals such as California Agriculture, or presented at conferences such as at the Annual International Research Conference on Methyl Bromide Alternatives

These projects are often in conjunction with key researchers at universities and university extensions around the world. Research topics include: fumigation, product optimization, evaluating new markets/market development, application method development, regulatory, microbial products, varying tarps, and more.



QUICK STATS

13 PhD'S ON STAFF
30+ RESEARCH TRIALS ANNUALLY
288+ RESEARCH PAPERS AUTHORED



CLOSING STATEMENT

We wholeheartedly believe that growers are on the frontlines of sustainability. That's why we are doing everything we can to empower growers with targeted solutions so they can do more with less, while continuing to feed the world.

It's not an easy task, but we've been up for the challenge since we first started in 1961. The words might have changed, but sustainability has always been at the core of what we do. We understand the importance of offering practical solutions so growers can combat soilborne diseases and pests while remaining economically viable.

Our targeted products and solutions allow growers to use less inputs while increasing marketable yields, improving quality, and sustain a business that can last for generations into the future.

We also understand the interconnectivity of our global food supply. The TriCal Group's suite of products and solutions allows consumers to have access to more fresh fruits and vegetables of higher quality at a price they can afford—all because growers are able to manage severe pests and diseases in a safe, controlled way.

We are committed to expanding sustainability efforts across our affiliate network as we seek new ways to support growers, improve our internal processes, and lay the groundwork for the next generation of agricultural leaders.

¹ *What is Sustainability?* | *UCLA Sustainability*. (n.d.). UCLA Sustainability. <https://www.sustain.ucla.edu/what-is-sustainability/>

² *The Future of Food and Agriculture - Trends and Challenges*. (2017). FAO. Retrieved April 19, 2023, from <https://www.fao.org/3/i6583e/i6583e.pdf>

³ *Crop Protection Benefits*. (n.d.). CropLife International. Retrieved April 19, 2023, from <https://croplife.org/crop-protection/benefits/>

⁴ *How to feed the world 2050 - global agriculture towards 2050*. (2009, October). FAO. https://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Global_Agriculture.pdf

⁵ Chu, J. (2017, April). *Watering the world New design cuts costs, energy needs for drip irrigation, bringing the systems within reach for more farmers*. MIT News. <https://news.mit.edu/2017/design-cuts-costs-energy-drip-irrigation-0420>

⁶ Goldenberg, S. (2016, July 13). *Half of all US food produce is thrown away, new research suggests*. The Guardian. Retrieved April 19, 2023, from <https://www.theguardian.com/environment/2016/jul/13/us-food-waste-ugly-fruit-vegetables-perfect>

⁷ Fay Newbery, Aiming Qi, Bruce DL Fitt, *Modelling impacts of climate change on arable crop diseases: progress, challenges and applications*, Current Opinion in Plant Biology, Volume 32, 2016, Pages 101-109, ISSN 1369-5266, <https://doi.org/10.1016/j.pbi.2016.07.002>

⁸ Somasekhar N., Prasad J.S. (2012) Plant – Nematode Interactions: Consequences of Climate Change. In: Venkateswarlu B., Shanker A., Shanker C., Maheswari M. (eds) *Crop Stress and its Management: Perspectives and Strategies*. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-2220-0_17

⁹ Rousy, G. (2022, May 17). *Urban sprawl erodes rural lands: Study shows urban sprawl devouring farmland at “unsustainable” rate*. Farm Progress. Retrieved April 19, 2023, from <https://www.farmprogress.com/business/urban-sprawl-erodes-rural-lands>

¹⁰ *Agricultural Quarantine and Inspection (AQI) Program*. (2023, March 27). USDA. Retrieved April 19, 2023, from <https://www.aphis.usda.gov/aphis/ourfocus/plant-health/import-information/agriculture-quarantine-inspection>

¹¹ *Importance & benefits of pesticides: Without crop protection, including pesticides, more than half of the world's crops would be lost to insects, diseases and weeds.* (n.d.). Pesticide Facts. Retrieved April 19, 2023, from <https://pesticidefacts.org/topics/necessity-of-pesticides/>

¹² *New technology provides first-ever snapshot of fumigants' impact on soil health.* (2022, June 17). Vegetable Grower News. Retrieved April 19, 2023, from <https://vegetable-growersnews.com/article/new-technology-provides-first-ever-snapshot-of-fumigants-impact-on-soil-health-triest/>

¹³ Ibid.

¹⁴ Ibid.

¹⁵ Ibid.

¹⁶ Ibid.

¹⁷ Yuan Zeng, Zaid Abdo, Amy Charkowski, Jane E. Stewart, Kenneth Frost. Responses of Bacterial and Fungal Community Structure to Different Rates of 1,3-Dichloropropene Fumigation. *Phytobiomes Journal*, 2019; 3 (3): 212 DOI: 10.1094/PBIOMES-11-18-0055-R

¹⁸ J. Washington, 2022. Microbial shifts occur following application of Chloropicrin and 1,3-Dichloropropene across soils and crops from diverse regions. MBAO Conference, Orlando, FL Nov 2022