BeCrop
Guide

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Introduction

Welcome to the BeCrop 3.0 guide. This comprehensive document will support you as you explore your BeCrop Test Report. There are multiple sections within this report including soil quality, health, and nutrition, allowing you to map out the myriad of microbial community roles in overall crop health. Discover the microbial activities that balance your crop's soil ecosystem, including functions like nutrient release, biocontrol, phytohormone production, and promotion of plant stress tolerance. The microbiome has a lot to tell you!

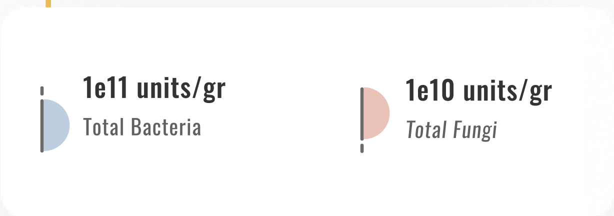
What is the BeCrop Report Methodology?

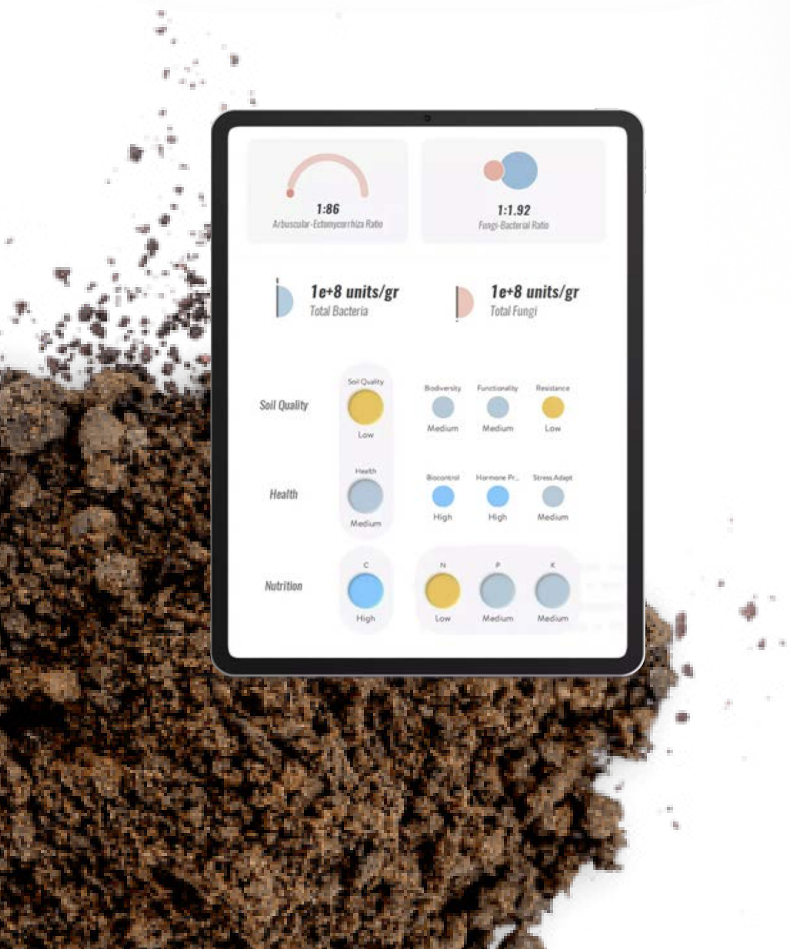
Each report has been generated through the identification of bacterial and fungal soil communities **using 16S rRNA and ITS marker genes sequenced with Illumina MiSeq technology and analyzed with the Biome Makers pipeline**. The phylogenetic assignment has been performed comparing an average of 300,000.00 high-quality raw sequencing reads with a Biome Makers proprietary taxonomically classified sequences database. All the microorganisms identified in the report and their proportions are available on the BeCrop online portal. The evaluation of multiple indexes is conducted by comparing client data with Biome Makers soil microbiome crop-specific reference database.

Report Highlights

1 Quantification of species:

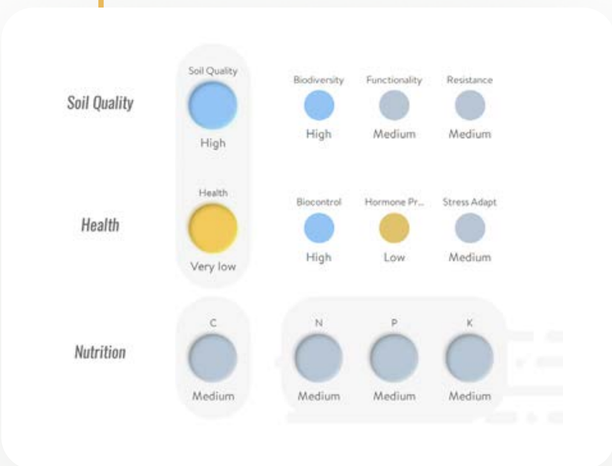
In this section, you can see the total quantity of fungus and bacteria found in your sample(s) per gram of soil, based on an internal reference control and the number of fungi or bacteria molecules detected.

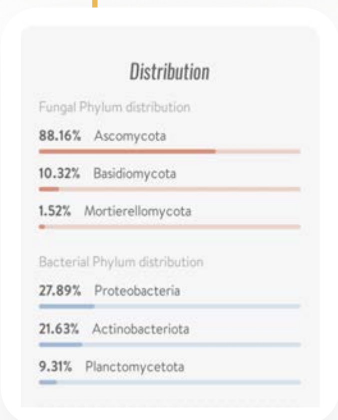




2 Summary:

A glance at the general status of your crop.





Distribution, here you can see a summary distribution of the most abundant Bacterial and Fungal phylum in your sample.

Report Highlights

3 Soil Quality:

Diversity and functionality of microbial species and their metabolic functions present in the soil, and the vulnerability of the system based on estimation of the microbiome's resilience. Here you can see Biodiversity, Functionality, and Resilience Indexes, as well as an overall Soil Quality metric based on the full microbial ecological network.

Soil Quality

SOIL QUALITY	MEDIUM	FUNCTIONALITY	MEDIUM
BIODIVERSITY	HIGH	RESILIENCE	MEDIUM

4 Health:

The role of microorganisms in plant health and yield is defined by the balance between levels of soilborne pathogens, biocontrol, hormone production, and stress adaptation.

BIOCONTROL
VERY LOW

HORMONE PRODUCTION
LOW

STRESS ADAPTATION
MEDIUM

5 Nutrition:

The potential of soil microorganisms to cycle nutrients and to increase the bioavailability of nutrients for plants and sequester carbon in the soil. This section is divided into macronutrients and micronutrients.

C	N	P	K
Carbon	Nitrogen	Phosphorus	Potassium
MEDIUM	MEDIUM	MEDIUM	MEDIUM

Report Highlights

BACTERIA AND FUNGI RATIOS

In the first section of your report, four different metrics describe the overall composition of the microbiome by displaying the total presence of bacteria and fungi and the balance between them.

TOTAL FUNGI:

Total quantity of fungal molecules found.

TOTAL BACTERIA:

Total quantity of bacterial molecules found.

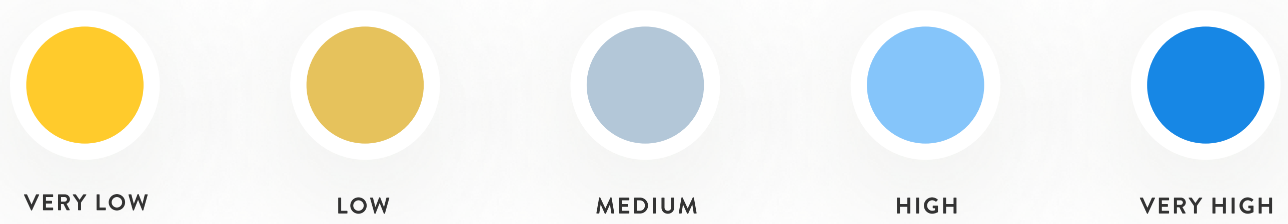
ARBUSCULAR AND ECTOMYCORRHIZA RATIO:

This ratio compares the populations of the two main types of mycorrhizal fungi, which are both known to play important symbiotic roles with plants. The exact abundance of arbuscular and ectomycorrhizal fungi is available for review in the Explorer tool in the BeCrop Portal.

BACTERIA AND FUNGI RATIO:

In this ratio, you can see the relationship between bacteria and fungi quantities in your sample. It is important to note that this fungi:bacteria ratio is not comparable to other traditional forms of soil biology analysis like PLFA tests due to the inherent differences in the nature of the tests. This ratio is strictly included as an informative tool.

Report Highlights



The color scale represents the rank of your sample compared to the distribution of values in the BMK crop database. The rank is divided in five color groups which represent the quintiles in which each sample of the BMK is located", from very low values to very high

Insights

Soil Quality

Soil quality values are calculated by analyzing the microbiome's species composition and ecological synergy and functionality. These indexes are biomarkers of the microbial ecosystem and are related to agricultural management practices.

What is it?

Soil quality provides a metric based on soil microbiome properties like the microbial community network, taxa, and functionality. Low values in the Soil Quality index are indicators of intensive practices that can degrade soil health, while high indexes are linked to regenerative practices, such as cover crops, conservation tillage, organic amendments, and biological/biostimulant products. Soils with a high Soil Quality rating tend to be less specialized and more versatile and cooperative, similar to a natural forest system, while lower soil quality values represent a highly specialized microbiome with more niche partitioning and negative interactions between microbes driven by the selective influence of human and environmental selection.

How is it calculated?

It is inferred through network properties analysis.

Insights

Biodiversity

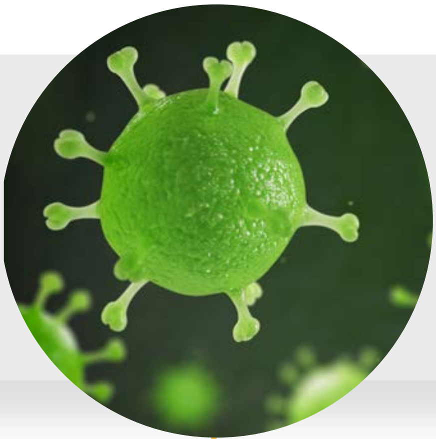
What is it?

Biodiversity assesses the community of microbial life that exists in the soil based on taxonomy. It accounts for all the species of fungi, bacteria, and archaea identified in each sample.

How is it calculated?

It is assessed by calculating taxonomic diversity and converting it into a contextualized and meaningful score. It is based on the number of species present, the evenness (relative abundance) between species, and phylogenetic similarity.

Insights
Functionality



What is it?

The quantity of ecological functions performed by soil microbes in the sample. In contrast to biodiversity which is based on species identity, this metric is based solely on microbial functions.

How is it calculated?

It is assessed based on the AI-predicted functional-gene profile of the soil microbiome.

Insights

Resilience

What is it?

An ecological index based on the ability of communities or populations to remain unchanged when stressed by a disturbance like a drought, flood, tillage, or a pathogen in the soil.

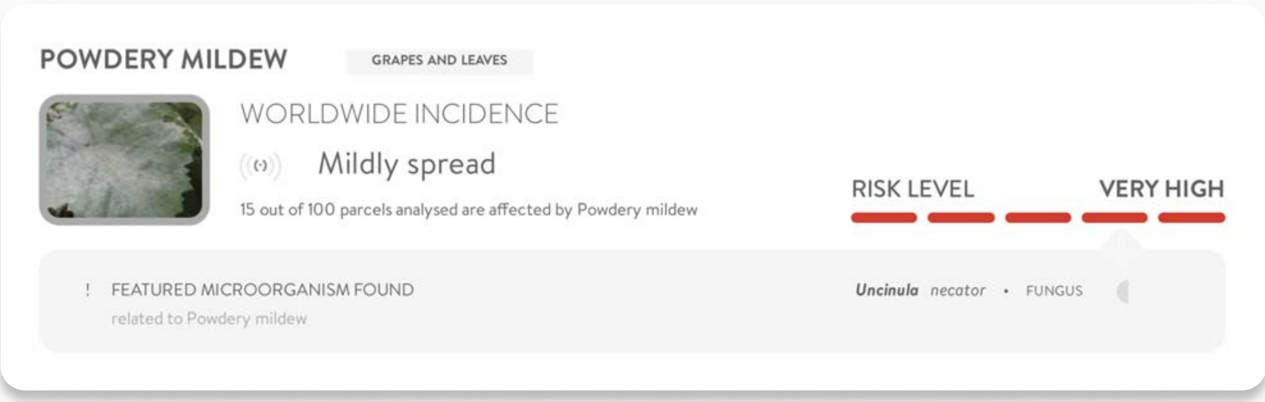
How is it calculated?

It is inferred through ecological network analysis.

Insights
Health

Healthiness Status: crop health according to the detected pathogens. It is calculated using epidemiological information (based on a compilation of data gathered from other samples), and the vulnerability of the microbial ecosystem is analyzed. It is established depending on the risks of the progression of detected diseases. In this section, you can find information about the levels of soil microbes that support plant health, Biocontrol, Hormone Production, and Stress Adaptation

How is it calculated?



- The risk level is calculated based on the pathogen load, as well as the ecology (biocontrol levels) of the sample. High or very high risk levels indicate a high probability of developing the disease. Low or very low risks do not need immediate action, though they require attention.

- Three primary factors drive plant disease development and are commonly referred to as the “disease triangle”: Plant phenology, weather conditions, and presence/dominance of the pathogen, which is the factor measured here. A high risk does not mean that you are going to develop the disease, but does indicate that you should be aware that one of the three disease triangle factors favors disease development.

Insights

Health

Biocontrol

Microbial species are grouped here according to the type of pest or pathogen they can suppress. The four considered groups are Fungicides, Bactericides, Insecticides, and Nematicides.

Biocontrol agents could be predatory, parasitoids of pathogens species, or competing for the same ecological niche with them. Based on their level detected, the presence of biocontrol agents indicates potential for natural control of pests and pathogens by beneficial soil microbes. So soils with high-very high values in these biocontrol indexes may not need to rely on heavy applications of plant protection products to control pest or pathogen impacts.

Hormone Production

Hormone producers: microbial species grouped according to the type of phytohormone they produce. Phytohormones are organic substances synthesized not only by plants, but also by microbes as part of their coexistence and interaction.

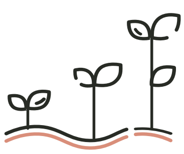
Phytohormones, even in low concentrations, are responsible for benefits to plant growth. We evaluate three main groups of phytohormone producing microbes in our report: Cytokinins, Auxins, and Gibberellins

HORMONE PRODUCTION
VERY LOW

AUXIN PRODUCTION (IAA)
Responsible for cell division and elongation.

GIBBERELLIN PRODUCTION (GA)
Responsible for elongation, germination, and flowering.

CYTOKININ PRODUCTION (CK)
Responsible for cell proliferation and cell differentiation.



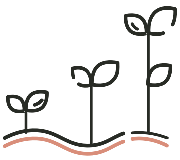
Stress management mechanisms play important roles in plant growth as they improve the general health status and development of plants. The presence of microorganisms with the ability to produce these stress adaptive substances will improve plant development and crop yield.

Insights
Stress Adaptation

Adaptation to stress conditions: Microbial species grouped according to their ability to produce metabolites that help plants withstand stress conditions. The seven considered mechanisms are ACC (1-aminocyclopropane-1-carboxylate) deaminase production, exopolysaccharide production, heavy metal resistance, salt tolerance, siderophore production, salicylic acid, and abscisic acid.

STRESS ADAPTATION
MEDIUM

Metabolite	Functions
Exopolysaccharide production	*Nutrient trap*
Heavy Metal Solubilization	*Bioremediation*
Salt Tolerance	*Alleviate Water Stress*
Siderophore Production	*Iron Nutrition*
ACC deaminase (ACC-D)	*Pathogen Protection*
Salicylic Acid (SA)	*Alleviate Water Stress*
Abscisic Acid (ABA)	*Growth Regulation*



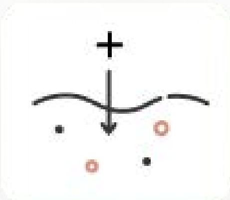
Stress management mechanisms play important roles in plant growth as they improve the general health status and development of plants. The presence of microorganisms with the ability to produce these stress adaptive substances will improve plant development and crop yield.

Nutrition

Major Nutrients

In this report section, you can see the nutritional status based on the potential microbial mobilization of certain compounds, divided into major and minor nutrients.

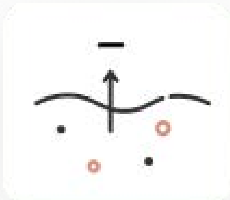
How do we Classify the Pathways According to Their Impact on Plant Nutrition?



Pathways that directly benefit plant nutrition (nutrient supply):

These pathways directly generate nutrients that can be used by plants for their nutrition.

- INORGANIC NITROGEN RELEASE
- INORGANIC PHOSPHORUS SOLUBILIZATION
- POTASSIUM SOLUBILIZATION



Pathways that take up nutrients from the soil (nutrient competition):

These microbial pathways compete for compounds that plants would also use for their growth. Although these microbial pathways can immobilize nutrients and thus reduce nutrient availability to crops in the short term, they also help reduce loss of nutrients from the soil in the long term.

- INORGANIC NITROGEN CONSUMPTION
- INORGANIC PHOSPHORUS CONSUMPTION
- POTASSIUM CONSUMPTION

Nutrition

Carbon Pathways

C

Carbon

VERY HIGH

Carbon is the basis of biological soil fertility. It is the main compound in organic matter and an essential source of food for beneficial soil microbes. The presence of organic carbon improves soil health and fertility, increasing crop yields and reducing soil degradation.
A low value indicates potential for Carbon Loss from the soil, while high values indicate potential for Carbon Sequestration.

Gain

CARBON FIXATION

The conversion process of inorganic carbon to organic compounds by living microorganisms.

Loss

AEROBIC RESPIRATION

The process in which microbes use organic compounds in oxygenated conditions, releasing CO_2

FERMENTATION

The process in which cells gain energy from organic compounds in non-oxygenated conditions, releasing CO_2

METHANOGENESIS

The formation of methane (CH_4) by microbes, contributing to the degradation of organic matter.

Indirect Benefits

ORGANIC MATTER RELEASE

The process in which soil microorganisms decompose vegetal debris, releasing diverse mineral nutrients. It is related to soil humification.

Nutrition

Nitrogen Pathways

Nitrogen is a major component of plant DNA, proteins, and chlorophyll, playing a fundamental role in crop yield. The mineralization of organic to inorganic nitrogen by microorganisms supplies N in readily available forms (nitrate and ammonia) for plants.

LOW values indicate low nitrogen mobilization potential by microbes.

Nutrient Supply

INORGANIC NITROGEN RELEASE

Mineralization, or the microbial transformation of organic nitrogen compounds to inorganic nitrogen compounds that serve as plant Nutrients.

Nutrient Competition

INORGANIC NITROGEN CONSUMPTION

Inorganic nitrogen consumption: immobilization, or the microbial transformation of inorganic nitrogen compounds to organic forms, which are not readily accessible for uptake by plants.

Indirect Benefits

INORGANIC NITROGEN CYCLE HEALTH

The process in which soil microorganisms decompose vegetal debris, releasing diverse mineral nutrients. It is related to soil humification.

Nutrition

Phosphorus Pathways

Phosphorus is a fundamental nutrient required in the regulation of protein synthesis and plant growth. It enhances the development of roots, while its deficiency leads to stunted growth, dark purple color of leaves, and inhibition of flowering. Low values indicate that the microbial processes that make phosphorus available for plants are low.

LOW values indicate that the microbial processes that make potassium available for plants are low.

Nutrient Supply

INORGANIC PHOSPHORUS SOLUBILIZATION

Certain soil microorganisms are capable of dissolving insoluble phosphorus from minerals and rocks. They convert insoluble phosphorus in the soil into a form that plants can access, improving their growth and yield. Major portions of conventional phosphorus fertilizers applied to fields end up locked in this insoluble form, so higher levels of phosphorus solubilizing microbes can improve phosphorus fertilizer use efficiency.

Nutrient Competition

INORGANIC PHOSPHORUS CONSUMPTION

Both plants and microbes require phosphorus to support their metabolic functions. High values indicate high competition/immobilization of phosphorus by soil microbes.

Indirect Benefits

ORGANIC PHOSPHORUS ASSIMILATION

Organic phosphorus may represent from 15% to 80% of the total content of this element in the soil. During the phosphorus mineralization process assessed by this index, organic phosphorus is converted by microbes from the organic form that is not readily available to the plant, to inorganic forms that can be more easily uptaken by the plant.

Nutrition

Potassium Pathways

Potassium is a regulator of metabolic activities, especially those involved in producing proteins and sugars and regulating crop evapotranspiration. When bioavailable potassium is deficient it causes leaf curl and sensitivity to droughts.

LOW values indicate that the microbial processes that make potassium available for plants are low.

Nutrient Supply

POTASSIUM SOLUBILIZATION

Certain soil microorganisms are capable of dissolving insoluble potassium from minerals and rocks. They convert insoluble potassium in the soil into a form that plants can access, improving their growth and yield.

Nutrient Competition

POTASSIUM CONSUMPTION

Both plants and microbes require potassium for their functioning. High values indicate a high potential for microbes to compete with the plant by assimilating this nutrient.

Nutrition

Minor Nutrients

Elements with less influence on the crop's nutritional status yet still serve important roles in plant growth and development.

IRON (Iron Mobilization)

Iron is the fourth most abundant element found in soil though it is largely present in forms that cannot be taken up by plants. Previously solubilized Iron is essential for microbial enzymatic structures and activities such as nitrogen fixation.

Medium to high values indicates a sufficient potential for iron microbial assimilation.

CALCIUM (Calcium Transport)

Calcium contributes to soil fertility by regulating the assimilation of other nutrients. Calcium deficiency symptoms in crops are usually caused by low calcium availability or water stress which result in low transpiration rates.

High microbial transport of calcium helps to maintain the physical properties of the soil and to stabilize soil structure.

ZINC (Zinc Transport Equilibrium)

Zinc is a micronutrient that plant needed in small amounts, yet it is crucial to correct plant development. It is key for the constitution of many proteins and enzymes and is essential for hormone production processes. Deficiency in zinc can reduce crop yield by over 20% before any visual symptoms of the deficiency occur.

Microbes are indicators of zinc problems through alterations of import/export processes to their cells indicates a sufficient potential for iron microbial mobilization. MEDIUM values are optimal for plant development

Nutrition

Minor Nutrients

COPPER (Copper Export)

Copper is one of the micronutrients needed in very small quantities by plants, rarely limiting, and excesses can be toxic. Copper toxicities can have a negative impact on crop growth and quality. Microbes are good indicators of copper excesses through export mechanisms.

High values indicate potential Copper toxicity

MANGANESE (Manganese Transport Equilibrium)

Manganese contributes to some biological systems including photosynthesis, respiration, and nitrogen assimilation. Manganese deficiency is a widespread problem, most often occurring in sandy soils, organic soils with a pH above 6, and heavily weathered tropical soils. Microbes are indicators of manganese problems through alterations of import/ export processes to their cells.

MEDIUM values are optimal for plant development

MAGNESIUM (Magnesium Transport)

Magnesium is the central molecule of Chlorophyll, a nutrient involved in many enzyme activities and the structural stabilization of tissues. It plays a key role in phosphorus transportation to where it is needed and the use of iron. It is crucial for the uptake of nutrients and for nitrogen fixation.

High values of magnesium transport by microbes are optimal.

Nutrition

Minor Nutrients

S
Sulfur
VERY HIGH

SULFUR (Sulfur Cycle Equilibrium)

Sulfur is an essential nutrient that plants need in sufficient amounts to maintain good health and achieve high yields. It is found in organic matter, but it is not available to plants in this form, so it must go through mineralization and cycling processes. It is crucial for chlorophyll formation, and it is an active agent in the metabolism of nitrogen.

MEDIUM to HIGH values indicate a healthy balanced functioning of the Sulfur cycle

Cl
Chlorine
VERY HIGH

CHLORINE (Chlorine Transport)

Chlorine is an important micronutrient that takes part in several physiological metabolic processes such as in disease resistance and tolerance, as well as in fruit quality and crop yields.

Medium to high levels of microbial transport helps to sustain a good equilibrium of this micronutrient. Soils may become deficient in chlorine if rainfall is high, or plants are irrigated too frequently, especially in sandy soils.

BECROP

A BIOME MAKERS TECHNOLOGY

Biome Makers, USA
202 Cousteau Pl Suite 100
Davis, CA 95618, USA
+1 916-378-8580
info@biomemakers.com

Biome Makers, Europe
Calle Estadio 9, Entreplanta C,
47006 Valladolid, España
(+34) 983 950 945
info@biomemakers.com