

PONGAMIA



SALICORNIA



PAULOWNIA



VETIVER

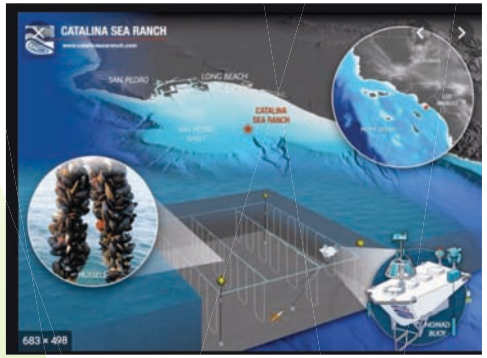
BIOTECH – BIOMASS - BIOFUELS



Catalina BioTech, Inc. is a 501(c)(3) non-profit organization with the mission to conduct research for pilot projects combating climate change

Regenerative Biomass for Fueling the Future with Renewable Biofuels

Catalina Sea Ranch, LLC (CSR), the first permitted aquaculture facility in U.S. Federal waters located 6 miles offshore California, has completed a $500,000 Department of Energy (ARPA-E) contract for growing Giant kelp in the open ocean. The 138 page final report serves as the business plan for producing high yields of sustainable kelp biomass for the emerging renewable biofuels industry. The three year Phase 2 contract worth $4.5M will implement the plan for producing regenerative kelp biomass offshore California.



The founder of CSR is also the founder of Syntheseas, a biotechnology company, that has partnered with leading bioenergy and research organizations to process and convert Giant kelp into biofuels at scale for commercialization and distribution. The relationships, technologies, and processes developed for this venture will be applied to this project.

Catalina BioTech (CBT), a nonprofit research organization affiliated with CSR, is proposing a pilot project for the Salton Sea Region to evaluate sustainable carbon and nitrogen sequestration biomass crops for producing renewable biofuels. This project would also demonstrate their potential as bioremediation crops for soil while creating habitat and dust suppression which is a high priority for funding Salton Sea restoration projects.

This project has the potential to be economically sustainable by leveraging the research for bioengineering and soil microbial impacts for the breeding of future higher-yielding biomass plants. Faster growing carbon and nitrogen sequestration biomass plantations, with shorter harvest rotational cycles, more tolerant to drought, wind, and salinity conditions in harsh environments, could revolutionize global desert agriculture and help mitigate climate change.

Syntheseas

FEDERAL, STATE, AND REGIONAL STAKEHOLDERS

CALIFORNIA AIR RESOURCES BOARD

CALIFORNIA natural resources AGENCY

The Salton Sea Authority

CALIFORNIA ENERGY COMMISSION

cdfa CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

USDA

CATALINA BIOTECH Protecting Our Oceans

BIOMASS FOR BIOFUELS



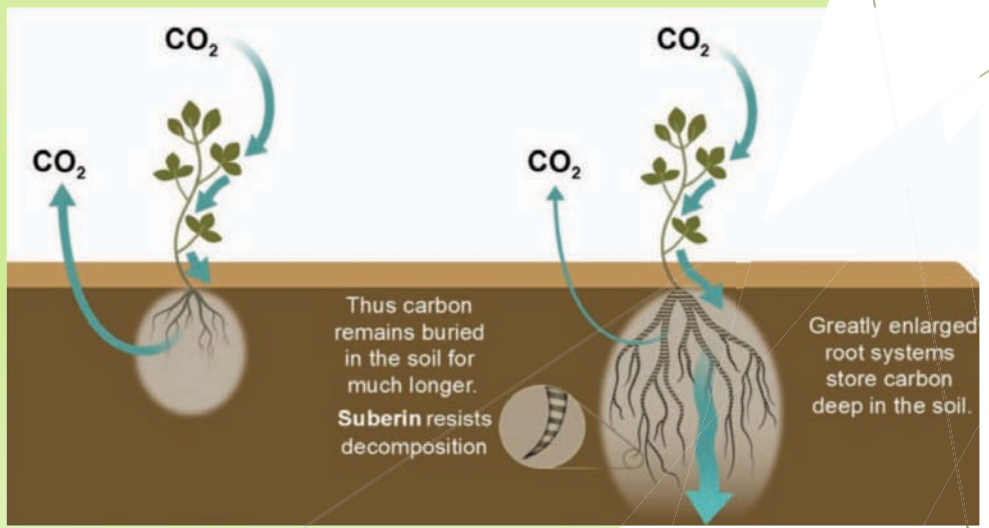
The Salton Sea Region provides an opportunity for funding as a total of $730 million has been authorized for mitigation and management activities from state, federal and local sources and $507 million remains unspent. Of this amount, $280 million is dedicated to begin projects implementing the state's ten-year management plan, which has a priority for both providing habitat and agricultural dust suppression.

Phase I will identify locations and secure lease and water rights for the pilot project as a model for expansion to create an economically sustainable biomass industry. Much of the properties in the Salton Sea Region are undeveloped and marginal public lands not suitable for traditional agriculture; thus, avoiding the "food versus fuel" controversy for biocrops.

This pilot project would provide real world data on the effects of desert climate, soil conditions for future scaling of productive lush and regenerative biomass habitat in the currently dusty and degraded Salton Sea Region.

Bioremediation crops have the ability to extract compounds from contaminated soil and water with root systems descending deep for reaching compounds not just from the topsoil but also from lower horizons. The leaves absorb agricultural dust with their significant transpiration extracting destructive compounds from the atmosphere complimenting the roots rapid growth and tolerance to pollution for storing carbon deep in the soil.

The massive root systems probe deep into the soil drawing up nutrients through the stem and trunk and into the leaves. This organic material is broadcast in a large circle of the plant leaf litter, which begins regeneration of the soil. Depleted soil is transformed and restored and humus begins to form producing thriving flora and fauna with regenerative microorganisms.



RENEWABLE BIOFUELS



Biofuel crops for this project uniquely possesses the C4 photosynthetic pathway, a competitive advantage over the more common C3 plants under conditions of drought, high temperatures with nitrogen and CO2 issues. When grown in the same environment at 30 C, C3 plants lose approximately 833 molecules of water per CO2 molecule that is fixed, whereas C4 plants lose only 277. This water use efficiency of C4 plants means that soil moisture is conserved, allowing them to grow more rapidly and longer in arid environments.

Nitrogen-fixation occurs in certain leguminous crops and is highly important in the production of biofuel feedstocks. The major biofuel crops such as corn and sugarcane are not nitrogen-fixers and must rely on nitrogen fertilizers produced from fossil fuels that pollute as runoff causing eutrophication.

C4 plants represent roughly 5% of plant biomass on Earth, but account for about 23% of terrestrial carbon fixation. The crops chosen for this research project are all C4 not requiring nitrogen fertilization and the Paulownia and Pongamia trees are renowned for nitrogen fixation.

California has a Low Carbon Fuel Standard (LCFS) requiring fuels sold in the state to steadily decline in Carbon Intensity (CI) by offsetting with a credit trading system. This trading system is expected to reduce greenhouse gas emissions from regulated entities by more the 16% between 2013 and 2020, and by an additional 40% by 2030. It is a central component to the state's broader strategy to reduce total greenhouse gas emissions to 1990 levels by 2020 and 40% below 1990 levels by 2030.

The cap-and-trade rule applies to large electric power plants, large industrial plants, and fuel distributors. About 450 businesses responsible for about 85% of California's total greenhouse gas emissions must comply. The California Air Resources Board (CARB) implements and enforces the program.

The key metric for competitive biofuels in California is based upon the CI score measuring the greenhouse gas emissions of transportation fuels from production to consumption. The holy grail for biofuels is to achieve a negative CI which provides significant credits for commercialization in the marketplace. C4 biomass plantations, sequestering massive amounts of CO2 and grown on marginal lands, have the potential to achieve this goal.





R & D Partners

BIOENERGY CROPS
International Consulting for Sustainable Development

Syntheseas

JBEI
Joint BioEnergy Institute

Lawrence Livermore National Laboratory

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

FRESNO STATE
Discovery. Diversity. Distinction.

UC DAVIS
UNIVERSITY OF CALIFORNIA

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

LifeMine

FORT VALLEY STATE UNIVERSITY

RegenBiomass



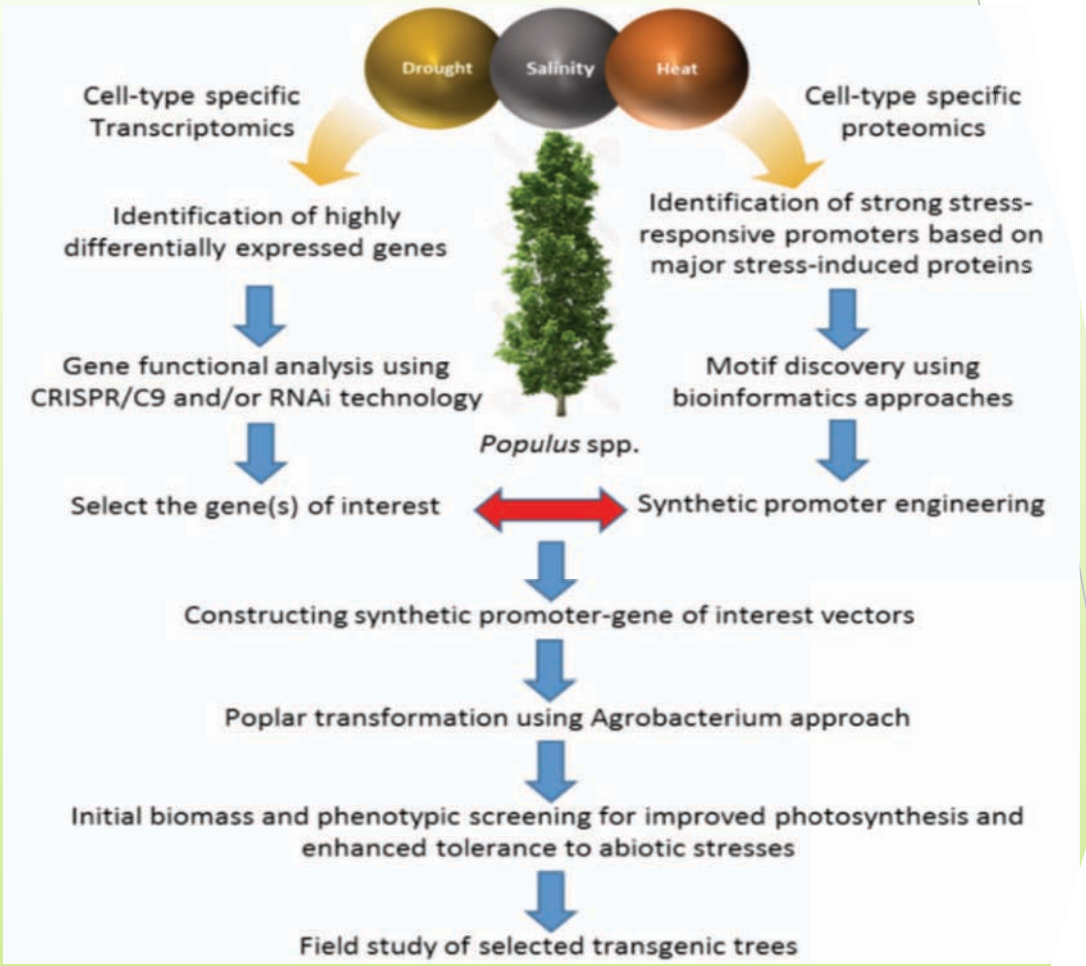
BIOENGINEERING

Genetic research for developing plants with desirable traits such as high biomass yield and other social and economic benefits, is critical for sustainably “fueling the future”.

Unlike most of today’s crop plants, which have gone through thousands of years of selection, breeding and domestication to achieve superior varieties, the bioenergy and bioremediation crops for this project, with genetic transformation, can produce rapid results for plant improvement.

Scientists are experimenting with genetic modification tools that supercharge plants to enhance carbon sequestration for convertion into carbohydrates, energy and oxygen. Plant biologists are targeting specific hormones and genes that increase biomass as carbon in roots, stored as complex carbohydrates, that are difficult for soil microbes to break down and therefore a more stable storage medium than above ground plants. The deeper roots store the carbon, the further from the atmosphere for improving the amount of natural carbon rich substance called “suberin” that resists decomposition and increases biomass and storage capacity of root systems.

Soil probiotics can also pull up over 100% more atmospheric carbon into the soil than non-treated plants amounting to an additional 4-8 metric tons of CO_2 equivalents per acre in one year. Trees and their roots forge chemical partnerships with microbes and fungi to take up extra nitrogen and phosphorus needed to balance their additional CO_2 intake.



Induction of polyploidy to obtain phenotypes with enlarged mass as a result of lower fertility spent on reproduction has been successfully employed in both plants and animals and will be researched during this project.

The R&D project partners have exceptional bioengineering and microbial scientific expertise for developing higher performing plants for increased biomass production and more tolerant to soil salinity, drought, and desert heat conditions.



PAULOWNIA PLANTATIONS

- Paulownia is the fastest growing tree in the world, can be harvested as quality lumber, and also grown as a short rotation biomass crop for the production of high value renewable biofuels. Whereas, most tree species can capture and store about 10 metric tons per acre of CO2 a year, these trees can absorb over 100 tons. They are not invasive to California, thrive when grown on marginal land, have minimal irrigation requirements. Moreover, a plantation of about 1,000 trees can annually absorb about 500 pounds of nitrogen.

- Paulownia trees do not require replanting as after each cutting (coppicing) the trunk regenerates for cyclical growth with a life span of up to 100 years. It is twice as resistant to fire (400 degree C) as other trees and insect resistant due to a high content of tannin. Previous commercial Paulownia plantations were economically driven by lumber harvested in 8-10 years.

- Due to Paulownia's rapid growth and high cellulose content, coupled with frequent coppicing capability, its potential as a biofuel crop has been extensively studied. The wood composition is 14% extractive, 50.55% cellulose, 21.36% lignin, .49% ashes and 13.6% hemi-cellulose. Under favorable conditions, a plantation of 1,000 trees can yield up to 150 tons of wood annually only 5-7 years after planting. Seeds contain 10.6% protein, 9.5% cellulose and 38.2% hydrolysable carbohydrates.

- While the calorific value of Paulownia trees is about 75% of coal, as a bioremediation and CO2 sequestration renewable resource, regulatory incentives makes it economically competitive as a biomass for renewable biofuels.



PONGAMIA BIOFUEL TREES

Pongamia is one of the few leguminous trees that each season can produce as much as ten times the oil per acre as soy for conversion into liquid biofuels and its seedcake is three times higher in protein than soy also making it competitive as a livestock feed.

This fast growing tree is draught and saline tolerant making it ideal for producing biomass on arid and marginal lands requiring bioremediation. It is also resistant to many diseases and pests not requiring pesticides, and as a legume, fixes nitrogen reducing the need for fertilizers.

The University of Queenland in Australia has documented the following benefits from its research for the commercialization of Pongamia trees:

- Next Generation biodiesel and aviation biofuel feedstock
- Each tree produces about 60 pounds of seed annually
- Yield up to 612 gallons of oil per acre annually
- Up to 55% seed oil content
- Nitrogen fixing legume
- Drought tolerance after sapling stage
- Salinity tolerance to 20 dS/m
- Precocious flowering possible in 15 months
- Major cropping possible in 4-6 years
- Seed delivers high fermentation yields for biofuels

Extensive research has been conducted with the genome sequenced and annotated showing wide genetic diversity. DNA fingerprinting has determined that offspring from several elite trees featuring desirable production traits are highly related.







SALT LOVING SALICORIA

Salicornia *bigalovii* is a halophyte (salt loving plant), native to California commonly called pickleweed. Salicornia could provide food, fodder and renewable biofuels without requiring precious fresh water. It can tolerate total immersion in saltwater without fresh irrigation water and easily absorbs the salt. It can resist salt concentrations up of 50,000 ppm, which is saltier than ocean water at 35,000 ppm. The Salton Sea is currently about 44,000 ppm and is projected to become saltier as it evaporates with each passing year. Thus, the need for research and bioengineering with this project.

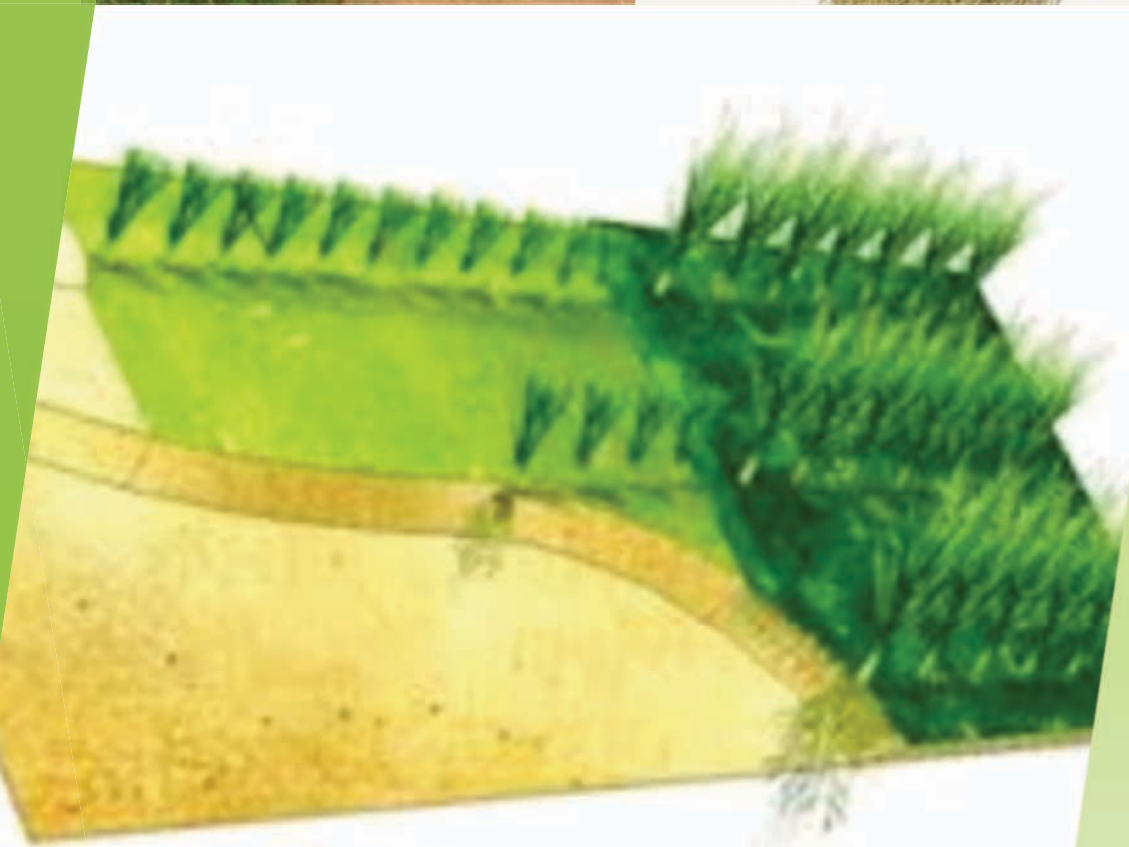
Salicornia is also a C4 plant with seeds containing high levels of unsaturated oil (30%) for conversion to biofuels and has protein at about the same amount as soy (40%) for food and fodder. It grows to about 2 feet tall in 7 months for producing high yields of biomass as a sustainable and renewable "Energy Crop".

An improved variety of Salicornia SOS-10 (Salicornia oilseed 10th year of development) was selectively developed during the early 1980's. During the 1990's Salicornia was successfully cultivated in Arabian Gulf waters at 40,000 ppm salinity with yields of 70 bushels per acre, which is about the same yield as soybeans on rich Iowa farmland.

During the past decade, the Masdar Institute and the International Center for Biosaline Agriculture in Abu Dhabi have been growing Salicornia in the UAE. More than 45 Salicornia genotypes have been screened for growth parameters under groundwater and seawater irrigation treatment. The results show tremendous breeding potential for these halophytic populations for higher yielding crops. In 2018, a vegetable crop of Salicornia reached 23.7 tons per hectare with a bumper seed yield of 3 tons per hectare using aquaculture effluents. It is estimated that an hectare of Salicornia can produce 225-250 gallons of bio-diesel and after extraction of oil its high protein meal (42-45%) can be used to feed livestock and fish farms.







VETIVER

Vetiver *zizanioides* is a perennial tufted California plant commonly cultivated around the world as a miracle grass with diverse environmental applications. Its massive root system (up to 12 feet deep) is used as fodder for livestock, soil and water conservation, rehabilitation, soil remediation and wastewater treatment. Vetiver also sequesters significant quantities of CO2 but there is minimal research as a potential biomass feedstock for biofuels. The leaves are rich in cellulose (32.6%, hemicellulose (31.5%) and lignin (17.3%).

Vetiver is ideal for intercropping and, in addition to its ecological benefits, commercial plants are non-evasive as they are naturally sterile hybrids incapable of propagating. Another important function is that this fast growing plant could serve as a windbreak for protecting rows of small plantation trees until their root structures mature.

VETIVER CHARACTERISTICS & RESILIENCE

- Survival in temperatures from -14 C to 55 C and soil pH ranging from 3 to 10.5
- Disease and pest resistant with life span up to 100 years
- Forms a dense hedge when planted close together for plantation protection from desert winds
- C4 photosynthetic ability produces massive biomass of over 100 tons per hectare.
- High tolerant to soil salinity levels and arid land conditions



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