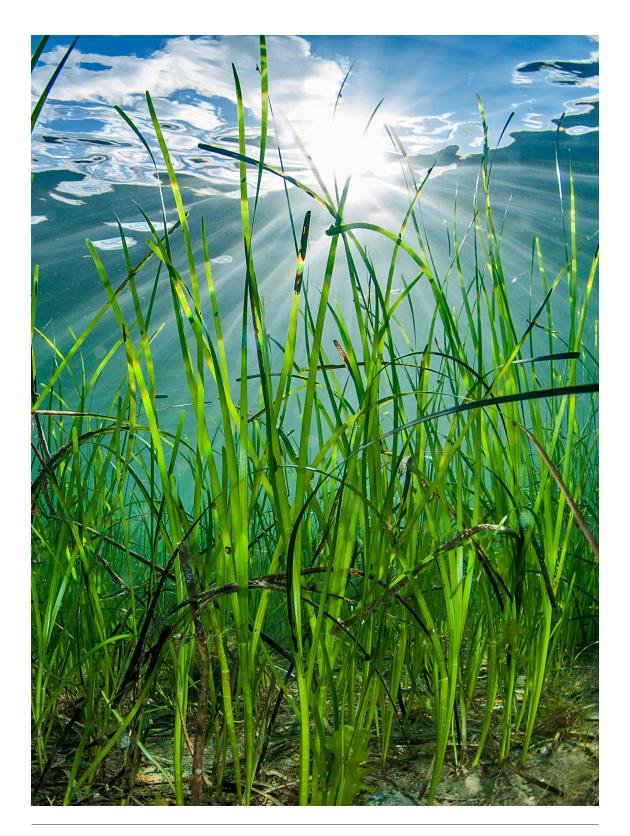
## APONIENTE & Marine grain

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#### MARINE GRAIN Another step forward in the discovery of the new foods to be found in the great pantry that is the sea, which plays a key role in combatting climate change.

#### INTRODUCTION

At Aponiente, for more than a decade now, we have been making observations and researching new foods and other products that come from the great pantry that is the sea. The idea is to include them in the human diet. Our dream is that one day people will be able to feed themselves exclusively with marine products that are not necessarily fish.

Every day, we immerse ourselves in our dream, in the waters of the Bay of Cádiz in the south of Spain. The Bay is located in Andalusia, and is separated from the African continent by a narrow strait. Today, we are just a bit closer to our goal thanks to the discovery of new uses for a marine grain, also known as sea rice.



#### What is the marine grain? The marine grain we've focused on comes from a kind of aquatic seagrass called Zostera marina.

It is thought that all land-based plants began as marine plants. We believe this one is a form of seagrass that adapted to grow on land many years ago, reproducing through flowers and seeds, but ultimately returned to the sea, where it continued to evolve into its current submerged state. This select plant belongs to one of the few families that followed this trajectory.

One of four types of marine phanerogams in Europe, the plant currently flourishes in its natural state. We discovered it about three years ago on one of our frequent underwater expeditions during which we harvest different marine plants for research purposes.

For the first time ever, we at Aponiente have managed to grow this marine plant under controlled circumstances. In 2017, we began a groundbreaking study, which has revealed the plant's feasibility for human consumption. What's more, it might be considered a "superfood" given its unique nutritional qualities."





#### Pioneering project on a world scale.

At Aponiente's research lab, we have achieved the cultivation of Zostera marina and its seed – marine grain. For the first time ever, controlled crops have been successfully grown. Never before has this goal been reached.

The project was launched in 2017 – the first of its kind in all the world. The undertaking allowed for the recovery of the native species, Zostera marina, helping to generate greater marine biodiversity, thus enriching our ecosystem and strengthening the region in the struggle against climate change.

Currently, the experimental cultivation area measures some 3000 m2, and is located in Bahía de Cádiz Natural Park, near the municipality of Puerto Real. Along the northern coast of Spain, and throughout Europe, there are naturally occurring marine meadows teeming with Zostera marina. The wild species is now protected, given that it plays a crucial role in the ecosystem, but it is still dying at an alarming rate in areas where it once grew in abundance. Human marine activities have had an adverse effect on the plant.

Despite their importance it is extremely challenging to carry out reforestation projects of this kind. The problem is that there are no nurseries that are prepared to supply the appropriate plants and/or seeds. One aspect of the present project that makes it so notable is that, for the first time, a seed bank will be created that will serve to repopulate coastal wetlands, which can then be restored and managed.

#### Cultivating the future.

After three years of hard work, we have proven the viability of the controlled cultivation of this plant, the creation of a seed bank, and the properties that are most beneficial for human consumption. Systems have been developed for planting, cultivating and harvesting the plant, all adapted to the marine environment.

We have challenged ourselves to create the world's first and only specialized R&D center for the cultivation of marine vegetation. The goal is to continue researching this marine grain, as it may hold the key to mitigating the effects of climate change. We also aim to restore aquatic ecosystems, develop future marine crops that until now have been cultivated only on land, and work toward making the "ocean garden" a reality.

Three quarters of the planet's land is bathed in salt water, whether along the coasts or deep in inland wells, making it impossible to drink the water there or grow crops. Our marine grain changes everything, paving



## Benefits and trade-offs.

#### What benefits does this new food have, and how can it contribute in an ecological, social and culinary sense?

- Extraordinary ecological, social and environmental benefits.
- Essential in the battle against climate change, regenerating marine life and contributing to the survival of numerous marine species.
- Provides a multitude of direct and indirect benefits for humans and for coastal areas.
- Cultivates biodiversity and marine resources.
- Retains sediments and protects coastal areas. Recycles nutrients and produces oxygen.
- The most sustainable crop currently known, requiring only seawater, without pesticides or treatments.
- A new superfood thanks to its high nutritional value. Contains essential fatty acids, Omegas 6 and 9, and amino acids not found in other common grains and minerals. Has significant glucose levels.
- Leads to enrichment of ecology, landscape and social systems. Can be cultivated in marshland and coastal areas.
- Economic wealth for depressed zones. Cultivation is much more productive and profitable than other kinds of land-based grains.
- Countless uses. Can be consumed as is, but can also be transformed into flour and related products.
- In future, these plants will remove carbon from the air, which may lead to a rise in the number of reforestation projects, and the subsequent demand for seeds and plants for the development of these undertakings.



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#### A new superfood with great nutritional value. Marine grains have a seed that is much denser and more nutritional than other grains. It might be classified somewhere between rice and other legumes.

In a comparative study with five other grains (rice, barley, wheat, oats and corn), we have determined that marine grain contains a greater quantity of high-quality proteins (13%), carbohydrates (82%, of which some 50% is starch), and less than 2% fat (vegetable). It also contains vitamins A and E, not found in any other kind of grain, as well as high concentrations of various B vitamins.

In addition to essential fatty acids, Omegas 6 and 9, and amino acids not found in other common grains and minerals, it also has significant levels of glucose, making it a superfood with exceptional qualities for a healthy diet. On a culinary level, it opens the door to a new texture: dense and firm, like pasta prepared al dente. Flavor-wise, it is aromatic, plant-based and iodized. Its characteristics for culinary use range from boiling it like a rice or a pasta, to processing it into flour to make breads or dried pastas.

#### Marine grain vs land-based grain

In a comparative analysis with common rice and other grains, we have determined that marine grain presents excellent characteristics and qualities:

• Macronutrients: much more balanced than common rice when it comes to percentages of proteins, carbohydrates and fiber.

• Micronutrients: contains more plant-based fatty acids than any other grain commonly eaten. It also has amino acids not found in common grains, high quantities of vitamins and minerals, and a significant proportion of glucose.

### Comparative Nutritional Table Marine Grain vs. Land-based grain

VALUES	COMMON RICE	MARINE GRAIN
Proteins	6,61	10,1
Lipids	0,58	2,9 (vegetales)
Carbohydrates	79,34	83,5
Fiber	0,4	0,38
Vitamin A	0	0,075
Vitamin E	0	0,98
Alanine	421mg	565mg
Arginine	480mg	486mg
Cystine	93mg	410mg
Phenylalanine	328mg	415mg
Glycine	345mg	561mg
Isoleucine	286mg	648mg
Leucine	556mg	822mg
Lysine	244mg	690mg
Valine	412mg	526mg
Tryptophan	76mg	124mg
Tyrosine	219mg	267mg



#### Sustainable crops.

The studies we have carried out confirm that Zostera marina, and marine grains in general, are the most sustainable crops currently known. Why? There are several reasons for making this statement, but there are two fundamental issues that must be highlighted:

• Crops do not require fertilizers or chemicals.

• Crops do not need additional nutrients, just the circulation of seawater.

# Leads to enrichment of ecology, landscape and social systems

At Aponiente, we have managed to bring the biological cycle of Zostera marina full circle. In addition, we have proven that the cultivation of marine grain generates diverse habitats when it comes to ecology, landscape, social systems and the environment.



In our detailed study of marine grain, we cultivated nearly 3000 m2 in the Bay of Cádiz. In the process, we recovered areas that had been abandoned for decades, thus contributing to the social and environmental revitalization of the area.

We are working to restore the ancient salt marshes and fish farms, in an experimental effort to favor the marine grain crops that have made it possible to maintain a primary traditional industry and recover whole ecosystems. The result is both species and high-value-added products (sea rice + fish + crustaceans), generating a level of marine biodiversity that had previously disappeared.

In addition, these crops contribute to carbon drawdowns, and as such, to the mitigation of harmful substances that are causing climate change.

#### Social surroundings.

Cádiz is located in one of the areas in Spain, and indeed in Europe, that is most affected by unemployment and the fragile economic situation. It is the only Spanish province that is eligible for ITI funds through the European Union. The tool was designed by the EU to support a set of integrated actions in a specific geographic area that is particularly depressed.

The province with the highest unemployment rate in Europe, currently in an economic and social situation that truly sounds the alarm, Cádiz is an extreme case. It is also the Spanish province with the greatest number of high-population municipalities in all of Spain. More than one million inhabitants, about half of whom live near the Bay, have always worked in tourism and construction. They have watched as almost the entire industrial sector has collapsed.



The value of the salt marshes and swamps of Cádiz was once impossible to measure. Today, most have sunk into abandon, while others have been lucky enough to be protected within proposed natural parks or are otherwise protected by UNESCO.

These spots are ideal for the development of ecosystems made up of communities of plants and animals, whether aquatic, land-based, coastal or marine. They are spaces where our marine grain can grow and evolve sustainably both naturally and economically.



**Key weapon against climate change.** The benefits for the environment are countless, given that coastal wetlands and marine grain meadows comprise ecosystems that are fundamental for the planet's equilibrium.

Phanerogam meadows are the most efficient carbon sinks on Earth. They provide protection from extreme climactic phenomena, including storming and flooding, which are on the rise thanks to global warming. This is one of the key reasons for the development of the present project: its contribution to caring for the environment.

- Captures blue carbon, generates oxygen and regulates the carbon cycle.
- Mitigates tidal effects and rising sea levels.
- Prevents underwater erosion and provides habitat for valuable underwater wildlife.



Extremely productive crop with few technical requirements. The studies we have carried out have determined that crop yields are similar to other kinds of grains, like common rice for example, in addition to being very productive and with scarce technical requirements:

- The results point to high productivity, with almost five heads per plant.
- Potential for up to 20 seed pods per generative shaft.
- Average density is about 675 generative shafts per square meter, with maximum levels of up to 1000 shafts/m2.
- Yield estimates in wild settings are of 5-7 tons per hectare, which is similar to the production of other kinds of grain.
- Preliminary calculations show that potential average harvests could be around 3.5 Tm./Ha, with conservative estimates of around 6 Tm./Ha, and a potential maximum of about 14 Tm./Ha.
- Thanks to chloral growth, the same plant recurs, resulting in numerous plants throughout the year. As such, the system makes use of exponential root reproduction (each year, five plants result from just one planting).
- Scarce technical requirements, keeping maintenance costs low.
- The plant is a perennial, making it unnecessary to plant crops each year. No pesticides are required, given that it remains free of blight and suffers from no known diseases. Neither is fertilizer needed as long as seawater is constantly circulating (not irrigation). The plant can also be used for other purposes, including drying leftover leaves for straw.
- Seed heads appear annually, and they drift away after dropping the seeds, leaving the harvest unaffected. The plants continue to grow and the harvest takes place the following year.



## APONIENTE 🕺 Marine grain

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