Labor shortages and disasters contribute to a looming problem with food supply.

What limits are there on reproducing sunlight, which gives rise to and nurtures all life?

# Nurturing with Light

Agriculture/ Fisheries

## Changes in agriculture

Centering on fruits and vegetables, research aimed at increased the efficiency and reliability of crop production has been going on for quite some time, even in regions and seasons that are not favorable to growing. Such research is motivated by consumer needs, and is directed at replacing production that relies on years of experience and in the face of weather fluctuations in the natural environment with protected horticulture that is grounded in the science of high-tech devices and environmental control. One aspect of this is industrialized agriculture, the so-called "plant factory."

"Vegetables that are grown in green houses, where temperature, light and water are controlled, are not subject to the vagaries of the weather, making it easy to set up production plans. Worries about plant diseases and pests are also reduced, making it possible to eliminate agricultural chemicals and deliver vegetables that are safe for the table." So says the development manager of Ushio's LED light sources for growing plants. With national support and participation of industries of other areas, the number of plant factories has grown steadily over the past few years, and it is a field with great prospects for future growth.

"Use of light to grow plants has been studied since long ago. Ushio began undertaking the development of light sources for plant factories at the instigation of a certain university's research laboratory, which talked to us about the possibility of replacing the metal halide lamps it was using for cultivating rice with LEDs. We undertook collaborative research on this topic with the aim of not simply saving power by changing the type of light source, but by providing added value through application of Ushio's own light control technology."

## The possibility of vegetables with functionality

As research progressed, we learned that the constituents included in vegetables were affected by the wavelength of light and the duration of irradiation. "Depending on the wavelength of light and fertilizer components, we can grow vegetables of new types that have never been seen before. Take, for example, lettuce in which the proportion of potassium has been reduced to 1/10. While potassium has the effect of lowering blood pressure by forcing sodium out of the system, its concentration in the blood increases in cases of kidney failure, resulting in worsened symptoms. Reducing the amount of potassium in lettuce by 90% allows it to be eaten with confidence even by people who have restricted diets. Furthermore, the ruthin contained in komatsuna (Japanese mustard spinach) and spinach is a powerful antioxidant which is attracting attention for its usefulness in preventing eye diseases such as cataracts and age-related macular degeneration. Also, basic research into genetic modification and related techniques raises the possibility of incorporating influenza or other vaccines into crops such as rice, raising the possibility that it will one day be possible to eat vaccines rather than take them as an injection. The field of preventive medicine is just one in which 'functional vegetables' are being studied as a means of delivering vaccines and antibiotics."

Experiment in rice growing using high-intensity LED units.

Continuing, the manager says, "Crops capable of providing both food and medicine together can be safely eaten even by infants and the elderly. It also makes use of syringes unnecessary in areas where sanitation conditions are poor, and has a variety of other advantages. Expectations are high

# Agriculture/ Fisheries

that such crops could also be mixed into animal feed, helping to prevent losses due to disease, etc. Since I used to do semiconductor-related work, it's odd to imagine that now I find excitement in the fun and challenge of raising vegetables. It's a lot of fun!"

Ushio's endeavors in agriculture are not limited to raising vegetables, but also extend to studying how UV light can be used to keep vegetables fresh and prevent growth of mold after crops have been harvested. "Increasing shelf life by even a day greatly enlarges the geographical area in which agricultural products can be sold, allowing more people to enjoy the benefits of fresh fruit and vegetables. This can help vitalize agriculture."

Sales people say that this will also help to develop demand in countries that don't have suitable growing environments. We have our sights on both how agriculture is conducted and on addressing the world's food problem.

## How Ushio is changing fishing lights

Ushio also has a long history with the fishing lights that fishermen use to lure squid, mackerel and other fish. "In the 1970s, Ushio was the first company to offer halogen lamps as replacements for the ordinary incandescent lights that fisherman were using to lure fish," says our manager of fishing lights. Because squid are attracted to the surface more by brighter lights, fishermen competed with each other to outfit their boats with the most lamps. This competition became so fierce that the government stepped in to impose limits on the number of lamps that could be installed.

"For many years, fishermen used metal halide lamps when fishing for squid and halogen or incandescent lamps when fishing for mackerel. With mackerel fishing, the cost of fuel to power the lamps could amount to more than 30% of operating costs, and somewhere between 30 and 60 percent of all fuel carried would be consumed to power the lighting. At one point, rising crude oil prices pushed up the cost of oil fuel used in fishing by 300% in just five years, leading to a demand for more efficient and effective LED fishing lights. The question was, how deeply and brightly can LED lighting penetrate the ocean? And that wasn't the only problem. In the harsh environment of the ocean, lamps must also be able to withstand vibration and resist salt."

The key to increasing the efficiency of fishing is increasing the size of the catch. In order to test the ability of light to attract mackerel and squid, developers would sometimes ride on fishing ships. "Just as the color of the ocean differs slightly according to region, there are also slight variations in the color of light that is most effective for catching fish. Bluer light works better in colder waters, and redder light works better in waters that are warmer. Preferred light colors also differ by nationality, and Taiwan, China, and Korea all have different color preferences. There is still much that is unknown about the relationship between light and fish, and we often look to fishermen's experiences for ideas and suggestions. We would like to see fishing with lights spread to the countries of Southeast Asia, where economic development is leading to an increase in scale of the fishing industry. I would like to continue supporting the development of light so that the fishing methods used in Japan can serve as an example in other countries."

Fishing lights are so bright that they can be clearly seen in photos taken from satellites. Ushio's fishing lights will continue lighting the night seas in years to come.

**LED for plant growing**
Bar-type LED unit that allows users to vary light according to need by adjusting the light of separate red and blue LEDs.

Fishing boat with shining squid lights



**Halogen fish-luring light**
Introduced in 1973, this was Japan's first fish-luring light to use a halogen lamp. Twice as bright, lasts five times as long, and one tenth the size.