Bio-cycles: A contribution to sustainable agriculture

The Ajinomoto Group produces the amino acids used in its products through fermentation processes from crops that are easily available in each region. Nearly 100% of the nutritionally rich by-products (co-products) that remain after extracting amino acids in the fermentation process are then used as fertilizer and feed. The Group considers such recycling-based amino acid fermentation processes that procure sustainable agricultural production while enriching regional agriculture as "bio-cycles." These bio-cycles are a means of simultaneously contributing to reliable supplies of food resources and realizing sustainable agriculture. For this reason, the Group is introducing these cycles at its fermentation factories worldwide.

The chart assumes worldwide annual production of approximately 0.5 million tonnes of the umami seasoning AJI-NO-MOTO® by the Ajinomoto Group using only sugarcane. The values of sugarcane grown and sugar production are commonly used global figures, and the values of resources used for producing AJI-NO-MOTO® are based on actual statistics from the Group.

If fermentation were not used to make amino acids...

Assuming an annual production of AJI-NO-MOTO® with fermentation by the Group 0.5 million tonnes

- If all were made from kombu kelp... 25 million tonnes in dry weight required 833 annual harvests of kelp in Japan

- If all were made from tomatoes... 200 million tonnes required 1.6 annual harvests of tomatoes worldwide

[1] Calculated based on the average extraction of glutamate of 2.24 grams per 100 grams of kombu kelp
[2] Calculated based on the average extraction of glutamate of 0.14 grams per 100 grams of ripe tomatoes
From amino acid co-products to value-added fertilizer

Plants synthesize amino acids from absorbed nitrogen and sugars gained through photosynthesis, then use amino acids to synthesize proteins necessary for growth. Even under insufficient photosynthesis conditions caused by cloudy weathers or low temperatures, plant growth can be stimulated by supplying amino acids as fertilizer.

For more than 40 years the Ajinomoto Group has been effectively utilizing the nutrient-rich co-products of amino acid fermentation as organic-type fertilizer. By fortifying these co-products with suitable amounts of phosphoric acid and potassium, for example, the Group has developed fertilizers with higher added value. Continued experiments and researches have been revealing these amino acid enriched fertilizers to have an enhancing effect on root development, plant growth, and harvest yields.

**AJIFOL® foliar fertilizer**

Foliar fertilizer formulated with concentrated amino acids and minerals, used to effectively supply nutrition through the leaves in small amounts. First released in Brazil in 1989 and now produced in seven countries worldwide.

Micronutrients are efficiently absorbed in small amounts.

**Benefits of AJIFOL®**
1. Higher yields
2. Stronger disease resistance
3. Sweeter fruit (Brix value)

High-bench strawberry cultivation. AJIFOL® was used on strawberries that displayed inhibited growth from root damage, with poor leaf color, blossoming and growth. Plant vitality returned with foliar supplementation of amino acids.

**ROOTMATE® and AMIHEART® for enhanced root development**

Rich in root-development-stimulating nucleic acids, these fertilizers promote crop growth by mitigating the effects of inadequate sunlight and heat stress.

Better developed roots increase adsorption of water and micronutrients essential to plant growth, such as nitrogen, phosphorus, and potassium.

**Effect on tomatoes**

Control (chemical fertilizer) 0.1% AMIHEART® Control 0.04% AMIHEART®

Larger fruit
Toward sustainable coffee beans procurement
Initiatives at Ajinomoto AGF, Inc.

To address the looming supply shortages facing coffee, Ajinomoto AGF, Inc. has begun strengthening connections with coffee beans producers and creating systems of stable procurement long into the future. Relationships are being developed mainly through providing farming supplies and equipment and outsourcing to farmers the verification testing of co-product AJIFOL® and other high value-added fertilizers produced by overseas group companies.

Coffee beans bio-cycle from partnerships between group companies

Group companies

- Suggest value-added fertilizer using fermented mother liquor
- Raw beans
- Coffee products of Ajinomoto AGF, Inc.

■ Brazil

Brazil is the largest coffee producer in the world. Most production is concentrated in the central, east, and southwest regions of the country. At a coffee plantation in the east Cerrado region, where Ajinomoto AGF, Inc. has been testing the enhancing effects of AJIFOL® fertilizer produced by AJINOMOTO DO BRASIL IND. E COM. DE ALIMENTOS LTDA. (“AJINOMOTO DO BRASIL”) on coffee bean productivity and quality since September 2016, the fertilizer shows equivalent effect to an existing fertilizer the plantation has been using based on its many years of experience. While further testing is needed—the test will take at least two years—the company plans to continue strengthening relationships with producers with an eye to boosting the value of its coffee products.

■ Indonesia

In Indonesia, Ajinomoto AGF, Inc. has been test-spraying AJIFOL® and providing equipment and supplies to farms mainly in the Pagar Alam region since September 2017. So far, the company has handed out weeding equipment, tarp tents, insect traps, long-sleeve T-shirts, rubber boots, and work gloves.

■ Vietnam

At 10 coffee farms in the Krông Nâng, Ea H’leo district of Vietnam, Ajinomoto AGF, Inc. supplied 250,000 young coffee trees between May and September 2017 and began testing fertilizer from AJINOMOTO VIETNAM CO., LTD. The company also provided technical guidance to more than 3,000 local farmers on watering methods and the planting of shade trees to protect coffee trees from direct sunlight.
Production without waste: Resource-saving fermentation technologies

Demand for the crops used in amino acid production is rising as they are important food resources and also used as biofuels and industrial materials. As a leading amino acid producer, the Ajinomoto Group has a social responsibility to developing lower-impact production methods.

Leveraging its advanced proprietary leading-edge bioscience and fine chemical technologies, the Group has been actively working over the years to develop efficient “resource-saving fermentation technologies.”

Two examples of resource-saving fermentation technologies are those that reduce raw materials and energy use by enhancing fermentation productivity, and those that employ rice husks, wood chips, and other unused local biomass as energy sources. These technology developments help secure food resources while reducing water use and carbon emissions in procurement and production. The Group also aims to apply technologies that make use of non-edible biomass such as bagasse (sugarcane fiber) and corn stalks without competing with food resources.

To accelerate R&D and further improve these technologies, the Group is partnering with various entities with cutting-edge technologies in Japan and abroad, including venture companies, universities, and research institutes.

Technology roadmap

Around 80% of amino acid production factories slated for introduction of resource-saving fermentation technologies have introduced raw materials and energy-reducing technologies as of the end of fiscal 2017. The Group will complete technology introduction at roughly 90% of target factories by fiscal 2019, beyond which it will pursue further technology development and deployment. The Group also aims to realize on-site production of ammonia, a sub raw material, at certain factories by around 2021.

Around 60% of factories use biomass as of the end of fiscal 2017. The Group will continue to shift to cogeneration systems[1] and increase this number.

Efforts in natural capital valuation

The Ajinomoto Group recognizes the critical importance of accounting for its business impacts on natural capital for realizing sustainable growth. Taking amino acid production as a case study, it compared impacts between current methods and production using non-edible raw materials.

Specifically, the Group compared the value of natural capital, converted to US dollars, in two different scenarios of converting raw materials into umami seasoning AJI-NO-MOTO® in Thailand: first, fermenting cassava root as a sugar source, and second, fermenting non-edible biomass.

The results show that using non-edible biomass is more advantageous, as it could save at least several million US dollars in social costs while reducing adverse impacts on natural capital.
Conservation of ecosystems and biodiversity

■ Biodiversity approach

The Ajinomoto Group expresses its approach to ecosystems and biodiversity in the Group Shared Policy on Environment and Ajinomoto Group Long-Term Environmental Vision, and works as a group to achieve its goals based on these vision and policies.

■ Fisheries

Ajinomoto Co., Inc. is committed to conserving resources and working toward sustainable use, as a company that uses skipjack as an ingredient in its major flavor seasoning product, *HON-DASHI®*. Since 2009, the Company has conducted the joint skipjack tagging survey with the National Research Institute of Far Seas Fisheries (NRIFSF) in Japan.

In recent years, skipjack catches have fallen significantly in waters around Japan, resulting in difficult times for the domestic skipjack fisheries. Against this backdrop, the company has been actively sharing the knowledge of skipjack ecology gained from surveys with domestic stakeholders, aiming to contribute to sustainable regional development and the domestic skipjack fishing industry which supports Japan’s food culture.

In fiscal 2016, the survey area was expanded upstream of the Kuroshio Current as joint surveys with the Taiwan Fisheries Research Institute started. In April 2018, a consortium was launched from the survey’s parent organization. Moving forward, the Company will encourage more stakeholder involvement and advance the study of skipjack distribution and ecology for better resource management and to establish international resource management rules.

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[1] Research team formed by the participation of Hokkaido University, University of Tokyo, Kyoto University, and Tokyo University of Marine Science and Technology in the Japan Science and Technology Agency (JST) Strategic Basic Research Programs

[2] Fisheries Research Institute, Council of Agriculture, Taiwan, Republic of China

Overview and findings of the joint tagging survey of skipjack

Scientific knowledge, such as skipjack ecology, is necessary to establish international resource management rules. However, many things about the skipjack are still unknown, including its ecology and migratory routes to Japan. Accordingly, regular tag-and-release surveys of about 10,000 skipjacks started from 2009; further, use of the latest archival electronic tags started from 2011 to confirm skipjack migration routes along the main stream of the Kuroshio Current, from the Nansei Islands to the Pacific coast in western Japan.

Tag-and-release survey findings
Skipjacks were previously believed to migrate north by traveling on the Kuroshio Current, but the survey findings estimate that there are currently four migratory routes from subtropical regions to the coastal waters of Japan (Figure 1). Moreover, analysis of vertical swimming behavior for 10 days revealed that skipjacks inhabit the deep at daytime and shallow depths at night (Figure 2).

Use of the latest ultrasonic tags (pingers)
Since 2015, the survey has adopted the latest pingers using ultrasonic transmission of skipjack swimming data in cooperation with the Tokyo University of Marine Science and Technology. In 2016, researchers developed onboard receivers for fishing vessels and successfully conducted an experimental study in the open seas at Yonaguni Island. From the data obtained, researchers can watch skipjacks accumulating in areas and then separating and moving away, and also specific movements between fish aggregating devices (FAD) in the region. The system also allows local fishermen and Tokyo researchers to share real-time data for observing fish behavior.

Expanding this pinger-receiver network should yield major progress in understanding the wide-ranging behaviors of highly migratory species including skipjack. The Company is now talking with local stakeholders to expand the receiver network to waters near the Miyako Island and Kochi prefecture in Japan.
Agriculture and forestry

In its Long-Term Environmental Vision, the Ajinomoto Group has set a goal to achieve procurement with 100% sustainable palm oil and paper (FSC®-certified paper or 100% recycled paper, or paper considered environmentally responsible by the Group) by fiscal 2020.

Refer to the fair operating practices section for details of initiatives.

Sustainable land use and local ecosystems

Corporate land used for offices and factories is also a part of the local natural environment, with green spaces, in particular, playing an important role in local ecosystems.

The Tokai Plant of Ajinomoto Co., Inc. is situated in a large industrial complex in Yokkaichi City, Mie Prefecture. The site includes an approximately 5,000-square-meter freshwater pond surrounded by trees. In 2002, the company expanded the area into a 1.27-hectare biodiversity conservation area called the Ajinomoto Bird Sanctuary in Yokkaichi.

The sanctuary is currently home to six species of heron including the intermediate egret, which is designated as an endangered species by Japan and Mie Prefecture. Other rare species include the northern goshawk and common kingfisher, the latter being a species only found in clean water habitats. The sanctuary also serves as a stopping point for migrating birds.

The Company will continue its ecosystem surveys and other initiatives to restore the entire Yokkaichi ecosystem and develop preservation efforts.