Research and Development for Businesses, Products, and Technology

To help solve social and environmental issues, it is imperative to adopt perspectives of sustainability and environmental conservation in each process of product development at each stage of the product development process, and carry out relevant R&D. The Ajinomoto Group is working hard—not just at its business and R&D centers around the world but also in cooperation with others outside the Group—to reduce its environmental impact across its business activities and throughout the life cycles of its products, and create new socially and environmentally beneficial businesses.

■ Toward creating greener businesses that contribute to the environment

To achieve sustainability both in terms of global society and business, companies, when conducting R&D, must make predictions about the future of the global environment as well as gain an accurate understanding of current conditions. The Ajinomoto Group will contribute to solving the problems humankind facing in the 21st century through its business activities and R&D (and resultant intellectual property), as well as through open innovation in collaboration with various sectors of society. The three main areas on which the Ajinomoto Group will focus its R&D activities are food, pharmaceuticals and health, and environment and lifestyle. Particularly in the area of environment and lifestyle, the Ajinomoto Group is expected to utilize its advanced biotechnology while introducing a wide range of technological innovations in production, such as renewable energy and processes with a smaller environmental footprint, in order to help solve increasingly serious global environmental and food resource problems. To explore broader possibilities in the search for solutions to global social problems, Ajinomoto Co., Inc. reorganized its research laboratories in October 2010 and launched a new R&D system.

21st century global issues to resolve through R&D

Global sustainability
- Climate change
- Shortage of fossil fuel resources
- Worsening biodiversity

Food resources
- Food shortages due to growing population
- Disposal of large amounts of food waste

Healthy living
- Malnutrition and overnutrition
- Aging society
- Rising health care costs

Solutions
- Developing renewable energy and materials
- Manufacturing technologies with minimum environmental impact
- Securing renewable raw materials
- Increased and more efficient food production
- Reducing malnutrition in developing countries
- Increasing safety awareness
- Increasing health awareness
- Better healthcare and health management
- Needs for affordable healthcare

Ajinomoto Group initiatives

Environmental and lifestyle technologies
Sustainable, environmentally friendly technologies
- Low-resource consuming fermentation
- High-function, high-efficiency agricultural, stockbreeding and fisheries materials
- Renewable, low-environmental impact specialty chemicals
- Development and utilization of new biomaterials
- Use of resource- and energy-conserving materials

Current major activities
- Development of ecological materials
- Use of unused biomass
- Effective use of by-products
- Reducing the environmental impact of discharged water
- Eco-friendly designs for containers and packages
- Reduction of greenhouse gas emissions
- Quantitative assessment of emissions throughout the business and product life cycle (LC-CO2) and improving the energy efficiency of the production processes
- Promoting the 3Rs (Reduce, Reuse, Recycle) and the use of eco-friendly materials and unused resources

Food technologies
Technologies for enhancing the taste and healthiness of food around the world
- Effective utilization of food resources
- Enhancement of taste and safety
- High-function taste sensitivity technology
- Integrated taste sensitivity technology based on new gustatory technologies (low-salt, sugar, and fat)
- Application technologies to enhance taste and support health

Pharmaceuticals and health technologies
Technologies for healthy living
- Healthcare
- Diagnosis and health management
- Highly advanced medical treatment
- Bio-fine chemicals technologies to further upgrade advanced medical treatment
The Ajinomoto Group’s major research and development centers across the world

- **Institution for Innovation**
  - Fundamental Technology Labs.
  - Frontier Research Labs.
- **Institute of Food Sciences and Technologies**
  - Technology Development Center
  - Product Development Center
- **Research Institute for Bioscience Products & Fine Chemicals**
  - Material and Application Development Labs.
  - Process Development Labs.

### Pushing technological innovation forward
The Ajinomoto Group has R&D centers across the world, with each laboratory and regional technology center (RTC) developing special technologies and creating knowledge within a particular field that has relevance to its particular geographic region. With regard to common environmental issues affecting all companies and countries, such as energy conservation and resource recycling, the laboratories and RTCs share information and technologies, and collaborate with each other to develop new environmentally friendly technologies and products with environmental contribution characteristics.

The Group also carries out an environmental assessment (see page 52) whenever it launches a new business, changes the materials and production processes, or releases a new product. These assessments represent an important management tool in the Group’s business and product development.

### Developing R&D strategies that contribute to environmental conservation

The R&D Planning Department of Ajinomoto Co., Inc. is responsible for formulating R&D strategies to promote the growth of the entire Group and ensuring that those strategies are fully implemented. Contributing to environmental conservation is essential for the future of the Ajinomoto Group and at the same time represents a very important area of growth for the Group. The world’s leading corporations are coming under increasing pressure to carefully select raw materials, production process, and packaging materials during product development, while also studying ways to minimize environmental impact throughout each stage of product life cycles from use to disposal. It is also important to assess and quantify our activities, and clearly define our goals. We are currently developing a medium- to long-term R&D strategy for the Group to enable its R&D division to make further environmental contributions.

### Technology leading to downsizing and reduced energy consumption of electronic equipment

**Application an amino acid technology for semiconductor substrates**

The Ajinomoto Group has actively promoted the creation of a new business based on its expertise in amino acids1. One of its achievements in this area is Ajinomoto Build-Up Film (ABF), an insulation material for semiconductor substrates developed in 1998 that effectively enables reductions in the size and energy consumption of electronic equipment as well as in the amount of organic solvent used. Because of its high functionality and production efficiency, ABF is now used in many semiconductor substrates. ABF functions as an electrical insulator between layers of a substrate. The semiconductor substrate comprises multiple layers of copper circuits to incorporate complicated wiring. To increase the throughput of a chip, the circuits need to be imprinted with patterns as fine as possible (as high integration density as possible). The superior electrical insulation properties of ABF makes it possible to minimize the width of each circuit, enabling denser integration as well as contributing to the reduction of the weight and size of electronic equipment. The film—as opposed to liquid—form of ABF also helps realize finer wiring, significantly improved workability, and reduced use of organic solvent. Before ABF was developed, liquid ink containing organic solvent was used. In the case of ink, however, chip makers had to go through a long process of coating one side of the PCBs, drying them, turning them over, and then coating the other side and drying again, a process that generated a large amount of organic solvent vapor. ABF eliminates this entire step. What’s more, the organic solvent that is used in the production of ABF is collected and reused as a heat source for ABF production. The reduced weight and size of electronic equipment produced using ABF means less resources and energy are consumed during their production. This new amino-acid-based technology is thus playing an important role in protecting the environment and thereby becoming an integral part of modern life.

Ascertaining environmental impact for the entire product life cycle

Based on the belief that an accurate understanding of the environmental impact and benefits of its businesses and products throughout their life cycles will serve as an important index for the development of eco-friendly products and technologies, the Ajinomoto Group has been carrying out life cycle assessment (LCA) for many years. In particular, investigation into life cycle CO2 emissions (LC-CO2) and the carbon footprint of products (CFP) for the creation of a low-carbon society is considered an important issue, and the Group is actively taking part in relevant research schemes. Research findings are presented at academic conferences to make them available for use by others and are introduced into assessment and other processes aligned with product development at the Group.

■ Opening the LC-CO2 emissions factor database for food-related materials

In order to reduce the environmental impact of products, it is important to understand the impact not only during production process but throughout a product’s entire life cycle, from the extraction of raw materials and their processing at factories, to the distribution of the product, and consumption and disposal by the consumer. The Ajinomoto Group therefore places particular focus on total CO2 emissions during the product life cycle (Life Cycle CO2), among many other environmental indexes, as key data to be monitored for achieving a low-carbon society. For this reason, Ajinomoto Co., Inc. has become a member of the Food Study Group run by the Institute of Life Cycle Assessment Japan to study LC-CO2.

One of the achievements made through this study is the Ajinomoto Group LC-CO2 emissions factor database for food-related materials, which covers basic LC-CO2 data regarding food materials and ingredients. The database has been made publicly available on the company website since April 2007. The company also created a new version—made publicly available in October 2010—that is compatible with the 1990, 1995, 2000, and (latest) 2005 edition of the Embodied Energy and Emission Intensity Data for Japan Using Input-Output Tables (3EID). This database has been utilized and highly rated by industrial, academic and government organizations and researchers.

By making this database available, we hope that it will be used by various parties who share our mission to protect the global environment and create a sustainable society.

LC-CO2 emissions factor database for food-related materials (Japanese only)


■ Research and achievements in the provision of carbon footprint information

The Ajinomoto Group began assessment of the carbon footprint of its products (CFP)1 early on. Ajinomoto Co., Inc. participates in the Study Group for Developing and Promoting a Carbon Footprint Program (CFP Study Group) set up by the Japanese Ministry of Economy, Trade and Industry. The CFP Study Group is made up of companies from a wide range of industries and carries out investigations with regard to the rules of calculation and labeling of CFP, using the products of the respective members. Ajinomoto Co., Inc. has applied for the registration of feed-use lysine in the draft Product Category Rule (PCR)2 development plans, which are underway as part of the Carbon Footprint Calculation and Labeling Pilot Program, and is currently in the process of developing draft calculation and labeling rules (see page 24). In addition, the Pilot Program has adopted the Ajinomoto Group LC-CO2 emissions factor database for food-related materials described above as a secondary database used for temporary calculation of CFP. This allows the database to be utilized by many companies participating in the Pilot Program for their CFP calculations. The Ajinomoto Group will continue its efforts to create a low-carbon society by promoting the quantitative assessment of the CO2 emissions of not only its own products but also society as a whole.

1. Carbon footprint of products (CFP): The carbon footprint of products is an index calculated and displayed as the quantity of CO2 equivalent emissions of greenhouse gas produced over the entire life cycle of a product or service (raw material procurement, production, distribution and sale, utilization and maintenance, disposal and recycling);
2. Product Category Rule (PCR): A set of rules that define how to calculate and display CO2 emissions for each type of product and service

■ Incorporating LC-CO2 as an indicator for assessment of containers and packaging

Ajinomoto Co., Inc. has created a system for calculating LC-CO2 emissions for containers and packaging, based on material weight, surface area and package shape. Since 2003, the company has incorporated LC-CO2 assessment into the Eco-Index for Containers and Packaging (see page 39), an original mechanism for assessing product development from an environmental perspective. The index has been continuously revised since its introduction in 1991 to keep it abreast of environmental changes.
Development of Containers and Packaging

Unlike packing materials whose role is fulfilled as soon as the products are delivered, food containers and packaging have a very important role in preserving and protecting their contents from the moment the customer purchases the product until the contents are consumed. In recognition of their importance, the Ajinomoto Group began to pursue environmentally friendly designs for containers and packaging early on to minimize their footprint on the environment after use. The Group is taking the initiative to disclose information about packaging materials to stakeholders and cooperate in this area with trade organizations.

Containers and Packaging 3R Promotion Plan

Major achievements in fiscal 2009

- Reduced the weight of packaging used by approx. 3,500 tons in comparison with fiscal 2004—Reduction of approx. 267 tons of plastics and approx. 1,300 tons of paper
- Presentation of the company’s 3R best practices to various organizations, lectures at symposiums, contributions to special interest magazines

Establishment and implementation of the Containers and Packaging 3R Promotion Plan

Ajinomoto Co., Inc. established the Containers and Packaging 3R Promotion Plan in order to reduce packaging waste in accordance with the purpose of the Act on the Promotion of Sorted Collection and Recycling of Containers and Packaging. The plan came into effect in April 2007. To make sure we achieve this goal, a Containers and Packaging 3R Promotion Committee meeting is held every half fiscal year to allow representatives of the divisions related to packaging to regularly check the interim results and the progress of the plan, and share information.

3. 3Rs: Reduce, Reuse, Recycle

3R results and weight of packaging used

The amount of packaging by weight used by Ajinomoto Co., Inc. has been decreasing for the last few years. In fiscal 2009, the amount was reduced by about 1,000 tons compared to the previous fiscal year. Compared to the base year of fiscal 2004, although the total weight of both plastics and paper packaging decreased, the per-unit usage of these materials increased. This is because although there are many products for which the 3Rs have been improved, for some products: (1) the amount of packaging used increased due to the increased number of smaller volume products offered in response to changes in consumer behavior; and (2) the implementation of the 3Rs was restricted due to the incompatibility with the existing production machinery and possible effects on the preservation of the products. Looking ahead, the company will work even harder to reconcile merchantability, compatibility with the existing production machinery, and the 3Rs to ensure that it fully achieves its goals by fiscal 2010.

Reduction goal for per-unit usage of materials* by fiscal 2010 (compared to fiscal 2004)

<table>
<thead>
<tr>
<th>Material Type</th>
<th>FY2004</th>
<th>FY2008</th>
<th>FY2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastics</td>
<td>146,589</td>
<td>133,593</td>
<td>130,848</td>
</tr>
<tr>
<td>Paper</td>
<td>146,589</td>
<td>133,593</td>
<td>130,848</td>
</tr>
<tr>
<td>Weight of containers and packaging (tons)</td>
<td>7,431</td>
<td>7,208</td>
<td>7,163</td>
</tr>
<tr>
<td>Per-unit usage of materials (g/kg)</td>
<td>50.7</td>
<td>52.9</td>
<td>54.7</td>
</tr>
</tbody>
</table>

* Per-unit usage of materials = Weight of containers and packaging materials / Weight of product

Packaging usage results and per-unit usage of materials

The data covers the household products of Ajinomoto Co., Inc. Some estimates included.

Trends in expenses for outsourced recycling services and weight of containers and packaging by container material type for products sold

Recycling outsourcing expenses are estimated based on the weight of the containers and packaging for the year before the previous fiscal year.
Mechanisms for promoting environmentally friendly containers and packaging

When a product is released under the Ajinomoto brand, the product is required to undergo a Quality Assessment for Newly Developed Products, which includes an evaluation of containers and packaging. The assessment is implemented according to the Eco-Index for Containers and Packaging, the company’s original set of assessment standards. Under these standards, each product is checked in a multi-dimensional manner from four perspectives—(1) Reduction in volume of packaging materials, (2) Selection of materials, (3) Recyclability, and (4) Labeling (and extra information for customers)—to promote eco-friendly design of containers and packaging.

In addition, by integrating this containers and packaging assessment system with the 3R Management System, we can now: (1) utilize the data on the volume of used packaging materials indicated in the Eco-Index for the calculation of recycling fees, (2) disclose data on the internal portal site, and (3) update data on the volume of used packaging materials every month. This integration of the systems has not only resulted in facilitating the calculation of recycling fees and the promotion of 3Rs at the company, but also in making it possible to implement reporting and distribution within and outside the company and provide accurate data to recycling organizations on a real-time basis.

Independent assessment standards Eco-Index for Containers and Packaging (Household Edition Ver. 7 and Business Edition Ver. 3)

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Evaluation item</th>
<th>Evaluation points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficient use of resources</td>
<td>Reduction in volume of packaging materials</td>
<td>Ratio of weight of individual containers to product content, assuming containers are discarded after use (external packaging and cushioning packaging materials are also included for bulk products)</td>
</tr>
<tr>
<td>Efficient use of resources</td>
<td>Weight reduction ratio</td>
<td>Is the weight of individual packaging materials less than that of existing and similar products?</td>
</tr>
<tr>
<td>Efficient use of resources</td>
<td>Degree of over-packing</td>
<td>Can the product be removed from the container by removing the packaging in one step? Or have the steps needed to open the package been reduced?</td>
</tr>
<tr>
<td>Efficient use of resources</td>
<td>Availability of refill products</td>
<td>Is the applicable product based on the concept of refilling?</td>
</tr>
<tr>
<td>Efficient use of resources</td>
<td>Transport efficiency</td>
<td>Is highly efficient transportation being used in order to reduce CO2 emissions as much as possible in the transport process?</td>
</tr>
<tr>
<td>Efficient use of resources</td>
<td>Use of materials derived from plants</td>
<td>Are any plant-derived materials used to contribute to a reduction in CO2 emissions?</td>
</tr>
</tbody>
</table>

Assessment items for special points

- Environmental measures for other packaging materials
- Environmental measures for packaging processes
- Are improvements made, compared with existing or competing products, other than those reflected in the above evaluation items?
Efforts to make containers and packaging environmentally friendly outside Japan
Interest in environmentally friendly containers and packaging is relatively low on a worldwide scale (particularly in Southeast Asia and South America), and only a handful of nations have followed the lead of the United States, Europe, and Japan and legally mandated the recycling of containers and packaging. As a global organization, however, the Ajinomoto Group seeks to ensure not only its own compliance with Japanese regulations, but also the environmental friendliness of its products sold in foreign markets.

Umami seasoning AJI-NO-MOTO®, the Group’s signature product, is packaged in 11 countries in volumes varying from several grams to one kilogram per pack. Because of this variation in package size among the different countries, we researched the sizes used in each country and have proposed optimal standard sizes to realize both high design efficiency and maximum environmental friendliness.

Improvements to containers and packaging

Case 1: Masako® calendar packs
The paper headers were eliminated in 2004, resulting in a 767-ton reduction in paper used per year (as of 2009).

Comment from the designer
The header was changed from a paper type to film type, eliminating the need to staple the header. This resulted in an improvement in package quality and lower labor costs, as well as a reduction in the use of paper.

Case 2: Calpis PET bottle (Taiwan)
The 1.5-liter Calpis concentrate PET bottle for business use sold by Taiwan Calpis Co., Ltd. was made lighter by four grams, going from 59 to 55 grams.

Comment from the designer
While more than 80% of beverages sold in PET bottles in Taiwan do not have perforated labels, Calpis Water has been provided with such a label to make it easier to remove for recycling.

Case 3: Kankyo-Ippin eco-gift series
Palm empty fruit bunch (EFB) fibers were adopted as packaging material for fiscal 2009 Kenko Sarara year-end gift products, resulting in reduced waste and a 3.7-ton cut in the amount of cardboard used compared with the previous year.

Comment from the designer
We came across palm EFB while seeking a way to make gift packages more environmentally friendly. Because we were the first company in Japan to use this material, we undertook careful testing of the hardness, slip, and physical strength of the material, as well as checking its compatibility with our production lines.

Case 4: Cook Do® Gyoza
The reduced content weight allowed us to make the package thinner and cut the amount of paper used by about 0.3 tons per year.

Comment from the designer
The container and packaging design staff were involved in the concept development stage, which made it possible for them to select the right thickness of the package for the content weight.

Case 5: Pasta Do®
One of the pouches was made smaller, while the other pouch was eliminated, resulting in a cut in the amount of plastic used of about 1.0 ton per year.

Comment from the designer
By conducting a series of packaging tests and evaluations at one of the plants, we were able to minimize the size of the pouch without reducing the content weight.

Cooperation with outside organizations
Nowadays it is difficult for average consumers to determine which type of packaging is environmentally friendly, given the diverse forms of containers and packaging on the market.

In order to address environmental problems relating to packaging across our entire society, it is important that consumers choose environmentally friendly products based on an understanding of the functions and roles of packaging. Ajinomoto Co., Inc. is actively participating in opportunities for cooperation with relevant outside organizations. The company will continue to actively implement awareness-raising activities relating to containers and packaging, and to promote 3R activities in cooperation with the rest of society.

Usage of packaging materials for AJI-NO-MOTO® in markets outside Japan

Coordinations throughout the Entire Lifecycle

Initiatives throughout the Entire Lifecycle

Contributions to special interest magazines
Examples:
- Hoso Gijutsu (Packaging Technology), September Issue (September 2009)

Presentation of the company’s 3R best practices
Examples:
- Display of 3R best practices in the Kurashi-no Hoso packaging exhibition (October 2009)
- Presentation of 3R best practices to recycling promotion organizations and others