Amino acids are known as the source of all life. Over about 100 years the Ajinomoto Group has provided products that are highly functional because of the use of amino acids as their ingredients in a wide spectrum of fields that are closely related to life, such as umami seasoning AJI-NO-MOTO®, the product that forms the foundation of the Group’s business, as well as health, pharmaceutical and feed-use products. In order to provide these products on a permanent basis, the Ajinomoto Group is making efficient use of raw materials and minimizing the environmental impact of manufacturing by seeking new through innovations, while pursuing the potentials of amino acids that can support the sound lives of various creatures. In the field of nutrients, the Group will continue to take on new challenges not only for people but also for animals and plants.
Ensuring the Sustainable Production of Amino Acids
Making contributions to the environment through the innovation of manufacturing processes

The Ajinomoto Group makes amino acids by fermenting a variety of locally available plants, such as sugar cane, cassava and corn. In recent years there has been a growing demand for plants both as food resources for the increasing world population and as carbon-neutral materials. Considering the limitations of the spaces available for crop cultivation, it is becoming even more important for the Group to make the most efficient use of plant resources as raw materials while lowering its environmental impact by reducing the use of water, generation of waste and greenhouse gas emissions.

Manufacture of AJI-NO-MOTO® and effective use of food resources

Assuming that the annual amount of AJI-NO-MOTO® made by the Ajinomoto Group by fermenting sugar cane and cassava is 500,000 tons.

If all were made from kelp:
25 million tons of kelp are required.
Equivalent to 833 times the yearly average amount of kelp produced in Japan!

If all were made from tomatoes:
200 million tons of tomatoes are required.
Equivalent to 1.6 times the yearly average amount of tomatoes produced in the world!

Column
Zero emissions from amino acid production

The Ajinomoto Group uses natural gas to produce amino acids using the fermentation method, and has introduced cogeneration systems to further conserve energy. Moreover, to make use of unused biomass to avoid using food resources as raw materials, the Group is investigating use not only in Southeast Asia, which is a region blessed with plant resources, but also in South America and Europe.

In addition, the Group aims to increase its productivity by developing technologies to reduce the use of both materials and energy and also to reduce the use of auxiliary materials that are now necessary to extract fermented products.

<table>
<thead>
<tr>
<th>Column</th>
<th>FY2002</th>
<th>FY2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per-unit CO₂ emissions</td>
<td>2.1 t-CO₂/t</td>
<td>1.3 t-CO₂/t</td>
</tr>
<tr>
<td>Per-unit volume of discharged water</td>
<td>183 t/t</td>
<td>46 t/t</td>
</tr>
<tr>
<td>Resource recovery ratio of waste</td>
<td>96.6%</td>
<td>99.7%</td>
</tr>
</tbody>
</table>
Progress to Next-Generation Amino Acid Manufacturing

In recent years, against the backdrop of increases in the world population and boosted demand for biomass resources, it has become necessary to make more effective use of food resources. Under these circumstances the Ajinomoto Group is fostering research and development of new technologies to make even more efficient use of resources in manufacturing amino acids using the fermentation method based on the bio-cycle mechanism that it has built up, while reducing CO₂ emissions and the use of auxiliary materials.

To this end, amino acid factories of the Group are examining a range of new challenges across the globe.

**Introducing a new fermentation process to reduce the use of resources and contribute to the sustainability of the Earth and conservation of food resources**

In fiscal 2011 onwards, the amino acid production sites will introduce a range of new technologies across the world.

**Technologies to internally produce part of the main materials and to make effective use of by-products as a biomass energy source**

<table>
<thead>
<tr>
<th>Sites where the technologies will be introduced</th>
<th>Changes in main materials to be purchased</th>
<th>Main materials to be internally produced and the energy source</th>
<th>Production item</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2011 Ajinomoto do Brasil Indústria e Comércio de Alimentos Ltda Laranjal Paulista Plant</td>
<td>Raw sugar and molasses derived from sugar cane</td>
<td>Raw material: Syrup derived from sugar cane – Sugar</td>
<td>MSG¹</td>
</tr>
<tr>
<td>FY2011 Introduction of large pilot equipment to the Kamphaeng Phet Factory of Ajinomoto Co., (Thailand) Ltd.</td>
<td>Starch derived from cassava</td>
<td>Main raw material: Starch – Sugar</td>
<td>MSG¹ ¹ I+G²</td>
</tr>
<tr>
<td>*To be introduced to amino acid factories in Thailand on a full scale in FY2013</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Technology to use non-food resources as materials**

<table>
<thead>
<tr>
<th>Production of feed-use lysine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-technology to reduce the use of main and auxiliary materials and energy</td>
</tr>
</tbody>
</table>

¹ MSG: Monosodium L-glutamate  ² I+G: Disodium 5′-ribonucleotides

**Bio-cycle**

For the sustainable provision of amino acids, the Ajinomoto Group has been fostering the manufacture of amino acids developed using the fermentation method, thereby promoting the productive use of resources. For more than 30 years the Group has been implementing a mechanism known as the bio-cycle for manufacturing in order to make the most efficient use of all the riches of the land and foster abundant regional fruits of the field. At the amino acid production sites of the Group located all over the world, amino acids are made by fermenting vegetable materials that are readily available in the region, and the nutrient-rich liquid (by-product) left over after extracting amino acid from the fermentation liquor is also processed into fertilizers and feed for the benefit of local communities. For the stable production of amino acids, it is essential to ensure the stable supply of crops to use as the materials. To this end, the Group has established a bio-cycle that fosters the local use of by-products to support the sustainable production of amino acids.

**Basic pattern of a bio-cycle**

- **Contributes to reduction in CO₂ emissions arising from chemical fertilizer production**
- **Covers 70% of the chemical fertilizer (nitrogen content) required by 500,000 hectares of sugar cane fields**
- **500,000 hectares of sugar cane fields**
- **Absorption of atmospheric CO₂ by photosynthesis (28 million tons)**
- **Sun**
- **Harvest**
- **Bio-cycle**
- **By-product (6 million tons)**
- **Umami seasoning AJI-NO-MOTO®**
- **500,000 tons**
- **Products**
- **Cane molasses (syrup derived from sugar cane) 1.5 million tons**
- **Nitrogen content**
- **Sugar production plant**
- **Sugar cane 38 million tons**
- **4.2 million tons**
- **Raw sugar**

The chart assumes worldwide annual production of approximately 500,000 tons of AJI-NO-MOTO® seasoning produced by the Ajinomoto Group using only sugar cane. The values for sugar cane grown and sugar production represent average global use, while the values for resources used for producing AJI-NO-MOTO® and values for by-products are based on actual Ajinomoto Group statistics.
In Brazil, the Ajinomoto Group started production of amino acids in 1977 and the country now represents one of the main amino acid production centers for the Group. Brazil is the world’s largest sugar producer, and at the four amino acid production sites of Ajinomoto do Brazil Indústria e Comércio de Alimentos Ltda, amino acids are produced based on a bio-cycle mechanism and with the use of raw sugar derived from the syrup of locally harvested sugar cane.

In order to advance the bio-cycle, the Laranjal Paulista Plant of the company is launching a new initiative for the practical use of sugar cane not only as a material for amino acids but also as an energy source. By the end of fiscal 2011 the factory will complete the installation of necessary equipment and renovate the bio-cycle to make it more carbon-neutral.

The cycle is thus enhanced to help to ensure the stable procurement of materials and make the most efficient use of local resources for the local cultivation of sugar cane and other purposes.

Features of the advanced bio-cycle fostered at the Laranjal Paulista Plant

1. Purchase sugar cane as part of raw materials (about 10% of the total) from contracted farmers in addition to raw sugar
2. Make use of bagasse and woodchips procured from outside as well as the bagasse generated from the factory’s sugar cane syrup extraction equipment as fuel
3. Newly install a biomass boiler within the factory to supply about 70% of steam required by the entire factory from the boiler
4. The use of carbon-neutral biomass, which absorbs CO₂, will help to reduce CO₂ emissions substantially.
5. Co-products such as the Ajifer® generated from by-product fermentation liquid and also ash remaining after the incineration of bagasse will be utilized as soil conditioners.

Amino acid factories of the Ajinomoto Group are working to conserve energy and CO₂ emissions based on their zero emission plans. Factories of the Group in Brazil are using natural gas and other resources as fuel, and at major five factories, highly energy-efficient mechanical vapor recompression (MVR) equipment had been introduced as of 2008. CO₂ emissions at the factories, have been reduced by about 50,000 tons compared with emissions before the installation of the equipment.
In Thailand, the Ajinomoto Group is producing amino acids using sugar derived from sugar cane and cassava, which are locally cultivated in large amounts. The local factories of the Group are recycling by-products generated from their manufacturing fermentation processes into fertilizers for use by local rice farmers, thereby promoting a bio-cycle for materials. In addition to this activity, the Kamphaeng Phet Factory, which is committed to becoming a green factory, has introduced a biomass boiler that uses rice husks as fuel to promote a bio-cycle for energy. The factory has thus been fostering two bio-cycles in parallel.

Now the factory is launching a new project to make even more effective use of cassava used as materials by internally producing cassava starch and is also promoting the use of biomass as fuel.

Research into a next-generation manufacturing process

Extracting starch and methane gas from cassava as materials to be fermented to produce amino acids and as fuel necessary for the production, respectively

In Southeast Asia, the Ajinomoto Group has been purchasing cassava-derived starch from starch factories as the material to be fermented for the production of amino acids. As a new initiative, the Group will take on the challenge of internally producing starch at its local factories. Specifically, it will purchase tapioca chips made by slicing and drying raw cassava, produce starch from the chips and saccharify the starch, which will be used as the main material.

In this process, bagasse pulp and wastewater will be generated as by-products, from which methane gas can be extracted efficiently by anaerobic fermentation under improved conditions and with the use of suitable equipment. The gas thus produced can be used as fuel for the manufacture of amino acids. It means that even fuel can be produced internally in the manufacturing process.

Moreover after methane gas has been extracted from bagasse pulp, the residue will be separated and dehydrated to generate a by-product that can be used as fertilizers, etc.

With this process, in which starch is efficiently extracted from tapioca chips and a range of organic matter left behind in the process, are used as high-quality energy sources, resources can be used even more effectively and CO₂ emissions are reduced. There are therefore increasing expectations for this process as a next-generation manufacturing process.
Testing and practical implementation of the process at the Kamphaeng Phet Factory

The tests for the two processes, one to produce materials and one to produce fuel, will be started at the end of 2011. The tests will be conducted on a large scale at a pilot plant established within the Kamphaeng Phet Factory by producing starch in the amount equivalent to 10% of the total amount of starch usually used and fermented by the factory, and the equipment necessary for the practical implementation of the processes will be introduced to the plant.

Within fiscal 2013, 50% of the starch to be fermented by the factory as material and about 10% of the total steam energy used by the factory are to be produced internally, which will lead to a reduction of about 16,800 tons of CO2 emissions from the factory per year.

The factory introduced a biomass boiler in December 2008 and has been implementing a bio-cycle for energy by using rice husks, which were unused local resources, as carbon-neutral fuel. In the future the factory will make combined use of the internal materials/fuel production process and the biomass boiler in a well balanced manner to build an innovative manufacturing process while contributing to local agriculture through the provision of by-products as fertilizers.

The Ajinomoto Group will examine similar initiatives for other amino acid factories of the Group in consideration of the features of the regions in which the factories are located.

### Biogas recovery facilities (Illustration)

- **Recovery of biogas**
  - Bagasse pulp
  - Equipment to recover biogas from bagasse pulp (Anaerobic fermentation)
- **Preprocessing equipment**
  - Dissolves organic matters
- **Equipment to recover biogas**
  - From wastewater (Anaerobic fermentation)
- **Sedimentation and separation equipment**
- **Wastewater from the starch refining process**
- **Biogas recovery facilities (Illustration)**

### Recycling phosphates

The Kamphaeng Phet II Factory of Ajinomoto Co., (Thailand) Ltd. manufactures ribonucleotide-based umami seasoning (I+G), for which polyphosphates are necessary as material. The factory has been purchasing the material from outside. This material, however, is a limited resource, just like fossil fuel, and the supplies are expected to become tight in the future.

The factory therefore introduced a system to recycle phosphates generated as a by-product in the I+G manufacturing process into polyphosphates in fiscal 2010. At present about 40% of polyphosphates used at the factory are obtained by recycling the by-product. The factory is thus pursuing the circulation and effective use of resources from a range of perspectives.
Helping the Growth of Plants and Animals through the Provision of Amino Acids

Pursuing the possibilities of amino acids, which are known as the source of all life

The amino acid business of the Ajinomoto Group, which set out to provide people with tasty food, has blossomed out into medicines and feeds and so on, and is continuing to make fresh challenges in fostering field and marine resources. It is becoming a common target of the world to improve food productivity in a manner that supports ecosystems and is friendly to the global environment, which will in turn make it possible for people across the world and a range of creatures on the Earth to live in harmony together. Amino acids, which are essential for life, have a range of potentials to help the growth of plants and animals in addition to supporting the health of people. The Ajinomoto Group, as a leading company in the field, is fostering research and development to make use of its findings on amino acids to help maintain sound ecosystems and improve food productivity.

World’s food demand and productivity

The world’s food supply and demand balance is coming under strain due to the degradation of ecosystems, increases in the world population and changes in people’s lifestyles.

<table>
<thead>
<tr>
<th>Increases in demand</th>
<th>Status of supply</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>World population</strong>&lt;sup&gt;1&lt;/sup&gt;</td>
<td><strong>Cultivated acreage</strong>&lt;sup&gt;5&lt;/sup&gt;</td>
</tr>
<tr>
<td>The world population will increase by 2050 to 9.3 billion</td>
<td>The world area of farmland for grains remained on the same level (1961 to 1963: 650 million hectares&lt;br&gt;2002 to 2004: 670 million hectares)</td>
</tr>
<tr>
<td><strong>Demand for food</strong>&lt;sup&gt;2&lt;/sup&gt;</td>
<td><strong>Yield per unit area</strong>&lt;sup&gt;5&lt;/sup&gt;</td>
</tr>
<tr>
<td>To meet the increasing demand, it is necessary to increase the food supply by 70% from the 2005 level by 2050</td>
<td>The growth rate of the world’s grain production is becoming stagnant (In the 1960s: 3.0% → In the 1970s: 2.0% → In the 1980s: 1.7% → In the 1990s: 1.3%)</td>
</tr>
<tr>
<td><strong>Consumption of meat</strong>&lt;sup&gt;3&lt;/sup&gt;</td>
<td><strong>Degradation of soil</strong>&lt;sup&gt;6&lt;/sup&gt;</td>
</tr>
<tr>
<td>Due to changes in people’s lifestyles, demand for meat in developing countries will increase by 2030 by 40% or more from the level in the late 1990s</td>
<td>Among all the farmland in the world, including pastures, 40% was classified as being eroded and malnourished.</td>
</tr>
<tr>
<td><strong>Consumption of seafood</strong>&lt;sup&gt;4&lt;/sup&gt;</td>
<td><strong>Decreases of seaweed beds</strong>&lt;sup&gt;7&lt;/sup&gt;</td>
</tr>
<tr>
<td>Due to changes in people’s preferences and increases in population, the world’s demand for seafood doubled from 1970 to 2003. Annual per-capita demand increased by 1.5 times on an average (United States: 1.4 times; EU: 1.3 times; China: 5.7 times)</td>
<td>The area of seaweed beds, which support marine ecosystems in Japan’s coastal areas, decreased by about 40% over 30 years (1978: about 208,000 hectares → 2007: about 125,000 hectares)</td>
</tr>
</tbody>
</table>

---

1 World Population Prospects, the 2010 Revision, the United Nations
2 Agricultural Outlook 2009-2018, OECD-FAO
3 World Agriculture: Toward 2015/2030, FAO
4 Annual Report on the Environment in Japan 2010 (made by the Japanese Ministry of the Environment based on the FAOSTAT database)
5 FAO (FAOSTAT)
6 Millennium Ecosystem Assessment, the United Nations
7 White Paper on Fisheries (Fiscal 2011), the Japanese Fisheries Agency
Amino acids are essential nutrients for all animals. In particular, amino acids that cannot be synthesized within the body—known as essential amino acids—must be obtained through the diet. However, there are amino acids that tend to be deficient in conventional compound feeds given to livestock, which are usually comprised of corn and wheat for energy, and soybean meal for protein. It is indeed difficult to maximize the growth of livestock only by using these feeds.

Feed-use amino acids, represented by lysine, threonine, and tryptophan, are used to compensate for these deficiencies. By adding these amino acids to conventional feeds, other amino acids that have been wasted will be effectively used without being much excreted, which will contribute to the solution of food and environmental problems.

The Ajinomoto Group has been conducting the feed-use amino acid business for more than 40 years. By conducting marketing activities based on scientific proof and using innovative production technologies, the Group has been expanding its market share of feed-use amino acids across the world. In the field of lysine, threonine, and tryptophan, which are the Group’s major feed-use amino acids, the Group has long held its position as a market leader. The use of feed-use amino acids helps to reduce the impact of livestock waste on soil and water quality and curb emissions of greenhouse gases substantially, and also helps reduce the area used to grow feed crops. For these reasons, feed-use amino acids are now attracting much attention across the globe.

Demand for meat has been increasing year on year, and in order to enhance its feed-use amino acid business to make more contributions to the solution of environmental and food resource problems, the Ajinomoto Group newly established a feed-use amino acid business company named Ajinomoto Animal Nutrition Group, Inc. (AANG) in September 2011. Ajinomoto Co., Inc. transferred the control of its feed-use amino acid business to AANG on November 1, which will become the parent company of Ajinomoto Eurolysine S.A.S. and Ajinomoto Heartland, Inc. On a long-term basis, AANG will expand its business beyond the framework of feed-use amino acids to a wider range of animal nutrition field in its search for new business growth opportunities. It will attempt to become one of the best business groups in the world through a range of business innovations.
Calpis Co., Ltd. has been using the results of its longstanding research into intestinal bacteria to help maintain livestock health and increase the feed efficiency rate.

The probiotic product “Calsporin” (Bacillus subtilis C-3102) developed by the company, has proven to increase the number of useful bacteria when passing through the intestines of livestock. The product thus helps to increase the feed efficiency rate, which in turn leads to reductions in the use of grains.

At present, about one-third of the world’s annual grain production (2.2 billion tons) is used for livestock feed, and the use of Calsporin across the world is helping to increase the feed efficiency rate, leading to reductions in the use of feed grains (soybeans, corn, wheat, etc.) by about 500,000 tons per year1. In recognition of this achievement, the product was granted an Environmental Business Award at the eco japan cup 2010.

In order to spread environmentally friendly livestock farming more widely on a global scale, the Ajinomoto Group is taking on new challenges as a leading manufacturer of feed-use amino acids.

We will make the new value of feed-use amino acids more recognized in the world based on scientific proofs, eventually to contribute to the prevention of global warming.

In 2011 Ajinomoto Heartland, Inc., which conducts the feed-use amino acid business in the United States, began selling AjiPro™-L, that has been developed for cows.

Within the Ajinomoto Group, feed-use amino acids had been developed mainly for pigs and chickens. Ajinomoto Heartland, Inc. became the first company in the Group to sell a product for cows. Cows have four stomachs and when conventional feed-use lysine is fed to cows, it is mostly broken down in the rumen without being absorbed as a nutrient. The company took on the challenge of solving this problem and succeeded in developing a technology to make it possible to have lysine absorbed by cows through the small intestine without being broken down in the rumen.

There are 9 million cows in the United States alone, and the product is believed to have great potentials both in terms of business and the reduction of environmental impact.

Newly developing lysine for cows

In April 2011 Ajinomoto Heartland, Inc., which conducts the feed-use amino acid business in the United States, began selling AjiPro™-L, that has been developed for cows.

Within the Ajinomoto Group, feed-use amino acids had been developed mainly for pigs and chickens. Ajinomoto Heartland, Inc. became the first company in the Group to sell a product for cows. Cows have four stomachs and when conventional feed-use lysine is fed to cows, it is mostly broken down in the rumen without being absorbed as a nutrient. The company took on the challenge of solving this problem and succeeded in developing a technology to make it possible to have lysine absorbed by cows through the small intestine without being broken down in the rumen.

There are 9 million cows in the United States alone, and the product is believed to have great potentials both in terms of business and the reduction of environmental impact.

In 2011 Ajinomoto Heartland, Inc., which conducts the feed-use amino acid business in the United States, began selling AjiPro™-L, that has been developed for cows.

Within the Ajinomoto Group, feed-use amino acids had been developed mainly for pigs and chickens. Ajinomoto Heartland, Inc. became the first company in the Group to sell a product for cows. Cows have four stomachs and when conventional feed-use lysine is fed to cows, it is mostly broken down in the rumen without being absorbed as a nutrient. The company took on the challenge of solving this problem and succeeded in developing a technology to make it possible to have lysine absorbed by cows through the small intestine without being broken down in the rumen.

There are 9 million cows in the United States alone, and the product is believed to have great potentials both in terms of business and the reduction of environmental impact.

In 2011 Ajinomoto Heartland, Inc., which conducts the feed-use amino acid business in the United States, began selling AjiPro™-L, that has been developed for cows.

Within the Ajinomoto Group, feed-use amino acids had been developed mainly for pigs and chickens. Ajinomoto Heartland, Inc. became the first company in the Group to sell a product for cows. Cows have four stomachs and when conventional feed-use lysine is fed to cows, it is mostly broken down in the rumen without being absorbed as a nutrient. The company took on the challenge of solving this problem and succeeded in developing a technology to make it possible to have lysine absorbed by cows through the small intestine without being broken down in the rumen.

There are 9 million cows in the United States alone, and the product is believed to have great potentials both in terms of business and the reduction of environmental impact.

In 2011 Ajinomoto Heartland, Inc., which conducts the feed-use amino acid business in the United States, began selling AjiPro™-L, that has been developed for cows.

Within the Ajinomoto Group, feed-use amino acids had been developed mainly for pigs and chickens. Ajinomoto Heartland, Inc. became the first company in the Group to sell a product for cows. Cows have four stomachs and when conventional feed-use lysine is fed to cows, it is mostly broken down in the rumen without being absorbed as a nutrient. The company took on the challenge of solving this problem and succeeded in developing a technology to make it possible to have lysine absorbed by cows through the small intestine without being broken down in the rumen.

There are 9 million cows in the United States alone, and the product is believed to have great potentials both in terms of business and the reduction of environmental impact.

In 2011 Ajinomoto Heartland, Inc., which conducts the feed-use amino acid business in the United States, began selling AjiPro™-L, that has been developed for cows.

Within the Ajinomoto Group, feed-use amino acids had been developed mainly for pigs and chickens. Ajinomoto Heartland, Inc. became the first company in the Group to sell a product for cows. Cows have four stomachs and when conventional feed-use lysine is fed to cows, it is mostly broken down in the rumen without being absorbed as a nutrient. The company took on the challenge of solving this problem and succeeded in developing a technology to make it possible to have lysine absorbed by cows through the small intestine without being broken down in the rumen.

There are 9 million cows in the United States alone, and the product is believed to have great potentials both in terms of business and the reduction of environmental impact.

In 2011 Ajinomoto Heartland, Inc., which conducts the feed-use amino acid business in the United States, began selling AjiPro™-L, that has been developed for cows.

Within the Ajinomoto Group, feed-use amino acids had been developed mainly for pigs and chickens. Ajinomoto Heartland, Inc. became the first company in the Group to sell a product for cows. Cows have four stomachs and when conventional feed-use lysine is fed to cows, it is mostly broken down in the rumen without being absorbed as a nutrient. The company took on the challenge of solving this problem and succeeded in developing a technology to make it possible to have lysine absorbed by cows through the small intestine without being broken down in the rumen.

There are 9 million cows in the United States alone, and the product is believed to have great potentials both in terms of business and the reduction of environmental impact.
Japan

Quantitative assessment of greenhouse gas emission reductions and the formulation of emission reduction initiatives

In order to spread environmentally friendly livestock farming, it is necessary to communicate the fact that greenhouse gas emission reductions could be achieved by the use of feed-use amino acids in an easy-to-understand manner to livestock farmers, and to ensure that the farmers who have used feed-use amino acids can benefit from the emission reductions they have achieved.

The Ajinomoto Group took on the challenge of quantitatively assessing the emission reduction effects of feed-use amino acids and establishing an emission offsetting credit scheme to encourage livestock farmers to use feed-use amino acids, and in Japan the Group made great progress with regard to the scheme during the period from fiscal 2010 to 2011. Based on the encouraging results, the Group believes it is possible to globally establish a scheme that is similar to the one promoted in Japan and provides a basis for the Japanese livestock industry to further reduce its environmental impact.

Establishment of an offsetting credit scheme as an incentive to encourage livestock farmers to reduce greenhouse gas emissions —— Making it possible for livestock farmers to sell emission credits under two credit schemes for the first N2O emission trading in Japan

Feed-use amino acids are said to contribute to the reduction of N2O, which is a major greenhouse gas emitted from livestock farms and has the global warming potential that is 300 times that of CO2. Ajinomoto Co., Inc. had been conducting demonstration tests to prove the N2O emission reduction effect of feed-use amino acids jointly with research organizations in Japan. Based on the results of the joint research, the company applied to the Offsetting Credit (J-VER) Scheme2, which the Ministry of the Environment announced in fiscal 2008, to obtain carbon offset credits for “low-protein feed fortified with feed-use amino acids.” In July 2010 the project received J-VER certification. Moreover in March 2011, the project received certification under the so-called “domestic credit system”3 implemented by the Ministry of Economy, Trade and Industry. Pig farmers who have reduced greenhouse gas emissions through this project certified under the schemes can obtain credits according to the amount of greenhouse gas emission reductions they have achieved in CO2 equivalent and can sell these credits to make a profit. Emissions trading in Japan has hitherto been limited to CO2, and this is the first time that N2O emissions have been traded. Ajinomoto Co., Inc. is now making preparations to expand the target of the project to include chicken farmers.

It is epoch-making that the environmental contributions of feed-use amino acids are recognized under Japan’s carbon offsetting credit schemes, which represents great progress for the Ajinomoto Group. In comparison with Western countries, where livestock farming has long been popular and feed-use amino acids have been widely used to comply with strict regulations regarding the nitrogen in animal waste, in Japan per-unit N2O emissions from livestock are rather high, and the annual CO2 equivalent of the N2O greenhouse gas emitted by pigs and chickens amounts to about 6 million tons.4 Even a partial reduction of these emissions would be highly effective in curbing global warming. The company hopes that the certification of the project under the schemes will help increase the popularization of low-protein feed fortified with feed-use amino acids in Japan, which will lead to the reduction of greenhouse gas emissions from livestock.

For the quantitative assessment of greenhouse gas emission reduction effects —— Establishment of feed-use lysine CFP value

From the manufacturing process of feed-use amino acids, as from that of other products, CO2 and other greenhouse gases are emitted due to the use of energy, etc. The use of feed-use amino acids, however, helps to decrease the emissions of N2O from livestock farms. To quantitatively assess the emission reduction effects, it is necessary to conduct a life cycle assessment of the product, from manufacture to use. This will also help spread environmentally friendly livestock farming.

Ajinomoto Co., Inc. has participated in the Carbon Footprint5 Pilot Program promoted by the Ministry of Economy, Trade and Industry and other government agencies. It is a project in which products are labeled with the CO2 equivalents of the total greenhouse gases emitted throughout their entire life cycle, in an effort to encourage the realization of a low carbon society through the quantitative assessment of the CO2 emissions of products and services.

In September 2009 Ajinomoto Co., Inc. filed an application to register a draft Product Category Rules (PCR)6 development plan for feed-use lysine under the program, and received certification for the plan in January 2011 (certification No.: PA-BU-01). Subsequently in September 2011, the specific CFP value (144 kg-CO2/25 kg-Lys) calculated according to the certified standards was approved for use (validation No.: CV-BD1-001). By labeling the value on the product package, the company will be able to clearly show the environmental contribution effect of feed-use lysine to users in a quantitative manner.

At present the international community is making preparations to set international standards on carbon footprints as ISO 14067. The results achieved in Japan will provide a basis for the international community to quantitatively assess the environmental contribution that could be made by feed-use amino acids.

---

2 Offsetting Credit (J-VER) Scheme: J-VER stands for Japan Verified Emission Reduction. It is a system in which the Ministry of the Environment gives official carbon offset credits for the reductions of greenhouse gas emissions achieved by businesses, and the businesses can sell these credits to make a profit.

3 Domestic credit scheme: A scheme promoted by the Ministry of Economy, Trade and Industry, in which smaller businesses receive funding, technologies and know-how from large companies in order to make joint efforts to reduce their CO2 emissions. They will obtain credits for the achieved emissions and sell the obtained credits.

4 Average values for 2000 to 2003 based on the values provided by the IPCC report

5 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 (from raw material procurement to disposal).

6 Product Category Rules (PCR): A set of rules that define how to calculate and display CO2 emissions for each type of product and service.
In recent years the pollution of rivers and seas, the eutrophication (or nutrient depletion) of seawater and the desertification of coasts due to global warming, a phenomenon in which algae become depleted, have grown into serious problems in Japan. Since microalgae are one of the keystones of the food chain, encouraging their growth will lead to the vitalization of the seas and rivers.

Ajinomoto Co., Inc., which has profound expertise in amino acids, began conducting research to develop concrete in which amino acid arginine is mixed to foster the growth of algae, believing that the use of the acids would contribute to the revitalization of marine ecosystems. Since 2009, the company has been developing Environmentally Active Concrete jointly with Nikken Kogaku Co., Ltd., a leading company of wave dissipation blocks, and the University of Tokushima’s Department of Ecosystem Design (headed by Professor Yasunori Kouzuki).

Beginning to Use Amino Acids Also to Help the Growth of Marine Life
Joint development of environmentally active concrete

Amino acid-mixed Environmentally Active Concrete releases amino acids slowly in waters. As a result of past experiments, it has been revealed that arginine can be mixed with concrete best among various amino acids and also fosters the growth of microalgae, which are one of the keystones of the food chain, by five to 10 times the usual growth level. In the experiments, environmentally active concrete attracted ayu fish and eels in the rivers and abalones and sea cucumbers in the sea.

By turning the inorganic concrete used in seas and rivers into an organic material it is hoped that it will be possible to improve the compatibility of natural and manmade objects, and help in supporting the food chain and ecosystem. The use of this concrete is also expected to contribute to the absorption and fixation of CO₂.

Transforming concrete for human into one for “creature”
Effect of “organic concrete” that improves the compatibility of natural and manmade objects

- Shift the focus from shape to material
- Turn inorganic concrete into organic concrete
- Make manmade objects and nature/ecosystems interface in a more harmonious manner
- Create an environment in which microalgae, which represent a keystone of the food chain, can grow easily by providing them with nutrients at a slow pace
- Support the creation of the food chain and ecosystems
- The organic concrete is expected to foster the absorption and fixation of CO₂.

Comparison results for algae growth

<table>
<thead>
<tr>
<th>Amount of chlorophyll-a, which serves as an indicator for the amount of algae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordinary concrete</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>Number of the months that have passed</td>
</tr>
</tbody>
</table>

The amount of algae attached to the concrete surface remains large even after 10 months have passed.

Joint research based on collaboration between different industries

The environmentally active concrete has been developed through joint research between Nikken Kogaku Co., Ltd., Ajinomoto Co., Inc., and the University of Tokushima.

Contribution to the environment and food resources through the provision of amino acids

Environmentally active concrete

Experimentation and evaluation of the environment recovery functions of the seas

The University of Tokushima

Human and natural environment to consider

Development of environmentally compatible materials and products

Nikken Kogaku Co., Ltd.

Ajinomoto Co., Inc.
Experiments are under way in 21 water areas across Japan

As part of the joint research, experiments are being conducted to check the effect of the environmentally active concrete for the growth of algae and for the attraction of fish and shellfish in a total of 21 sea and river areas across Japan as of July 2011, receiving cooperation from local communities and fisheries cooperatives. For the practical use of the concrete in a range of water environments, the joint development team is also asking external experts to conduct tests on the durability of the concrete as a construction material, while evaluating the mechanism and speed of releasing the amino acid. The team aims to spread the use of this innovative concrete, which will be effective for both disaster prevention and revitalization of water environments, across Japan and also in other countries in the future.

Water areas where the experiments are conducted (as of July 2011)

Installation of experimental pieces at actual construction sites (six sites)

1. Iwaki River, Aomori Prefecture
2. Weir of Katsuuri, Tochigi Prefecture
3. Oi River, Shizuoka Prefecture
4. Shin River, Kagawa Prefecture
5. Naka River, Tokushima Prefecture
6. Aki fishing port, Kochi Prefecture

Installation of experimental pieces (at 15 sites)

1. Coast of Rumoi, Hokkaido
2. Coast of Yubetsu, Hokkaido
3. Abashiri fishing port, Hokkaido
4. Mano Bay, Niigata Prefecture
5. Port of Yokohama, Kanagawa Prefecture
6. Saru-shima (Saru Island) and Shinyasuura fishing port, Kanagawa Prefecture
7. Off the coast of Ito, Shizuoka Prefecture
8. Kojima fishing port, Osaka
9. Amagasaki-Nishinomiyashi fishing port, Hyogo Prefecture
10. Tokushima-Komatsushima fishing port, Tokushima Prefecture
11. Murotsu Port, Kochi Prefecture
12. Fushino River, Yamaguchi Prefecture
13. Nama fishing port, Nagasaki Prefecture
14. Long water channel in Yojirou, Kagoshima Prefecture
15. Ishigaki fishing port, Okinawa Prefecture

Helping the Growth of Plants and Animals through the Provision of Amino Acids
The liquid fertilizer AMIHEART, which was developed at the Kyushu Plant of Ajinomoto Co., Inc. by using co-products, is made from the liquid derived in the process of fermenting starch into nucleic acids by the use of natto bacteria. The fertilizer is rich in nucleic acids and has proven to be effective to foster the rooting of plants, increase crop yields, and shorten the necessary growing periods. The product began to be sold in April 2011 for use to grow melons, strawberries, lettuces and tea plants. Also a horticultural fertilizer for home use was developed jointly with J-Oil Mills Inc., a company belonging to the Ajinomoto Group, by adsorbing AMIHEART to rapeseed oil cake (co-product of J-Oil Mills, Inc.) to increase the fertilization effect of the co-product with amino acids and nucleic acids contained in AMIHEART. This product is slated for release in the market in the spring of 2012.

The Ajinomoto Group calls nutrient-rich by-products generated from the fermentation process in the manufacturing of amino acids and nucleic acids as “co-products” and transforms them into fertilizers and feed by adding value to them. The Group conducts business by using the blessings of local nature as materials and wants to make the most efficient use of the materials for the growth of new lives in the agricultural, livestock, and fishing industries.

In fiscal 2010 the Group named the agricultural material-related project that focuses on the use of co-products the “A-Link” project. To add more value to co-products, it is accumulating more knowledge and expertise, including methods to make more effective use of co-products in each region and for each crop, while promoting the global use of amino acids and nucleic acids in the field of nutrients for plants and animals. The Group has already developed a range of high value-added co-products and is expanding the A-Link project across the world.

Adding more value to co-products in a range of fields

**Brazil**

**AJIFOL® foliar fertilizer**

The Group developed AJIFOL® spray fertilizer by making adjustments to amino acids and minerals contained in co-products so that they will be effectively absorbed by plants through their leaves. This product is manufactured and sold mainly in South America and Southeast Asia. It is used on soybeans, vegetables, and fruit trees. Farmers have commented that the product has resulted in increased yield as well as the sound growth of plants.

**France**

**Protein-rich feeds containing bacterial cells**

In France, which is a stock-raising country, the Ajinomoto Group developed high value-added protein feeds containing bacterial cells by using protein-rich bacterial cells separated from co-products that are often used as liquid fertilizers and feeds. The feeds have been used in the country for more than 20 years. At present, the feeds are also manufactured and sold in Southeast Asian countries, such as Thailand, Indonesia and Vietnam under the AJITEIN® brand.

**Japan**

**Liquid fertilizer AMIHEART**

The liquid fertilizer AMIHEART, which was developed at the Kyushu Plant of Ajinomoto Co., Inc. by using co-products, is made from the liquid derived in the process of fermenting starch into nucleic acids by the use of natto bacteria. The fertilizer is rich in nucleic acids and has proven to be effective to foster the rooting of plants, increase crop yields, and shorten the necessary growing periods. The product began to be sold in April 2011 for use to grow melons, strawberries, lettuces and tea plants. Also a horticultural fertilizer for home use was developed jointly with J-Oil Mills Inc., a company belonging to the Ajinomoto Group, by adsorbing AMIHEART to rapeseed oil cake (co-product of J-Oil Mills, Inc.) to increase the fertilization effect of the co-product with amino acids and nucleic acids contained in AMIHEART. This product is slated for release in the market in the spring of 2012.

**Column**

**Expanded use of co-products**

**Making the most efficient use of skipjack**

—Skipjack liquid fertilizer used to grow tea plants and lawns

Ajinomoto Co., Inc. established Bonito Technical Laboratory Co., Inc. jointly with a dried bonito manufacturer to develop technologies to use all parts of skipjack without any waste. In the production process of dried bonito to be supplied as material for HON-DASHI®, the fish are boiled and the bones are removed. Now the removed bones are used as material for calcium food products, and the concentrated and refined broth are used as an extract ingredient in HON-DASHI®.

Moreover, recent research is looking at ways of using enzymes inherent in skipjack to decompose the residual parts of the fish and turn them into fertilizers and feeds. Experiments are underway to test the efficacy of the fertilizers for tree plants and lawns, and the company has already begun selling “skipjack liquid fertilizer.”

**Special Feature 1**

Ensuring the Sustainable Production of Amino Acids for the Sustainability of Life

**Case 3**

Providing Co-Products to Help the Growth of Riches of the Field

Making the best use of by-products of amino acids for the growth of new lives

The Ajinomoto Group calls nutrient-rich by-products generated from the fermentation process in the manufacturing of amino acids and nucleic acids as “co-products” and transforms them into fertilizers and feed by adding value to them. The Group conducts business by using the blessings of local nature as materials and wants to make the most efficient use of the materials for the growth of new lives in the agricultural, livestock, and fishing industries.

In fiscal 2010 the Group named the agricultural material-related project that focuses on the use of co-products the “A-Link” project. To add more value to co-products, it is accumulating more knowledge and expertise, including methods to make more effective use of co-products in each region and for each crop, while promoting the global use of amino acids and nucleic acids in the field of nutrients for plants and animals. The Group has already developed a range of high value-added co-products and is expanding the A-Link project across the world.
Expanded use of co-products across the world

Fostering resource recycling-oriented production in cooperation with contracted farmers
—Processing animal and vegetable residues from frozen food production into fertilizer

The Shikoku Plant of Ajinomoto Frozen Foods Co., Inc. produces about 130 household and business-use food items, including stuffed dumplings and special “non-oil-fried” fried food. In order to make use of animal and vegetable residues, such as inedible cabbage stalks and outer leaves and other material that cannot be used in products, the plant introduced a system to process these residues into fertilizers in fiscal 2006 and has since been selling the fertilizers made by the system.

In the latter half of fiscal 2008, the plant began selling the fertilizer to contracted local farmers and has since been using the cabbages and onions produced by the farmers as the raw materials for its frozen food products. The plant is thus fostering the circulation of resources. In fiscal 2010, about 40% of the fertilizer produced by the plant was used locally. The plant will continue to foster resource recycling in cooperation with the contracted local farmers.

Residue is fermented, dried and turned into fertilizer.

Contracted farmers use the fertilizer when they grow cabbages and onions. The farmers cooperate in ongoing testing of the efficacy of the fertilizer and how growth is progressing.