



AXEEV® is a field crop herbicide and our main product. AXEEV® is applicable to major crops such as soybeans, corn, wheat, and sugarcane in the world, and is effective on a wide range of weeds including grasses and small-seeded broadleaf weeds at much lower use rate than conventional herbicides. In addition to the excellent herbicidal efficacy that meets the needs of growers, AXEEV® has a low impact on the environment and has been registered as an agricultural chemical in 21 countries, contributing to resolving social issues related to food insecurity and the global environment.

Social Issues

Food Insecurity, Worsening Global Environmental Issues, and the Spread of Herbicide Resistant Weeds

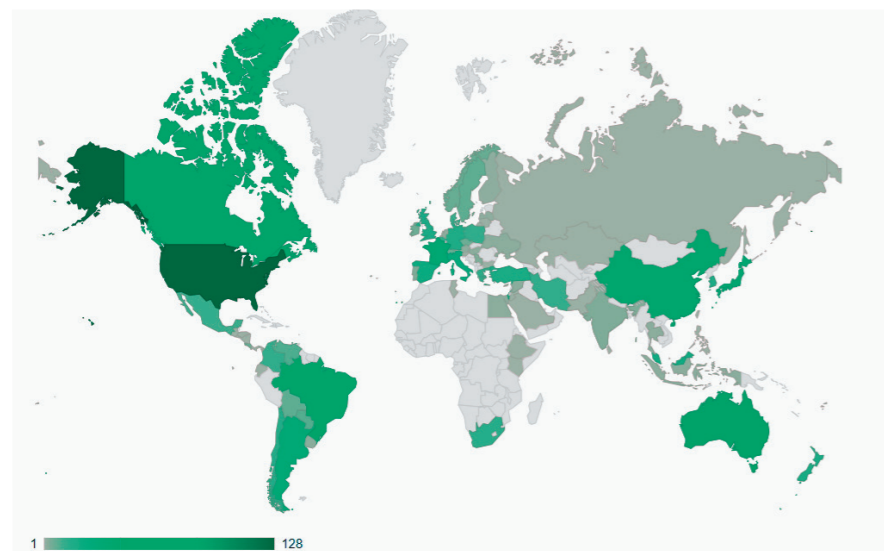
Increasing food production is an urgent issue in the world in order to support the world's population, which is expected to reach 9.7 billion by 2050. At the same time, this means that severe damage to the environment will be inevitable including deforestation in order to expand more cropland. To increase food production without relying the expansion of cropland, it's necessary to improve productivity through the proper use of safe and secure agricultural chemicals that have passed risk assessment on living organisms and the environment.

Recently, the impact of agricultural chemicals on the natural environment has drawn attention. In the EU, the "Farm to Fork Strategy" (Published by the European Commission in May 2020) and the "Strategy for Sustainable Food Systems, MeaDRI" (announced by MAFF in May 2021) in Japan were formulated to request less impact on the environment.

In the 1990s, genetically modified crops (GMOs*1) were introduced in the agriculture market that were tolerant to the non-selective herbicide glyphosate,

and this had a major impact on the cultivation system. Cultivation system using glyphosate capable of killing most plants and GMO crops tolerant to glyphosate quickly accepted by growers due to its convenience. Currently, the system accounts for more than 90% of the soybeans and corn production in the Americas. However, continuation of such cultivation system resulted in a problem. Weeds that were resistant to glyphosate (herbicide resistant weeds*2) began to appear. Glyphosate resistant weeds were first reported around 2000, and it was becoming a problem around 2005. By 2011, when AXEEV® was first introduced, it had already become a serious global problem. Currently, countermeasures are needed to control herbicide resistant weeds in order to ensure stable food production throughout the world. AXEEV®, which we developed, is widely accepted in the market as a tool to resolve such problem, and although it has been over 10 years since the first launch, the number of countries where it is registered continues to increase along with sales.

Total number of reports on herbicide resistant weeds



Herbicide resistant weeds have spread to the countries and regions shown in light green to dark green on the map. The number of reported serious cases in U.S. has reached 128.

Source: INTERNATIONAL HERBICIDE-RESISTANT WEED DATABASE (As of January 2023)

*1 GMO (Genetically Modified Organism): Crops that have been modified using genetic recombination technology. They are highly tolerant to diseases and pests, and are not killed by herbicides.

*2 Herbicide resistant weeds: Weeds for which herbicides have lost effectiveness due to repeated use of the same type of herbicide.

*3 Soil-applied herbicides: Herbicides that are applied onto the soil. Herbicides can be categorized into two types, soil-applied herbicides or foliar-applied herbicides.

Research and Development

13 Years of Research and Development

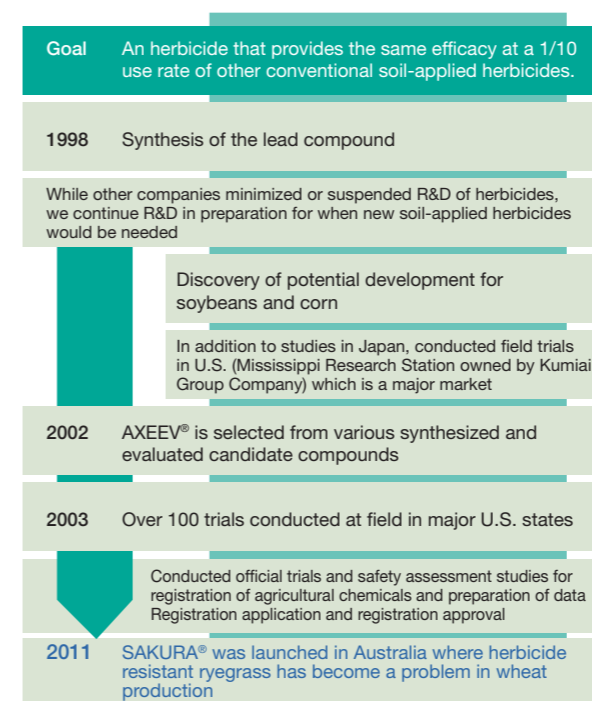
Exploratory Research for AXEEV®

Exploratory research for AXEEV® began with the aim of discovering a novel herbicide that provides the same efficacy at 1/10 the dosage of other conventional soil-applied herbicides*3 for field crops.

The lead compound of AXEEV® (the candidate compound we initially focused on) was synthesized in 1998, which showed potential for further development. At the same period, genetically modified crops (GMOs) with tolerant to the non-selective herbicide glyphosate began to appear, causing major changes to cultivation system. Use of glyphosate together with GMO crops became a common cultivation system, which caused some companies to minimize or suspend R&D for new herbicides. However, we expected there to come a time when new herbicides would be needed based on our accumulated knowledge from our R&D, and therefore, continued our research and development of new herbicides.

To discover new herbicides with high herbicidal efficacy and crop safety, we repeated synthesis and screening tests based on our lead compound, and in 2002, we finally discovered AXEEV® (active ingredient

name: pyroxasulfone). Later, more than 100 trials were conducted on fields yearly in U.S. Meanwhile, in Japan, research was being conducted to establish global formulations and on industrial manufacturing process. AXEEV® is a soil-applied herbicide that is applied on the soil and the active ingredient is absorbed by weeds through the soil. Therefore, we needed to study various factors including the type of soil and the impact from rainfall amounts which may influence herbicidal efficacy and selectivity. We conducted a large number of studies in Japan and field trials in target countries and then finally determined the proper application dosage and application conditions in each market. We also conducted assessment studies on safety and environmental impact, which are required for registration application of agricultural chemicals. It took considerable time and effort to prepare data for the registration application. In 2011, 13 years after the lead compound was first synthesized, we finally got the first registration approval of AXEEV® in Australia, and we launched the first AXEEV® product under the trade name SAKURA®.



GMO Trend

Introduction of genetically modified crops (GMOs) tolerant to the non-selective herbicide glyphosate (1996)



Field trials at the Mississippi Research Station

GMO crop cultivation system expands (Starting around 2000)



Glyphosate-resistant weeds were becoming a problem (Starting around 2005)

Value Creation Source

Unified Research and Development System

R&D Process

The R&D Division has a series of research institutes, the Chemical Research Institute (New Molecule Research Center, Formulation Technology Research Center, Process Chemistry Research Center), and the Life Science Research Institute (Agrochemical Research Center, Life & Environment Research Center). Each research center, which plays a different role, collaborates to establish an integrated agricultural chemical research and development system, from the synthesis of new compounds to the study of industrial manufacturing processes.

Kumiai Group also owns a research station in Mississippi, U.S., allowing us to have a system where site trials can be carried out at any time, which is essential for global development agricultural chemicals. Thanks to this system, AXEEV® could be discovered within a short period of about four years after exploration started, and the transition to industrialization was smooth.



Mississippi Research Station (U.S.)

The efficacy of AXEEV® on soybean cropland



Untreated area

Treated area

Chemical Research Institute (New Molecule Research Center)



- Synthesis of new compounds
- Physicochemical property evaluation

Life Science Research Institute (Agrochemical Research Center)



- Biological evaluation

Life Science Research Institute (Life & Environment Research Center)



- Safety assessment
- Environmental impact assessment

Chemical Research Institute (Formulation Technology Research Center)



- Formulation technology study

Chemical Research Institute (Process Chemistry Research Center)



- Process development
- Industrial manufacturing process research

Outcome

AXEEV® - Better productivity and lower environmental impact

AXEEV® is the brand name of the active ingredient “pyroxasulfone,” which is an agricultural chemical discovered and developed by Kumiai. Since its first launch 2011, it has been the main product of Kumiai Group and continues to grow steadily as a specific herbicide for controlling weeds that are resistant to conventional herbicides, and has helped to increase our business performance.

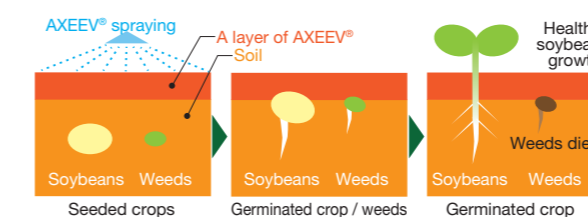
Improved productivity

Target crops Applicable to major crops including soybeans, corn, wheat, and sugarcane



Use applications Soil-applied herbicide for field crops
Sprayed onto the soil before weeds germinate

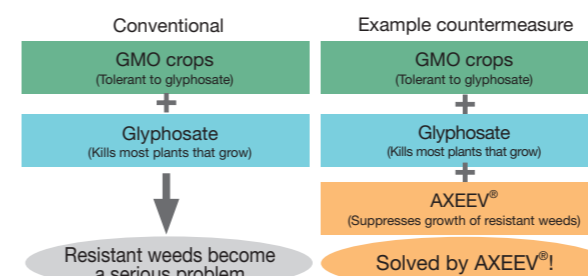
Spraying AXEEV® forms a layer of AXEEV® on the surface of the soil. When AXEEV® is absorbed by soybean and weed sprouts, only the weeds are killed while the soybeans continue growing.



Strength 1 Highly effective against glyphosate-resistant weeds

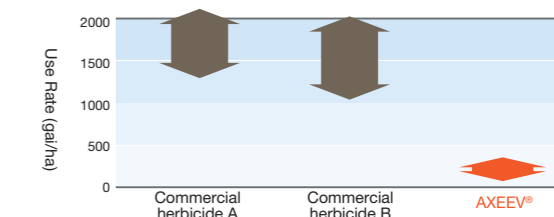
Currently, more than 90% of soybeans and corn in the Americas is grown using a combination of the herbicide glyphosate, which kills most plants, with GMO crops tolerant to glyphosate. This cultivation system was introduced in the 1990s, but during the 2010s, resistant weeds to glyphosate became a major problem. Since AXEEV® provides excellent efficacy for controlling glyphosate-resistant weeds, it is in high demand in areas where such resistant weeds have become a problem.

Image of cultivation system (Soybeans and corn)



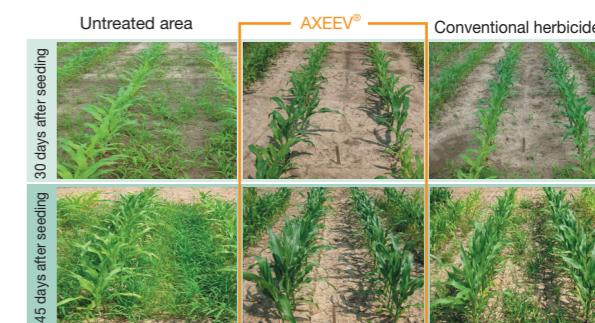
Strength 2 Low use rate

AXEEV® shows effectiveness at low use rate that are about 1/10 that of conventional soil-applied herbicide. This not only helps to reduce the labor needed for spraying agricultural chemicals, but it also suppresses the load on the environment as well as CO₂ emissions related to transportation.



Strength 3 Excellent long lasting weed control by soil-applied herbicide

AXEEV® is effective for about two weeks longer than conventional soil-applied herbicides. The negative impact of weeds on crops can be reduced, while better productivity and higher crop yield are expected as the results. Since it is possible to reduce the amount of agricultural chemical being applied, it will reduce an environmental load.



Strength 4 The mode of action making it difficult to develop resistance

AXEEV® has a mode of action that makes it difficult for resistance to be developed. Therefore, it is expected to continue to contribute to improved crop productivity as an herbicide resistant weed control product.

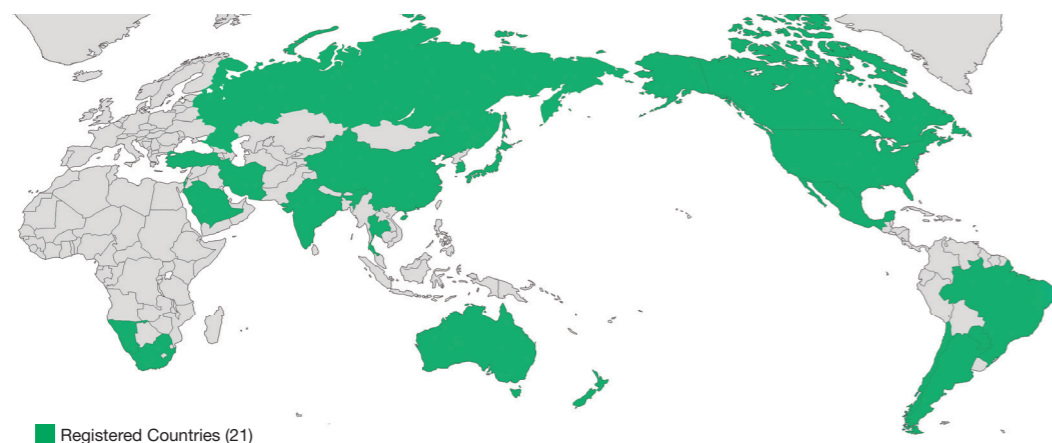
Feature Articles **Contributing to Resolve Social Issues**
Herbicide AXEEV®

Sales Trends & Strategies

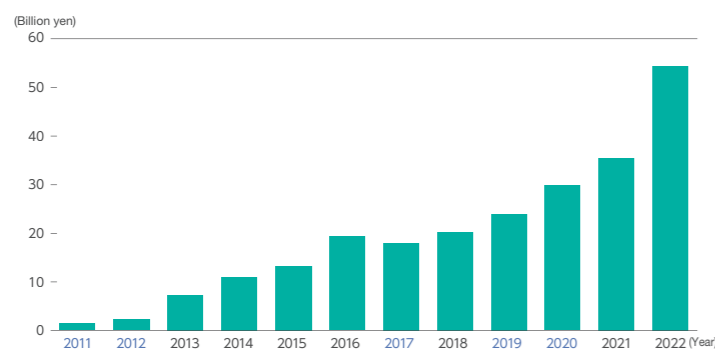
AXEEV® was launched in Australia as a soil-applied herbicide for wheat in 2011, and sales have continued to expand over these 12 years. Because it can be applicable to major crops such as soybeans, corn, wheat, and sugarcane, it is mainly sold in major markets including U.S., Australia, Argentina, Brazil, and India. AXEEV® shows excellent long lasting efficacy for controlling herbicide resistant weeds, especially against ryegrass in wheat and amaranthus in soybean. We have taken advantage of this characteristic to provide technical service and conduct sales promotion of AXEEV® products, and introduce new mixture products in the markets where herbicide resistant weeds are becoming big problem. As a result, AXEEV® comes to be recognized among growers as an essential product for controlling herbicide resistant weeds and established the position in the market. We also have promoted sales in countries where it is

on the market, and are making effort to expand the market by expanding its application to other crops while increasing the number of countries where it is registered. Now AXEEV® products are registered in 21 countries and distributed through our partners in each country. AXEEV® products are also developed for non agricultural use, distributed as an herbicide for turfgrass in golf courses in Japan and South Korea, and we are working to expand sales. Global agricultural chemicals market is continuing to grow, and is expected to expand in the future. Due to such good conditions in the market, net sales of AXEEV® have increased significantly, reaching 35.5 billion yen in FY2021 and 54.4 billion yen in FY2022. During the last ten years from 2013 to 2022, CAGR (compound annual growth rate) has continued to grow at a very high rate of 25%.

Registration status of AXEEV®



Movement in Net Sales of AXEEV®



Year of Launch in Major Countries

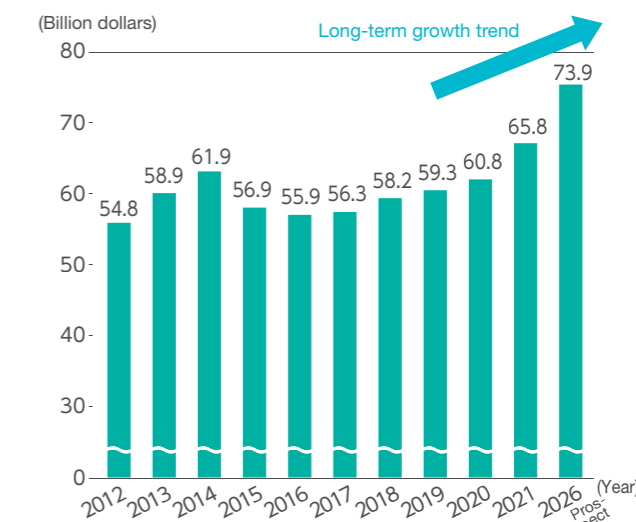
Year	Country
2011	Australia
2012	U.S.
2017	Argentina
2019	India
2020	Brazil

Future Prospects

AXEEV® largely contributes to the performance of Kumiai Group. In the current Mid-Term Business Plan that started in FY2021, maximizing the share of AXEEV® in countries where the products are distributed and expanding sales in countries where it is newly registered is positioned as priority measures for our agricultural chemicals business outside of Japan. The world agricultural chemicals market continues to grow, and in recent years, the market has expanded especially around South America and Asia. We expect this growth trend to continue for a long time due to increase in demand for grains and food with growth of global population and changes in eating habits. AXEEV® has already been registered as an agricultural chemical in India and Brazil, where the agricultural chemicals market is expected to grow. Our net sales target of 35 billion yen for FY2023 was reached ahead of schedule in FY2022. We will continue to expand the sales of AXEEV® in new countries and develop new mixture products suitable for each market. During FY2023, the final year of the current Mid-Term Business Plan, our aim is to reach net sales of 72.9 billion yen, which would be another leap forward. We have enhanced our presence in the world as an

agricultural chemical company with advanced R&D capabilities. We would like to contribute to global food security and environmental conservation through our business.

Changes in the global agricultural chemicals market



Source: Agbiolnvestor

Voice

Synthesis Researcher of AXEEV® NAKATANI Masao

(Currently: Research & Development Division, Manager, Intellectual Property Section)

While planting area of GMO crops had expanded, we focused on soil-applied herbicides which had stable position in the market, and started exploratory research. We were disappointed in the early stages of research because all plants, including crops, were killed by candidate compounds. However, based on the large amount of data and past know-how accumulated from years of research including such study, we could establish a hypothesis, conduct verification and perform continuous examination, ultimately resulting in the discovery of AXEEV®. We were able to conduct synthesis of candidate compounds, screening trials, and early stage safety assessment studies in parallel, targeting to carry out field trials in the season in U.S. I believe it lead the success of optimization research in short period.



Development Researcher of AXEEV® YAMAJI Yoshihiro

(Currently: General Manager, Corporate Strategy Office)

At the time, it was said that no herbicides other than glyphosate would be needed after the introduction of genetically modified crops. However, we recognized that glyphosate has a short effective period, so we aspired to develop a soil-applied herbicide with a long residual activity and for which it is more difficult to develop resistance. Development of AXEEV® required the technological know-how and efforts of many people, and was a great achievement by Kumiai as a company. This accomplishment has been passed on to the next generation and it continues evolving into new opportunities.

