Expanding Environment-friendly Products and Services

The Kubota Group is contributing to protecting the global environment and solving social issues in the food, water and living environment fields through the provision of environment-friendly products and services. The Group conducts environmental assessment of products in the design and development stages, and promotes environment-friendliness over the entire product life cycle, from the procurement of raw materials to the disposal of products. The Group internally certifies exceptionally environment-friendly products as Eco-Products, and is working to expand its lineup of certified products.

Environmental Considerations in the Product Life Cycle

Major Initiatives to Ensure Environment-friendliness

Design and development
- Product environmental assessment to ensure environment-friendly design
- Internal certification of Eco-Products

Raw materials and parts procurement
- Green procurement
- Optimal regional procurement

Production
- Reduction of waste and loss in the use of energy and other resources
- 3Rs for waste and water resources, use of recycled materials
- Reduction of VOC emissions, replacement of organic solvents with substitutes

Distribution
- Improving loading efficiency
- Modal shift
- Reduction of packing materials

Construction
- Improving efficiency and saving labor for construction work
- Shortening of construction period
- Reduction of resources used for construction

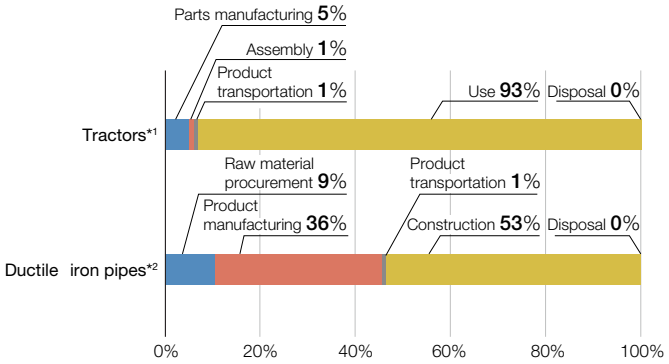
Use
- Reduction of fuel consumption
- Improving efficiency and saving labor for work and management
- Improving ease of maintenance, extending product life
- Reduction of exhaust gas
- Reduction of noise, vibration

Disposal
- Collecting/reuse/recycling of used products and parts
- Proper disposal

Analysis of Greenhouse Gas Emissions Volume in the Product Life Cycle

The Kubota Group handles a diverse range of products, from agricultural and construction machinery to pipe systems and water treatment equipment. As part of its product environmental assessment, the Group conducts life cycle assessment (LCA) for its major products to determine the amount of greenhouse gas emissions over each product life cycle. The results of the LCA were subject to third-party review in 2014 by the Japan Environmental Management Association for Industry.

Results of LCA: Proportions of Greenhouse Gases



*1 LCA results for tractors were calculated based on the assumption of towing and transporting work for 5,000 hours by the M9540DTHQ-EC agricultural tractor in France.
*2 LCA results for ductile iron pipes were calculated based on the data reported in the "Study on Piping Technologies for Sustainable Water Supply Service" (Japan Water Research Center). The proportions of raw material procurement, manufacturing, and product transportation were determined according to Kubota's CO_2 emissions data.

Greenhouse gases emitted in the use stage account for around 90% in the life cycle of agricultural tractors, while gases emitted in the manufacturing and construction stage account for around 90% in ductile iron pipes. Thus, the frequency and scale of environmental loads in the life cycle vary depending on the product type. The Kubota Group enhances its environment-friendly products and services by reflecting the results of the analysis of environmental loads in the product life cycle in its environment-friendly design development.

Examples of Initiatives to Ensure Environment-friendliness

Environment-friendly *Johkasou*, Decentralized Wastewater Treatment Plant

Johkasou is used to treat wastewater from houses, public and commercial facilities in areas not served by an adequate sewerage system. This product was developed in Japan but is currently also in widespread use overseas, particularly in Southeast Asia, where rapid urbanization has led to problems with contamination of the aquatic environment.

The Kubota Group offers customers a varied range of *Johkasou* depending on the quality and volume of the wastewater. In addition to contributing to improving the local aquatic environment, the development of high-performance, compact *Johkasou* brings environmental benefits at each stage of the product lifecycle.

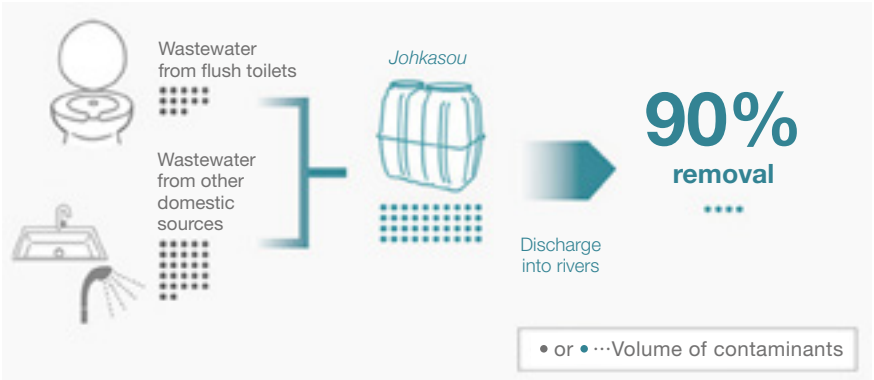
[Examples of Kubota-manufactured *Johkasou* in Use Overseas]

Small *Johkasou* in use for detached housing (Indonesia)

Large *Johkasou* in use at a hospital (Vietnam)

How a *Johkasou* Works

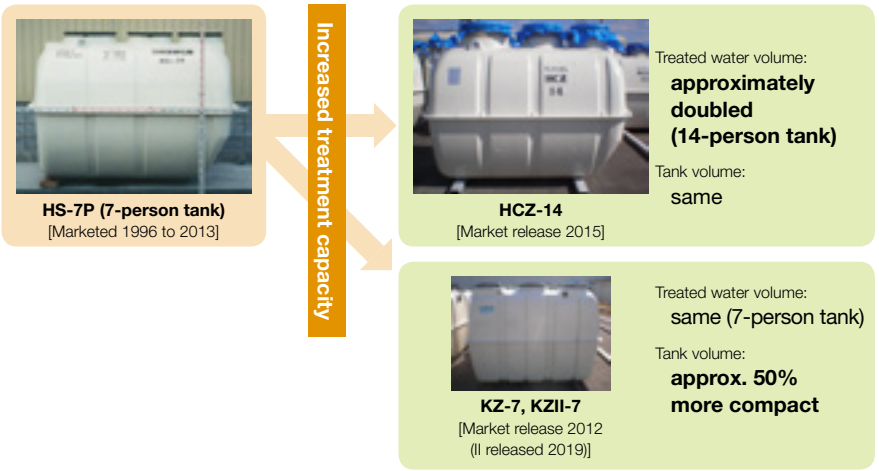
Johkasou uses the action of microorganisms to remove contaminants from domestic wastewater including effluent from flush toilets. Advanced treatment *Johkasou* removes not only contaminants but also nitrogen, which is a cause of red tides in enclosed bay and algal blooms in wetlands.



Treatment capacity of *Johkasou*

Development of *Johkasou* with Higher Performance and More Compact Dimensions

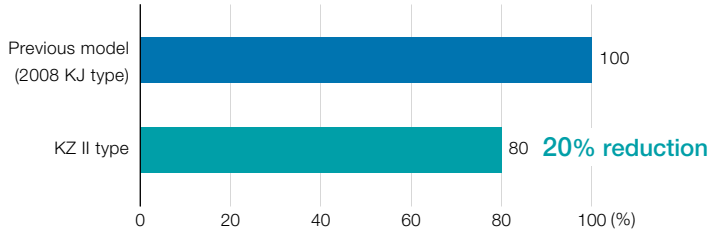
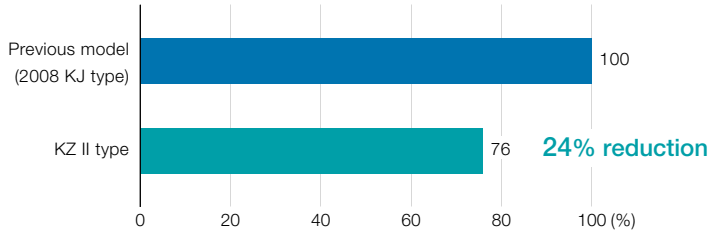
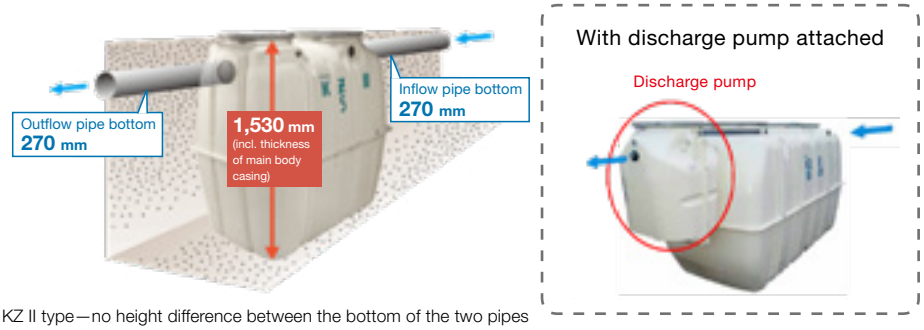
By using sponge-type carriers that can hold a larger number of microorganisms and making other improvements, the Kubota Group's *Johkasou* increases the treatment capacity per unit of volume to realize a compact design that fits neatly into any underground space. As it requires little excavation, it makes for less labor-intensive and speedier installation. In environmental terms too, it realizes savings in energy and resources.



Increased treatment capacity realizes increase in treated water volume and more compact dimensions

Johkasou with Environment-friendly Features at Each Stage of the Lifecycle

As illustrated below, Kubota Group *Johkasou* displays environment-friendly features at each stage of the lifecycle.

Lifecycle stage	Environmental issue	Environment-friendly feature of *Johkasou* (KZ II-5,7,10)
Procurement	Reduction of chemical substances	・Use of raw materials free of certain substances restricted by RoHS*1 directive
Production	Energy saving	・Number of assembly parts reduced through integration of functions, parts designed to be fitted in a single action—removing need for electric power tool operations such as screw fixing, reducing energy consumption in assembly process
	Resource conservation	・20% weight reduction in main body of product through more compact dimensions, resulting in 20% reduction in raw material use **Comparison of weight** 
Transportation	Energy saving	・Increased transportation efficiency through more compact dimensions, resulting in reduced fuel consumption
Installation	Energy saving	・24% reduction in excavation volume through more compact dimensions, resulting in shorter time using heavy machinery and reduced fuel consumption **Comparison of excavation volume* associated with installation**  * Excavation volume calculated based on Kubota in-house standards
		・The base plate used for installation is a dedicated product realizing weight reduction of around 85% and requiring less use of heavy machinery for laying, resulting in reduced fuel consumption*2
	Resource conservation	・As the outflow pipe is installed at the same high position as the inflow pipe, with no height difference between the bottom of the two pipes, a natural flow arises readily with no need for a discharge pump*3  KZ II type—no height difference between the bottom of the two pipes
Operation	Energy saving	・Switching to an energy-saving type for the blower that aerates the inside of the *Johkasou* results in reduced electric power consumption
	Ease of maintenance	・Simple opening and shutting of the attached valve effects cleansing of the interior (anaerobic filter tank) for easy maintenance

*1 RoHS directive: EU directive issued on July 1, 2006, limiting the use of certain hazardous substances in electric and electronic equipment (major revision on July 21, 2011)
*2 As the *Johkasou* must be installed on a level surface, in general concrete is either cast on-site or a precast concrete base plate is laid. The Kubota Group markets the KB plate, a dedicated KZ II lightweight foundation base plate weighing 48 kg for a 5-person tank.
*3 Depending on conditions at the installation site, if the water level at the discharge point is higher than the bottom of the outflow pipe, a discharge pump may be needed.

For detailed information on *Johkasou* follow this link:
www.kubota.com/products/johkasou/

Major Initiatives to Ensure Environment-friendliness by Product Group

C Tackling Climate Change
R Working towards a Recycling-based Society
W Conserving Water Resources
Ch Controlling Chemical Substances
B Conserving Biodiversity, etc.

Farm & Industrial Machinery

Product group	Major initiatives to ensure environment-friendliness	Life cycle				
		Procurement production	Distribution	Construction	Use	Disposal
Tractor	Reducing the number of parts	R				
	Reducing environmentally hazardous substances contained in paint	Ch				
	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Reducing fuel consumption by introducing an energy-saving mode				C	
	Conforming to exhaust gas regulations				Ch	
	Reducing noise, vibration				B	
	Indicating parts materials, providing information on points to be noted for disposal					R
Rice transplanter	Reducing environmentally hazardous substances contained in paint	Ch				
	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Reducing fuel consumption by introducing an energy-saving mode or a multiple-function capacity to simultaneously perform five farming operations				C	
	Reducing seedling cultivation-related materials by sparse planting or dense-sown seedling transplantation, and a straight-line maintenance function				R	
	Conforming to exhaust gas regulations				Ch	
	Indicating parts materials, providing information on points to be noted for disposal					R
Combine harvesters	Reducing the number of parts and weight	R				
	Reducing environmentally hazardous substances contained in paint	Ch				
	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Reducing fuel consumption by introducing an energy-saving mode				C	
	Reducing fuel consumption with improved reaping accuracy by horizontal control of the vehicle body				C	
	Conforming to exhaust gas regulations				Ch	
	Reducing noise, vibration				B	
	Indicating parts materials, providing information on points to be noted for disposal					R
KSAS (Kubota Smart Agri System)	Reducing fuel consumption per unit yield of agricultural machinery by improving farm work efficiency and increasing yield				C	
	Proper fertilizer application to prevent excessive fertilizers from flowing downstream				W	
	Facilitating self-maintenance and reducing mechanical problems by monitoring the operation status of agricultural machinery				R	
Cultivators	Reducing environmentally hazardous substances contained in paint	Ch				
	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Reducing CO_2 emissions by electrification				C	
	Achieving zero CO_2 emissions by electrification				Ch	
	Conforming to exhaust gas regulations				Ch	
	Reducing noise, vibration				B	
	Indicating parts materials, providing information on points to be noted for disposal					R
Riding mowers	Reducing environmentally hazardous substances contained in paint	Ch				
	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Reducing fuel consumption by introducing a unique mowing method to alleviate power load				C	
	Conforming to exhaust gas regulations				Ch	
	Indicating parts materials, providing information on points to be noted for disposal					R
Utility vehicles	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Conforming to exhaust gas regulations				Ch	
	Indicating parts materials, providing information on points to be noted for disposal					R
	Reducing RoHS-designated substances					Ch
Agricultural-related products (color sorter, rice-milling machine, etc.)	Reducing the number of parts and weight		C			
	Reducing air consumption necessary for sorting of defective rice by improving the air injection accuracy of color sorters				C	
	Reducing power consumption of electronic circuits				C	
	Reducing power consumption of improved thermal insulation efficiency of low-temperature brown rice storage containers				C	
	Reducing electric power consumption during waiting time for fruit selector measurement				C	
	Reducing the noise of rice-milling machines				B	
	Indicating parts materials, providing information on points to be noted for disposal					R
	Reducing RoHS-designated substances					Ch
Engines	Reducing fuel consumption by improving combustion efficiency and reducing losses				C	
	Accepting bio diesel/gasoline				C	
	Conforming to exhaust gas regulations				Ch	
	Reducing noise, vibration				B	
	Reducing RoHS-designated substances					Ch
Construction machinery	Reducing environmentally hazardous substances contained in paint	Ch				
	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Reducing fuel consumption by introducing an energy-saving mode				C	
	Conforming to exhaust gas regulations				Ch	
	Reducing noise, vibration				B	
	Indicating parts materials, providing information on points to be noted for disposal					R
	Reducing RoHS-designated substances					Ch
Precision machinery (Measuring instruments)	Reducing the number of parts and weight	R				
	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Reducing power consumption of electronic circuits				C	
	Reducing electric power consumption of peripheral equipment during waiting time for truck scale measurement				C	
	Reducing the number of waste batteries by introducing energy-saving measuring instruments					R
	Reducing RoHS-designated substances					Ch
Air-conditioning equipment	Using recycled resin	R				
	Reducing power consumption by installing a heat pump and a highly efficient motor				C	
	Easier maintenance by reducing the number of parts and adopting designs that are easy to disassemble				R	
	Providing information on points to be noted for disposal					R
	Reducing RoHS-designated substances					Ch

C Tackling Climate Change
R Working towards a Recycling-based Society
W Conserving Water Resources
Ch Controlling Chemical Substances
B Conserving Biodiversity, etc.

Water & Environment

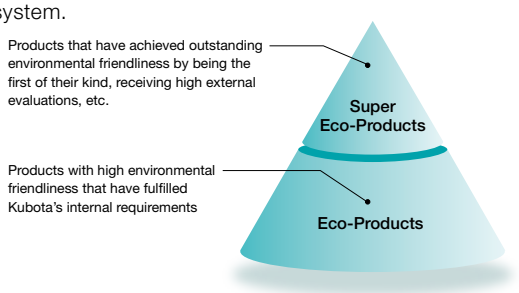
Product group	Major initiatives to ensure environment-friendliness	Life cycle				
		Procurement production	Distribution	Construction	Use	Disposal
Ductile iron pipes	Reducing weight by thinning pipes or changing the structure of couplings	R				
	Reducing VOC by changing the paint for the inner surface	Ch				
	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Reducing the width of the excavation groove by reducing the insertion force at the time of jointing couplings to decrease the number of items necessary for jointing			C		
	Reducing polyethylene sleeves by improving anti-corrosion performance			R		
	Improving maintenance performance by introducing a coupling structure with reduced insertion force or reducing the number of parts				R	
	Extending product life by improving anti-corrosion performance and introducing earthquake-resistant couplings				R	
Plastic pipes	Reducing chemical substances specified under the technical standards based on the Water Supply Act	Ch				
	Reducing power consumption when joining pipes by a fusing process			C		
	Indicating parts materials, providing information on points to be noted for disposal					R
	Reducing RoHS-designated substances					Ch
Valves	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Reducing the width of excavation grooves by reducing the insertion force at the time of jointing couplings to decrease the number of items necessary for jointing			C		
	Reducing polyethylene sleeves by improving anti-corrosion performance			R		
	Extending product life by improving anti-corrosion performance				R	
Pumps	Reducing the cut amount during processing by introducing compact casings	C				
	Reducing the weight and volume by introducing compact and thinner casings	R				
	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Reducing power consumption by improving pump efficiency				C	
	Reducing RoHS-designated substances					Ch
Businesses related to water purification, sewage and wastewater treatment (Condensation, dehydration, agitator, etc.)	Reducing weight and the number of parts by eliminating frames or introducing multi-function parts	R				
	Reducing the power consumption of dehydrators by downsizing hydraulic units, etc.				C	
	Reducing the power consumption by introducing agitating blades capable of efficient agitation with low power				C	
	Reducing the power consumption of fans by introducing a low-pressure membrane-type air diffuser				C	
	Reducing dehydrated sludge volume				R	
KSIS	Saving energy by the efficient operation of equipment through remote monitoring/ diagnosis using IoT				C	
	Extending equipment life by failure diagnosis using AI				R	
	Reducing water consumption through field water management systems				W	
Submerged membranes	Reducing weight and volume by reducing the weight per unit membrane area or the membrane filling rate	R				
	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Reducing power consumption per unit processing quantity by improving the membrane filtration performance and expanding the membrane-carrying area				C	
	Collecting/recycling of used membrane cartridges					R
	Reducing RoHS-designated substances					Ch
Membrane-type methane fermentation units	Generating biogases by the methane fermentation of food waste and palm oil mill effluent				C	
	Reducing the volume of food waste				R	
Decentralized wastewater treatment plant *(Johkasou)*	Using recycled resin	R				
	Reducing the weight and volume of *Johkasou* by improving the processing capacity per unit volume	R				
	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Reducing the amount of excavated soil at the time of burying by reducing volume			C		
	Reducing RoHS-designated substances					Ch
Steel pipes	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Reducing energy during construction by mechanical couplings			C		
	Reducing RoHS-designated substances					Ch
Ethylene thermal cracking pipes	Reducing the use of rare metals, using recycled rare metals	R				
	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Reducing fuel consumption necessary for decoking (maintenance) by changing the internal structure of pipes				C	
	Reducing RoHS-designated substances					Ch
Rolls	Using recycled rare metals	R				
	Reducing fuel consumption by improving loading efficiency in product transportation		C			
	Extending product life by improving the roll surface strength				R	
	Reducing RoHS-designated substances					Ch

Internal Certification System for Eco-Products

Regarding the Internal Certification System for Eco-Products

The Kubota Group's internal certification system for Eco-Products was introduced to internally certify products with exceptional environmental friendliness. We evaluate products in accordance with matters related to the five basic items for environmental conservation in the Kubota Group's environmental management, namely, "Tackling Climate Change," "Working towards a Recycling-based Society," "Conserving Water Resources," "Controlling Chemical Substances," and "Conserving Biodiversity," and certify those products that satisfy our internal standards as Eco-Products.

We have also received third-party assurance for our "Sales Ratio of Eco-Products," which is the ratio of sales generated by Eco-Products certified under our internal system.



Example of an Eco-Product label

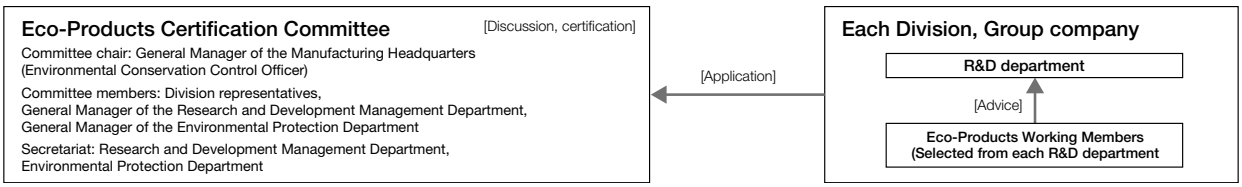
Reduced fuel consumption by xx% (vs. Kubota XX model, RYXXXX)

Eco-Products feature a label that shows their certification as Eco-Products.

Five basic items for environmental conservation	Evaluation items	Relationships with SDGs
• Tackling Climate Change	1. Energy saving (CO_2 reduction) Reducing energy consumption during production, transportation, construction and use, etc.	
• Working towards a Recycling-based Society	2. Resources saving Reducing weight and volume, extending product life, etc.	
• Conserving Water Resources	3. Recycling Using recycled materials and recycled rare metals, etc.	
• Controlling Chemical Substances	4. Reducing environmentally hazardous substances Reducing RoHS-designated substances, reducing gas emissions, etc.	
• Conserving Biodiversity	5. Information disclosure Notes about energy-saving operations, recycling and disposal, etc.	

Eco-Products Certification Committee

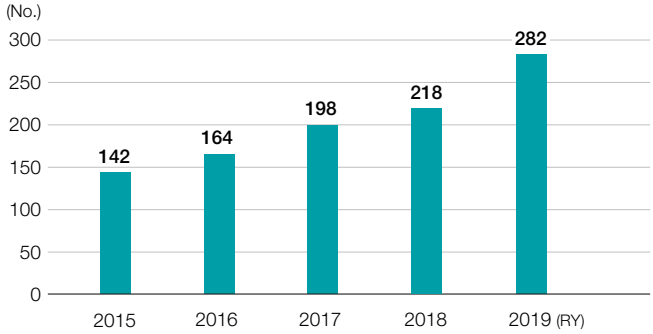
The Eco-Products Certification Committee, chaired by the General Manager of the Manufacturing Headquarters, consists of the committee members elected from each Division, as well as the Research and Development Management Department and the Environmental Protection Department. Upon receiving an application from each Division for the certification of a product, the Committee examines the product's adequacy as an Eco-Product and gives certification.



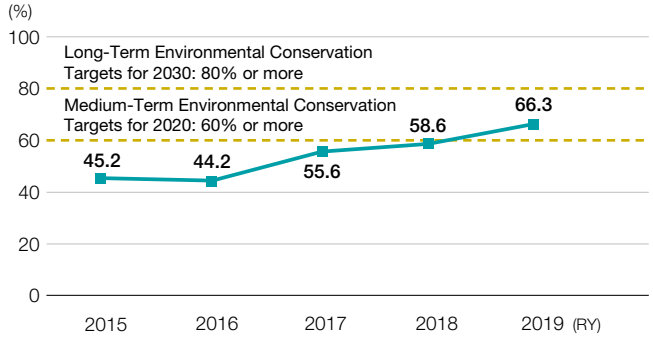
The Pathway to Expanding Certified Eco-Products

Based on our internal certification system established for Eco-Products, the Kubota Group certified an additional 64 products in RY2019, including 3 Super Eco-Products, bringing the total number of certified Eco-Products to 282. The sales ratio of Eco-Products grew to 66.3%, meaning that the Group reached its Medium-Term Environmental Conservation Targets for 2020 one year ahead of plan. We will continue to carry out initiatives focusing on the development of environment-friendly products and expand our Eco-Products lineup.

Trends in No. of Eco-Product Certifications (Total)



Trends in Sales Ratio of Eco-Products*



* The sales ratio of products that have fulfilled the internal requirements in our own Eco-Products Certification System
Sales ratio of Eco-Products (%) = Sales of Eco-Products / Sales of products (excluding construction work, services, software, parts and accessories) × 100

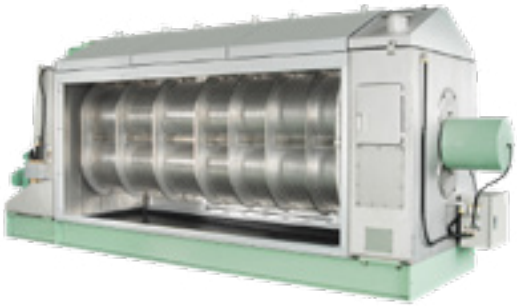
Products Certified as Super Eco-Products in RY2019

Combine harvester
Agri Robo combine harvester
WRH1200A

This is the industry's first combine harvester featuring automated driving assist functions, which will contribute to the realization of smart agriculture. As well as complying with the latest exhaust gas regulations, it also contributes to conserving energy and resources in agriculture.

Ride-on-type rice transplanter
NAVIWEL
NW8S-GS

This is the industry's first rice transplanter fitted with a keep-straight function, which will contribute to the realization of smart agriculture. As well as complying with the latest exhaust gas regulations, it also contributes to conserving energy and resources in agriculture.



High-efficient twin screw press dehydrator*
SHD-030W to 090W

This is the industry's first compact, high-performance sludge dehydrator with a high-efficiency twin screw. As well as the resource saving in the body of the product itself compared with conventional units (single screw), it contributes to reduction of waste materials by efficiently reducing sludge volume.

* A machine to reduce the volume of sludge from sewage treatment plants and similar sources through dehydration

Products Certified as Eco-Products in RY2019 (excerpt)

Tractor
Slugger Series
SL600H-GS

[Key certification point]
Compliant with exhaust gas regulations

Off-road vehicles
Utility vehicle
RTV-XG850 (North America)

[Key certification point]
Compliant with exhaust gas regulations

Construction machinery
Mini excavator
U-35-6S (Korea)

[Key certification point]
Compliant with exhaust gas regulations

Construction machinery
Compact track loader
SVL65-2 (North America)

[Key certification point]
Compliant with exhaust gas regulations

Non-destructive saccharimeter for vegetables and fruits
Fruit selector
K-BA800

[Key certification point]
Saving energy

Diesel engine
05-E5 Series
V1505-CR-TE5-BB (Europe)

[Key certification point]
Saving energy
Recycling
Compliant with exhaust gas regulations

Johkasou, Decentralized wastewater treatment plant
Small-size *Johkasou*
KZ II-5

[Key certification point]
Saving energy
Conserving resources/ Recycling
Reducing environmentally hazardous substances

Plastic pipe
Rigid PVC water supply pipes/joints
Nominal diameter 13-150 mm

[Key certification point]
Reducing environmentally hazardous substances

Click here for details on products certified as Eco-Products.
www.kubota.com/company/environment/ecopro/

Evolution and History of Environmentally Friendly Products and Services

Evolution and History of Rice Transplanters

The Kubota Group developed the world's first walk-behind rice transplanter using seedling mats in 1968 with the aim of reducing the burden of planting rice. In order to meet demand for labor-saving measures precipitated by the subsequent decline in the number of farmers and the aging of Japan's population, we continued to develop our lineup of rice transplanters—we made them rideable, bigger, and equipped them with more functions. We will continue to implement labor-saving efforts and reduce our impact on the environment by proposing efficient cultivation methods and refining agricultural practices with the use of ICT and automation.

Seedling mats grown in trays

■ Historical Development and Environmental Contributions of Rice Transplanters

Decade	Social trends in Japan	Progress in rice transplanter development	Environmental contributions
1950s	· High economic growth · Shift in labor from rural areas to cities	· Start of development	Increasingly lighter walk-behind rice transplanters
1960s	· The mechanization of rice transplanting lagged behind the emergence of tractors and binders · Increase in part-time farmers, the elderly, and women engaged in agriculture	· **Development and sales launch of SP model (2-row) walk-behind rice transplanter** (1968)	
1970s	· Shift from "walk-behind" to "ride-on" agricultural machinery · Boom in agricultural machinery · Convergence of high economic growth · Occurrence of so-called "red tide" at Lake Biwa (1977)	· **Sales launch of SPS model (2-row) walk-behind rice transplanter** (1970) · Start of volume production of SPS series (sales: 18,000 units in first year; 86,000 in second year) · **Sales launch of SPR600 model (6-row; tractor-driven), Kubota's first ride-on rice transplanter** (1976)	Increasingly larger ride-on rice transplanters and lower weight-to-power ratio
1980s	· Growing need to reduce burden of agricultural work [Rotary system] Adoption of rotational planting mechanism improved work speed by 50% and boosted efficiency  Miracle Rotary developed in 1991	· **Sales launch of NSR series of ride-on rice transplanters with row-side fertilizer applicator to reduce amount of applied fertilizer and prevent water contamination** (1980) **Pesticide spraying and other simultaneous features also subsequently developed** · **Sales launch of NSR85-D model (8-row) specialized ride-on rice transplanter** (1984) · Sales launch of S1-600R model (6-row) rotary-type ride-on rice transplanter (1988)	Expanding capabilities of ride-on rice transplanters to simultaneously perform other tasks
1990s		· Continued development of compact, lightweight rice transplanters, as well as larger ride-on rice transplanters · **Sales launch of SPM10 model (10-row) large ride-on rice transplanter** (1995)	
2000s	[Easy turning] Ability to complete smooth turns with only the steering wheel [Easy speed shifting] Prevents sudden acceleration and allows for smooth starts at ultra-low speed  World series performing smooth turns	· Sales launch of Welstar series of ride-on rice transplanters equipped with new easy turning and easy speed shifting capabilities to improve operability (2000) · **Sales launch of NSD8 model (8-row) ride-on rice transplanter capable of efficiently performing five functions simultaneously** (2007) · **Sparse planting proposal** (2009)	Proposing efficient cultivation methods
2010s	· Increasingly higher concentration of farmland among large-scale farmers · Skyrocketing fuel prices · Emergence of high-precision farming using ICT · Shift to driverless farm machinery [e-stop] Easy use of a lever to stop the engine when restocking seedlings or fertilizer reduces fuel consumption by around 12%* 	· **Sales launch of direct seeder for iron-coated rice seeds "Tetsumaki-chan"** (2010) · Sales launch of Racwel, the industry's first ride-on rice transplanters equipped with idling stop feature "e-stop" (2011) · **Sales launch of EP8D-GS model (8-row) ride-on rice transplanter equipped with industry-first straight-line keeping feature** (2016) · **Demonstration of dense seedling transplanting** (since 2017) · **Sales launch of NAVIWEL series of ride-on rice transplanters capable of maintaining planting distance, controlling amount of applied fertilizer, and keeping straight lines** (2019)	Eliminating inefficiencies with precision farming
2020		· **Sales launch of Agri Robo Rice Transplanter NW8SA, the industry's first self-driving rice transplanter**	

* Comparison of fuel consumption when planting rice seedlings under the following conditions (Kubota's estimates; fuel consumption may differ depending on the conditions): Rice transplanter capacity of 8 rows, area of 0.5ha, 20 seedling mats per 0.1ha, 40kg of fertilizer per 0.1ha, one transplanter operator, and one assistant


SP model—Kubota's first walk-behind rice transplanter

Increasingly Lighter Walk-behind Rice Transplanters

Even though the walk-behind rice transplanter first developed in 1968 increased in mass due to the addition of extra features through the 1980s, we made each model lighter and more streamlined mainly with the use of an aluminum gearbox housing and a plastic float. This meant we were able to conserve resources and make operations much more efficient.

<Changes in Weight and Horsepower of 2-row Walk-behind Rice Transplanters>

Launched	1968	1970	1981	1987	1990	2003
Model	SP	SPS-2	NS300-D	S1-25	S1-20	SP-2
Weight (kg)	**100**	**60**	80	**108**	**91**	**88**
		Weight reduction	Added features		Weight reduction	
Horsepower (PS)	3.0	1.7	1.4	2.1	2.3	2.3
Weight (kg) / Horsepower (PS) [vs. NS300-D]	33.3	35.3	**57.1**	**51.4 [-10%]**	**39.6 [-31%]**	**38.3 [-33%]**

Increasingly Larger Ride-on Rice Transplanters and Lower Weight-to-power Ratio

The ride-on rice transplanter that first went on sale in 1976 gradually increased in size so it could plant more rows at the same time, thus boosting work efficiency. However, the heavier it became, the deeper it sank into the mud, which easily hindered its running performance. We therefore strived to provide more horsepower when making the machine larger, but at the same time we took steps to make it lighter. By reducing its weight-to-power ratio (mass divided by horsepower), we were able to conserve resources and achieve higher operating efficiency.

<Changes in Size, Weight, Horsepower, and Planting Capacity of Ride-on Rice Transplanters>

Launched	1976	1984	1995	2014	2019
Model	SPR600 (Kubota's first ride-on model; tractor-driven)	NSR85-D (first specialized rice transplanter)	SPM10 (first 10-row transplanter)	EP10D	NW8S-GS
No. of rows	**6**	**8** Size increase	**10** Size increase	10	8
Weight (kg)	530	490	978	970	960
Horsepower (PS)	9	6.2	16.0	21.0	24.6
Weight (kg) / Horsepower (PS) [vs. NSR85-D]	58.9	**79.0**	**61.1 [-23%]**	**46.2 [-42%]**	**39.0 [-51%]**
			Lower weight-to-power ratio		
Time (min) required to plant 0.1ha	**25–30**	**15–20**	**7–**	7–	7–
	Higher work efficiency				

Expanding Capabilities of Ride-on Rice Transplanters to Simultaneously Perform Other Tasks

In the past, fertilizer was applied uniformly over the rice paddy after the seedlings were planted, but surface runoff from excessive application was one reason behind the occurrence of a so-called "red tide" at Lake Biwa in Shiga Prefecture in 1977. Kubota therefore developed a row-side fertilizer applicator to bury the right amount of fertilizer at the root of each seedling when it is transplanted. Not only did this prevent fertilizer runoff from overapplication, but the simultaneous application of fertilizer considerably reduced the amount of labor required and saved costs because less fertilizer was used. We took the idea of multi-tasking even further by developing a product in 2007 that can perform five jobs at once: transplanting, fertilizer application, herbicide application, pesticide application, and ground leveling. This equipment significantly reduced labor and made work more efficient.

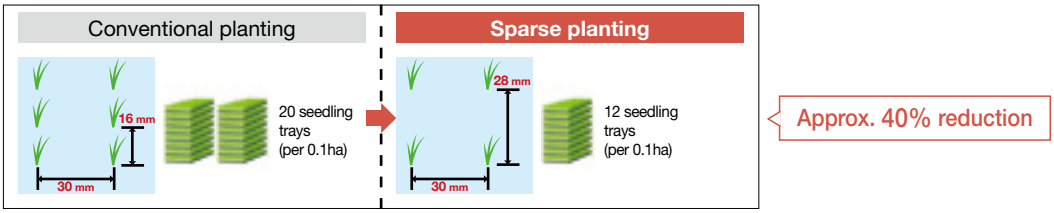
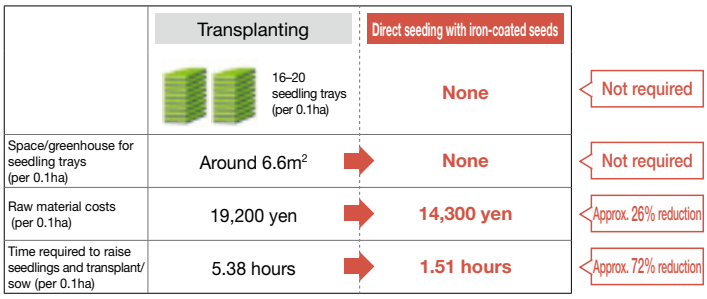
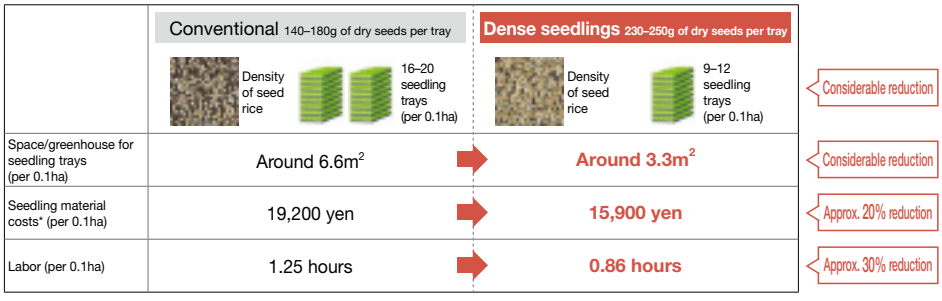
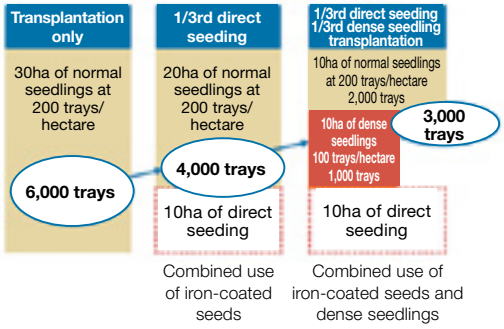
Five functions in a single rice transplanter

Proposing Efficient Cultivation Methods

The hours spent raising and transplanting seedlings account for approximately 30% of all wet-rice farming work. The Kubota Group proposes cultivation methods that can reduce the number of seedling trays used or even eliminate the very need to raise seedlings in order to reduce manpower, time, and costs involved in raising and transplanting seedlings.

Limiting the volume of seedlings raised, the number of seedling trays, and even the seedlings greenhouse reduces the resources introduced into the environment and also curtails the amount of energy required to maintain and manage a seedlings greenhouse.

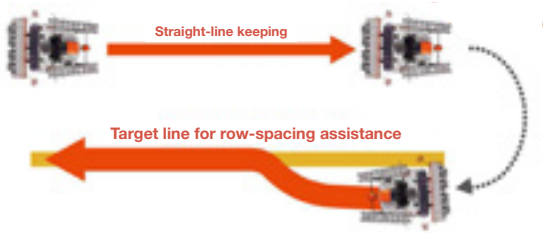
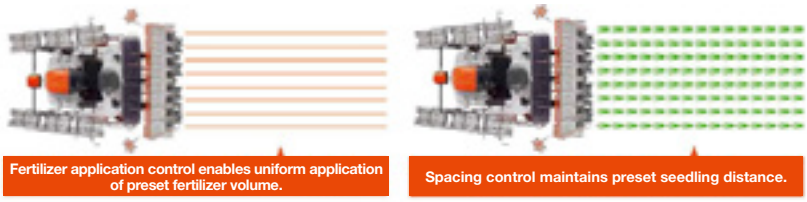
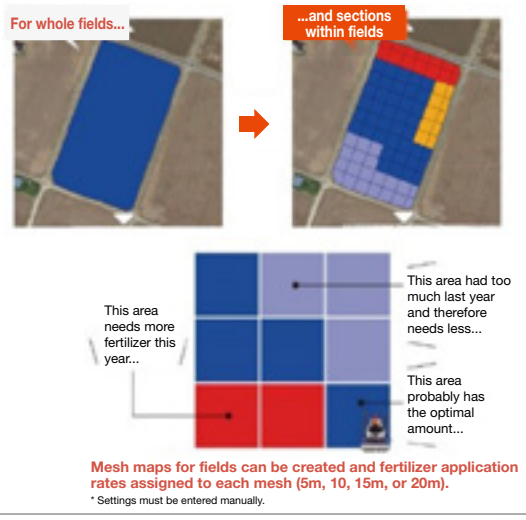
<Rice Cultivation Methods Proposed by the Kubota Group>

Method	Details
Sparse planting (since 2009)	This cultivation method employs a lower planting density by spreading out the clumps of seedlings. Reducing the density means fewer seedlings are required, thus reducing the number of seedling trays by around 40–50%. While this method results in somewhat fewer ears of rice, the volume per ear is higher, therefore the volume of unhulled rice per unit area is roughly the same as, or only slightly lower than, conventional planting. 
Direct sowing with iron-coated seeds (since 2010)	This method involves the dispersal of seeds coated with iron powder across the surface of the rice paddy. Unlike transplanting, the raising of seedlings is not required. If Kubota's direct seeder for iron-coated seeds is used, high-speed sowing at intervals, fertilizing, herbicide application, and grooving can be performed simultaneously to sharply reduce work time and conserve energy.  6-row direct seeder for iron-coated seeds (WELSTAR WORLD WP60D-TC)  * 2015 National Workshop on Agricultural Systemization (Yamagata)
Dense seedling transplantation (since 2017)	This cultivation technique involves the use of seedlings raised more densely than usual in a single tray. The seedlings are then planted in small amounts with a rice transplanter. The dense seedling transplantation method can halve the number of seedling trays compared to when using young seedlings grown the conventional way. Almost all Kubota rice transplanters are capable of transplanting dense seedlings.  * Results differ in each region. Please refer to region-specific information for more details. Source: 2017 National Workshop on Agricultural Systemization.
Combination of direct sowing with iron-coated seed and dense seedling transplanting	The Kubota Group proposes that the combination of direct seeding with iron-coated seeds and the high dense seedling transplantation can reduce seedling trays, spread out the harvesting season, and expand scale. Directly seeding iron-coated seeds, which significantly cuts down on labor, and transplanting a certain percentage of high dense seedlings, can reduce the number of seedling trays required. 

Eliminating Work Inefficiencies with Precision Farming and Helping Reduce Environmental Impacts

In Japan, more and more agricultural land is being managed by large-scale farming households, so it is vital that we develop high-performance, high-precision products to meet the needs of farmers to boost revenue and cut costs. In 2016, the Kubota Group outpaced its rivals in bringing to market a rice transplanter capable of maintaining straight planting rows. Ever since, we have continued to develop numerous functions to achieve high-precision rice transplanting. These features enable even the inexperienced to easily plant rice seedlings with great accuracy, while for seasoned farmers, they help improve work efficiency by alleviating fatigue.

<GPS-based ICT Functionality>

Function	Details	Environmental contributions
Straight-line keeping (GS) and row-spacing assistance	The straight-line keeping function uses GPS to self-steer when proceeding straight ahead so that even beginners can easily transplant seedlings in straight rows. When used in combination with the row-spacing assistance function, any deviations in distance between adjacent rows can be corrected.   Self-steering when checking the transplantation of seedlings	Planting seedlings in straight rows can help reduce the wasteful consumption of fuel and materials (seedlings, fertilizer, pesticide, etc.).
Spacing control and fertilizer application control	Owing to the fact that rice transplanters slog through the mud in rice paddies, the spacing between seedlings planted with the conventional wheel-linked mechanism can vary depending on the degree of slippage. Kubota's spacing control and fertilizer volume control functions use actual GPS-based speed data to accurately gauge distance travelled and correspondingly control the rotational speed of the planting claws and fertilizer rollers. This allows seedling transplantation and fertilizing to be carried out according to a preset distance between seedling clumps.  Fertilizer application control enables uniform application of preset fertilizer volume. Spacing control maintains preset seedling distance.	Farmers usually prepare 10% more seedlings and fertilizer than planned to compensate for errors caused by rice transplanter slippage. Kubota's spacing control and fertilizer application control functions can reduce these extras, thereby minimizing the materials and energy required to prepare seedlings and curtailing the amount of fertilizer resources actually used.
Adjustable fertilizing (NW8S-PF-GS)	KSAS* can be used to create fertilization maps of rice paddies that visualize where and how much fertilizer is needed. Rice transplanters equipped with adjustable fertilizing functionality can apply optimal amounts of fertilizer by syncing with this map data. * KSAS stands for Kubota Smart Agri System, our ICT-powered agricultural management support service.  Mesh maps for fields can be created and fertilizer application rates assigned to each mesh (5m, 10, 15m, or 20m). * Settings must be entered manually.	The optimization of fertilizer application rates minimizes unevenness in rice growth and delivers increased stability in terms of eating quality and yields. In turn, this reduces inputs per yield.

Furthermore, in 2020 we launched the self-driving Agri Robo Rice Transplanter NW8SA. Transplanting work is carried out by two people: one operator and one assistant to restock the seedling trays. However, the rice transplanter drives itself, thus reducing manpower and improving work efficiency. Stable cultivation is achieved because the machine plants the seedlings with minimum overlapping. It also curbs wasteful consumption of fuel and resources by automatically plotting the most economical route.

Agri Robo Rice Transplanter NW8SA

Feature: Developing Environmental Contribution Products

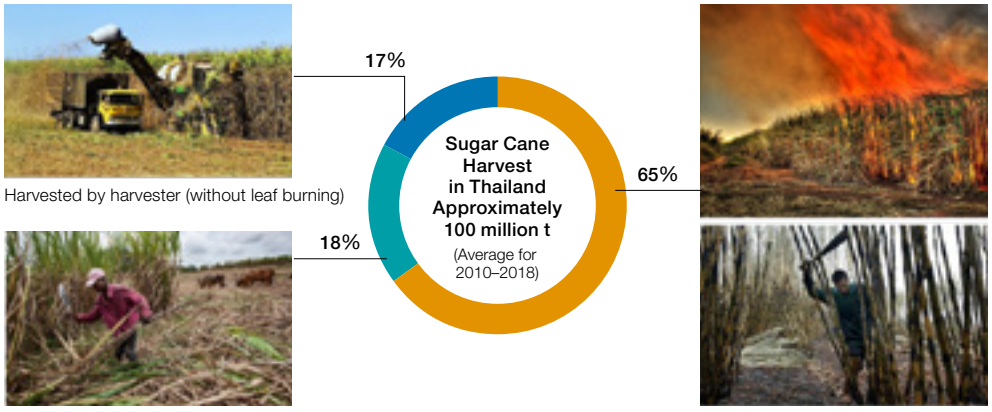
Contributing to Zero Burning through the Development of a Sugarcane Leaf Remover (Thailand)

KUBOTA Research and Development Asia Co., Ltd. (KRDA), an R&D site in Thailand, has developed the Sugarcane Leaf Remover (SLR110H), an implement that removes sugarcane leaves. The implement is contributing to the Thai government's zero burn policy and environmental conservation.

Sugarcane Leaf Burning and Air Pollution in Thailand

Thailand is the fourth largest sugar producer in the world and sugarcane production is widespread there. Because most sugarcane farmers are small-scale farmers who harvest by hand. As it reaches harvest time, the sugarcane produces a large quantity of covering leaves that obstruct the harvesting operation. Most farmers burn the leaves before harvesting to make the work more efficient. However, PM 2.5 air pollution is expanding in Thailand and agriculture-related burning, including leaf burning of sugarcane leaves, is thought to be one of the causes.

Ratio of sugarcane harvesting methods in Thailand*



Harvested by harvester (without leaf burning)

Harvested by hand (without leaf burning)

Harvested by hand after leaf burning

* Data by OCSB, Office of the Cane and Sugar Board

Development of the Sugarcane Leaf Remover

Leaf burning reduces the farmer's income by causing yield loss and quality degradation. KRDA has developed the SLR110H, an implement for removing sugarcane leaves, as a solution to eliminate leaf burning. SLR110H is an implement that can be used with small tractors that are already widely used by sugarcane farmers. It can efficiently remove leaves between sugarcanes inter-row by rotating a roller with a string-type trimmer attached. The trimmer removes leaves that it contacts. Its simple structure results in a highly cost efficient implement with a low price.

Since launching in the market in December 2018, unit sales have been steadily increasing and we are also focusing on exports to surrounding Asian countries.

SLR110H mounted on a small tractor

Before leaf removal Leaf removal using SLR110H After leaf removal

Click here to see the SLR110H in use
https://youtu.be/oDfvFmlpZIM

Contribution to Thailand's Zero Burn Policy

The Thai government has been advocating a zero burn policy since 2019 to resolve serious air pollution. At the "Thailand-Japan Environmental Solutions Week," held in Bangkok in January 2020, and jointly sponsored by Thailand's Ministry of Natural Resources and Environment and Japan's Ministry of the Environment, staff from SIAM KUBOTA Corporation Co., Ltd. of Thailand, which is in charge of sales of SLR110H, were invited to give a presentation about the company's initiatives, such as development of the SLR110H that is helping to reduce sugarcane burning in Thailand. The presentation drew a great deal of interest from the audience, which included officials, businesspeople, and researchers.

VOICE

Aiming to Eliminate Leaf Burning during the Sugarcane Harvest

Despite regulations prohibiting the burning of fields in Thailand, the ratio of farmers who conduct sugarcane leaf burning remains as high as ever, at 63% in 2009 and 66% in 2018. To ensure the success of the Thai government's zero burn policy, we developed the SLR110H to simultaneously satisfy the needs of farmers, harvest workers, and sugar mills.

In development, the specifications needed to be considered from various perspectives to cope with diverse sugarcane growing conditions. The size of the implement must be suitable for creating space for workers by removing leaves, while avoiding damage to the sugarcane. The trimmer material (string) must have sufficient weight and rotational speed to break the leaves without degrading the quality of the sugarcane.

Moreover, since the harvest season is just 3 to 4 months long, it is very important that the machine does not break down during this period. The SLR110H has a structure that makes it difficult for removed leaves to become entangled on the shaft, while the trimmer is designed to be easily replaceable without the use of tools. This enables users to keep working without losing time on faults or maintenance.

Since its launch in Thailand, SLR has been popular because it makes harvest operations more efficient while increasing quality and harvests compared with the leaf-burning method.

We will continue to develop products that solve customer needs and environmental issues to enrich the lifestyles of people living in ASEAN countries.

KUBOTA Research and Development Asia Co., Ltd.
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