Agriculture (Rice Industry)

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Abstract

In this report about the rice industry. Objective this report was to gather information related to the present status of the rice industry in Sri Lanka. We study about the rice plantation, paddy cultivation and different type of the rice. We describe about the rice production and consumption in the world. we have given some graphs and some tables to related to it. we include the table of principal Rice exporting countries worldwide in 2021/2022 and also include Total rice consumption worldwide from2008/2009 to 2021/2022. A. Then, we include about the barriers of the rice industry and solutions of barriers. Also, we study the status of the rice industry in Sri Lanka.

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Introduction

“Rice is great if you're really hungry and want to eat two thousands of something.”

By Mitch Hedberg

Our report briefly describes about the rice agriculture industry here we allocate agriculture as five tropics and made a report first is rice cultivation here, we briefly explain how the farmers cultivate the paddy and supply it. We allocate many sub parts under the rice cultivation and describe about and briefly describe. Next, we consider about production and consumption here we mainly and deeply research about the annual rice production in Sri Lanka. here we consider world production volume and paddy consumption as a graph method in this tropic we describe benefits of the rice and nutrition’s also mentioned as a pie chart by the county wide production of rice also described with the help of a bar chart in this category next, we consider about review of the global rice industry it includes the income and kg of the production and a bar chart describe about rice exported countries and the global supply of rice it includes export prize details Rice is the staple food of the inhabitants of Sri Lanka. Paddy crops is cultivated as a wetland crop in all the districts. Next, we consider about the problems in agriculture and how the farmers faced it and get solution fir it the agricultural barrier, which once contributed to more than half of Sri Lanka’s, is now facing a number of problems the problem is briefly mentioned and described in the point four.

Finally, it contains about study the status of the rice industry here we found the correlation between the rice and the need of water and we consider in this agriculture time. And we mentioned as rice supply demand. We hope you will be able to get sufficient knowledge and idea about rice industry from referring our report .

Methodology

The study was started by reviewing the statistics on rice cultivation. Subsequently, a survey was conducted on the productivity of global rice environments in the rice production industry, rice products, foods and the nutrients they provide. Then, this way followed by a statistical survey of the world production volume of rice and the total rice consumption worldwide. Then, to review the global rice industry, data on rice revenue, export prices of rice worldwide, production growth rates, overall global rice consumption, total global rice supply, export price scales were illustrated using diagrams. Then, this was followed by a review of current development in the rice industry, obstacles, difficulties, problems and solutions. Quantitative analysis was performed using statistical techniques such as linear correlation and quantitative analysis was also performed to identify barriers and solutions to them. Finally, a statistical review was conducted to study the state of the rice industry in Sri Lanka, such as the politics, the relationship of CO_2 to paddy cultivation, the gross yield of different rice lines with enhanced atmospheres, and the average yield of paddy.

Rice cultivation

Rice is the staple food of Sri Lanka and as such, paddy cultivation in Sri Lanka is given utmost importance in the agriculture industry. Ancient and traditional farmers were self-sufficient in rice production and ancient Ceylon is said to have been among the foremost paddy exporters in the world. Paddy production in the country flourished during the reign of Sri Lankan kings, who fostered and nurtured production in various ways including, most notably, the supply of water through the construction of large-scale irrigation tanks – Ceylon was popularly known as the 'The Great Barn of the East' during the reign of King Parakramabahu who is renowned for his hydraulic construction and renovation in aid of agriculture.

Ancient and traditional paddy cultivation practices were completely organic and did not induce any harm to the surrounding environment or health.

The Structure of a Kumbura

A Kumbura is a portion of a 'Kumburuyaya' or a large paddy tract that belongs to an individual farmer; i.e. the Kumburuyaya is divided into separately owned Kumburu. The paddy tract divides into discernible square areas of land called 'Liyadi' where paddy is grown. These are surrounded by ridges known as 'Niyara'. An opening is made in the Niyara called 'Vakkada' which supplies water into the Liyadi. Areas of land, comparatively smaller than Liyadi, known as Kanati are constructed to regulate and manage the water flow into the Kumbura. Two Kanati are located at the two ends of the Kumburuyaya; these portions, called 'Kurulupaluwa' are dedicated to birds for feeding. Ancient farmers believed that by providing these feeding grounds to birds, their threat to paddy would be minimized.

Kurulupaluwa is one of many altruistic methods practiced by ancient farmers. Much of the agricultural practices of old worked harmoniously with nature, inducing very little (these were reversible) to no damage to the environment and wildlife.

Types of Kumburu

There are two types of Kumburu: Godakumburu and Madakumburu.

Godakumburu are cultivated without a permanent water supply, instead, paddy is cultivated here with the aid of rainwater. These types of Kumburu were not popular among farmers, due to the unpredictability of rainfall. Madakumburu were much more popular as these had a permanent water supply by way of an irrigation tank or stream.

The procedure of Rice cultivation

See Sama (Harrowing)

See Sama is the process of harrowing and preparing land before paddy cultivation, which is done using a Nagula (plough) and oxen. See Sama was performed ceremoniously during the reign of kings in a festival called 'Vapmagula'. Many religious rituals were also observed by traditional and ancient farmers before harrowing commenced.

Once harrowing is complete, paddy seeds are sown or saplings are planted in the ground.

Enriching Soil

No chemicals or toxins were used to enrich the soil of paddy fields. Ancient and traditional farmers used manure, fallen leaves, and decayed hay to fertilize their land. These organic fertilizers improved microbial activity in the soil. The yield from this method of fertilization was high and absent of harmful toxins.

Poru Gama (Leveling)

Poru Gama is the process of leveling the paddy field with the use of oxen and a tool known as the Poruva. Poru Gama is generally done a few weeks after harrowing and fertilizing paddy fields. This process ensures that there is uniform water flow from one Liyadda to another.

Caring for Bovines

Bovines (oxen, bullock, cows) who help the farmer in the many stages of paddy cultivation are an invaluable asset to him. Thus, farmers treat their working animals with utmost love and care. They have never induced injury by the Kewita (a stick used to drive and direct the bovines) during See Sama, Poru Gama, etc. The animals are never overworked and are provided plenty of food, water, and rest promptly. At the end of a working day, the bovines would be bathed and cleaned, and provided forage. The animals are never employed the entire day (they are only worked around 5 to 6 hours a day) and are never worked under a harsh sun (this was especially during the day and at noon).

They were even referred to lovingly using names such as 'Amma' (mother), 'Appa' (father), and 'Vahudaruvo' (Calf children).

Sowing Seeds and Planting Sapling

Following the initial preparation, farmers would elect to either sow paddy seeds or plant sapling.

Weeding

Weeding is chiefly performed by women. Rhymes called ‘Nelum Kavi’ are generally sung together during the process to cast off weariness and boredom. Weeding an entire Kumburuyaya often takes a fortnight.

Safeguarding the Kumbura

A wooden fence called the Danduvata, made by stacking and tying fallen and trimmed tree stems and branches is set up around the entire Kumburuyaya to prevent wild animals from raiding crops. In addition, a scarecrow (Pambaya) is erected and a Takeya (a rough bell-type object) is hung to scare away birds and tiny animals. Farmers would keep watch over their Kumbura throughout the day and night in rough-hewn watch huts called ‘Pela’ to chase away raiding animals.

Diseases

Ancient and traditional farmers tilled their land according to the Kanna (period or season) systems, which avoided pest invasion. They also employed organic pest control methods.

It was also common to pray to religious faiths to protect the crop.

Harvesting

Paddy was harvested when they turn light golden. Farmers would harvest their crops together while singing ‘Goyam Kavi’. The harvest is temporarily stored in the Kamatha (threshing floor) before it is taken home.

Rice cultivation extent

The total paddy production in the country is estimated as a product of the average yield that is estimated through a sample survey and the extent harvested, which is based on a complete enumeration of all paddy parcels.

To estimate the average yield, 2,687 experiments were conducted during the season. Paddy statistics at block level for Mahaweli areas namely Mahaweli „B‟, „C‟, „G‟ and „H‟ and„Udawalawe‟ area is also published in this report.Distribution of sown extent by various aspects of paddy cultivation such as the method of land.

GROSS HARVESTED AREA, AVERAGE YIELD AND PRODUCTION OF PADDY

MAHA SEASONS (2013/2014 – 2019/2020)

MAHA SEASON	GROSS HARVESTED EXTENT		AVERAGE YIELD		PRODUCTION	
	'000 ACRES	'000 HECTARES	BUSHELS PER NET ACRE	Kg PER NET HECTARE	MILLION BUSHELS	'000 MT
2013/2014	1,433	580	78.89	4,065	107.15	2,236
2014/2015	1,816	735	83.45	4,303	137.88	2,877
2015/2016	1,835	743	80.79	4,165	139.11	2,903
2016/2017	946	383	78.95	4,071	70.63	1,474
2017/2018	1,532	620	80.45	4,148	114.87	2,397
2018/2019	1,789	724	88.58	4,567	147.26	3,073
2019/2020	1,828	740	87.87	4.531	153.21	3,197

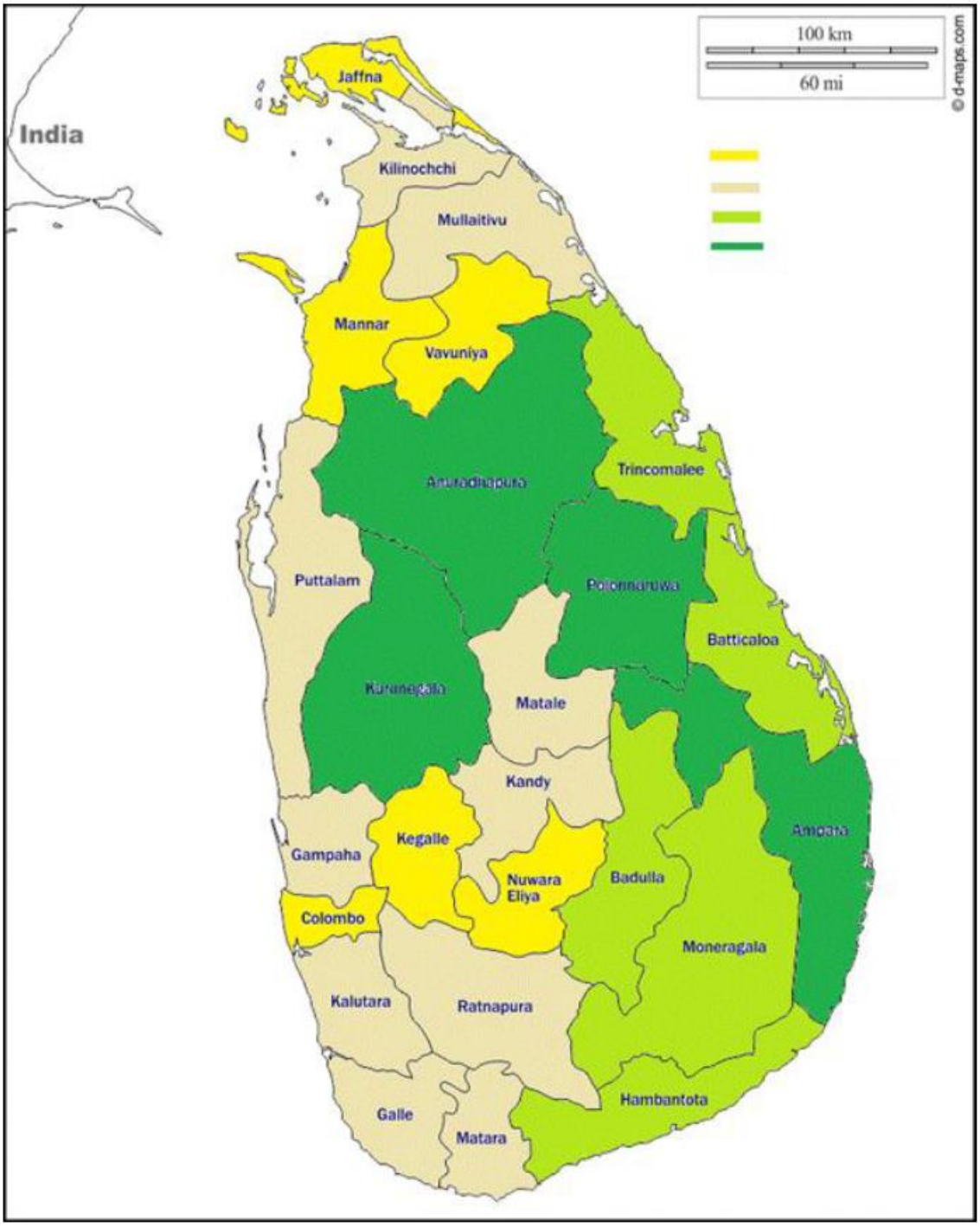
The sown extent under paddy cultivation during 2019/2020 maha season was 752,248 hectares. Out of which 349,744 hectares (46.5%) was reported under major irrigation schemes, 200,204 hectares (26.6%) under minor schemes and 202,300 hectares (26.9%) under rainfed. The largest extent of paddy cultivated was reported in Anuradhapura District, (118,902 hectares) which is 15.8% of the total extent of paddy cultivated in the country.The harvested extent during this season was estimated to be 739,911 hectares and it is about 98% of the sown extent.

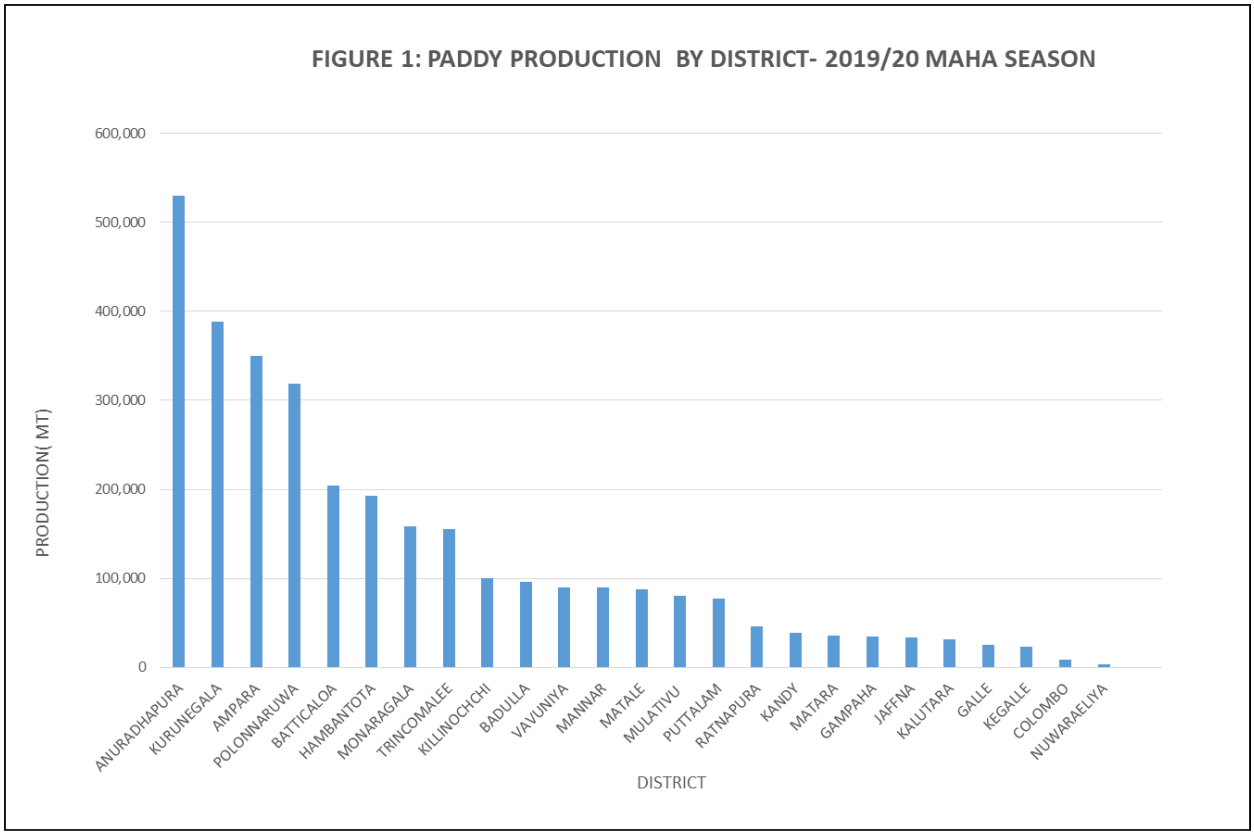
Average Yield

The average yield of paddy estimated for 2019/2020 Maha season was 4,531 Kg. per net hectare.The highest average yield of 6,302 kg per net hectare was reported during this season from Hambantota

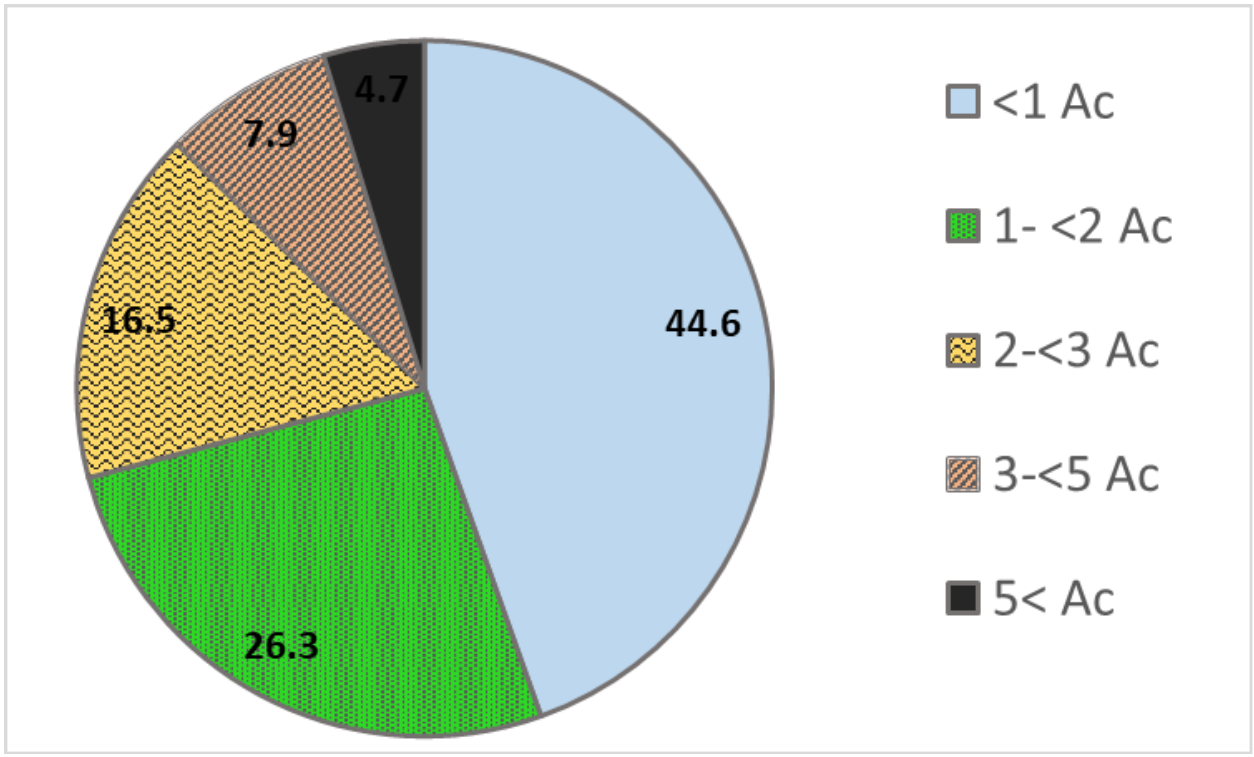
District. The average yields of Anuradhapura, Polonnaruwa, Matale districts are 5,574, 5,404, and 5,316 kg per net hectare respectively.

Distribution of Paddy Extent by District

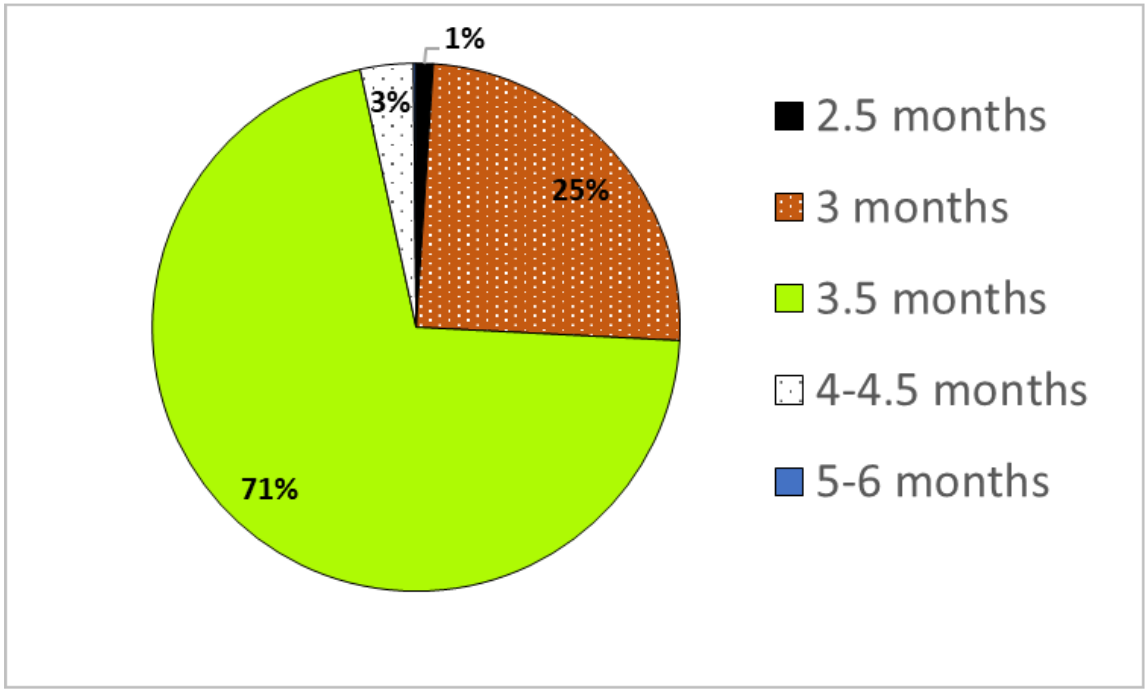




Number of paddy holdings by size



Annual extent of paddy cultivated by age group of new improved varieties



The most popular variety, with some 60% share, is the long grain rice (nadu); 22 percent of production is short grain rice (samba). Although white pericarp varieties are the most popular, the red pericarp varieties and traditional rice varieties are becoming popular.

The Department of Agriculture of Sri Lanka (DOA) forecasts a net production of 2.9 million metric tons of paddy for MY 2018/19 Maha crop, after deducting for crop damages, wastage, and seed paddy requirements. Nevertheless, Post forecasts a slightly higher production in the MY 2018/19 Maha crop based on the DOA estimates, industry information, weather, and other factors that prompt farmers to make cropping decisions.2

Post forecasts a higher overall output for MY 2018/19 owing to the bumper harvest in the Maha season, which followed several years of drought-affected production. With the favorable weather conditions, the average yield is expected to be high at 4.3 metric tons per ha for MY 2018/19.

TABLE 2 : SOWN AND HARVESTED EXTENT (GROSS & NET), AVERAGE YIELD AND PRODUCTION BY DISTRICT 2019/2020 MAHA SEASON (IMPERIAL UNITS)

DISTRICT	GROSS EXTENT SOWN(ACRES)				GROSS EXTENT HARVESTED(ACRES)				AVERAGE YIELD (BUSHELS PER NET ACRE)				NET EXTENT HARVESTED (ACRES)	TOTAL PRODUCTION ('000 BUSHELS)
	MAJOR SCHEMES	MINOR SCHEMES	RAINFED	ALL SCHEMES	MAJOR SCHEMES	MINOR SCHEMES	RAINFED	ALL SCHEMES	MAJOR SCHEMES	MINOR SCHEMES	RAINFED	AVERAGE YIELD		
COLOMBO	632	1,380	5,065	7,077	632	1,380	5,065	7,077	71.74	67.81	67.99	68.29	6,015	411
GAMPAHA	3,815	8,098	12,091	24,004	3,609	7,983	12,037	23,629	85.79	80.60	82.24	82.23	20,085	1,652
KALUTARA	265	3,222	20,127	23,614	265	3,221	19,967	23,453	70.67	68.32	70.98	70.61	21,635	1,528
KANDY	10,381	11,854	4,956	27,191	10,379	11,844	4,943	27,166	112.05	62.63	85.95	85.75	21,483	1,842
MATALE	16,994	17,484	11,131	45,609	16,916	17,407	11,109	45,432	105.03	100.12	104.85	103.10	40,857	4,213
NUWARAELIYA	1,037	3,236	12	4,285	1,037	3,236	12	4,285	69.91	69.96	78.24	69.97	2,415	169
GALLE	506	3,577	15,558	19,641	506	3,577	15,533	19,616	77.57	74.57	77.79	77.20	15,351	1,185
MATARA	9,631	6,837	12,556	29,024	9,526	6,664	12,465	28,655	89.76	68.91	67.84	75.38	22,623	1,705
HAMBANTOTA	69,197	14,399	2,836	86,432	69,115	14,384	2,823	86,322	127.39	106.24	77.42	122.23	75,420	9,219
JAFFNA	_	_	25,811	25,811	_	_	25,430	25,430	_	_	70.37	70.37	22,567	1,588
MANNAR	37,781	9,882	196	47,859	37,781	9,882	196	47,859	94.65	90.21	66.85	93.62	45,696	4,278
VAVUNIYA	10,788	30,655	6,102	47,545	10,774	30,373	6,091	47,238	91.14	97.63	96.62	96.02	44,569	4,279
MULATIVU	18,729	10,762	15,629	45,120	18,729	10,762	15,629	45,120	91.37	93.22	86.35	90.07	42,571	3,834
KILLINOCHCHI	29,870	1,366	35,890	67,126	29,870	1,366	35,890	67,126	73.28	64.57	87.37	80.64	59,568	4,803
BATTICALOA	60,482	9,416	95,652	165,550	49,820	8,694	92,825	151,339	74.17	78.73	72.44	73.37	133,572	9,800
AMPARA	147,601	10,992	37,651	196,244	143,470	10,187	36,105	189,762	96.70	76.91	79.65	92.39	181,356	16,756
TRINCOMALEE	50,408	17,019	27,178	94,605	50,408	17,019	27,178	94,605	92.17	85.69	70.73	84.85	87,888	7,457
KURUNEGALA	44,344	93,277	66,188	203,809	44,160	92,667	65,827	202,654	111.20	92.09	78.28	91.77	202,654	18,597
PUTTALAM	19,533	27,235	4,044	50,812	18,185	26,484	3,733	48,402	91.36	89.78	87.78	90.22	41,142	3,712
ANURADHAPURA	133,575	129,204	31,035	293,814	132,835	128,639	30,923	292,397	120.54	99.27	91.46	108.11	235,116	25,418
POLONNARUWA	140,748	18,363	6,488	165,599	140,193	18,103	6,262	164,558	103.59	121.65	83.49	104.81	145,568	15,257
BADULLA	26,125	24,043	13,194	63,362	26,125	24,043	13,194	63,362	87.30	87.89	77.30	85.44	53,858	4,602
MONARAGALA	22,148	26,905	35,843	84,896	21,298	26,493	35,369	83,160	122.66	90.93	76.71	93.01	81,497	7,580
RATNAPURA	9,647	11,653	5,278	26,578	9,643	11,633	5,257	26,533	118.24	92.72	76.89	98.86	22,553	2,230
KEGALLE	_	3,852	9,383	13,235	_	3,838	9,353	13,191	_	80.81	91.51	88.40	12,357	1,092
SRILANKA	**864,237**	**494,711**	**499,894**	**1,858,842**	**845,276**	**489,879**	**493,216**	**1,828,371**	**94.71**	**85.05**	**80.28**	**87.87**	**1,638,416**	**153,207**

HARVESTED EXTENT, AVERAGE YIELD AND PRODUCTION OF PADDY BY SEASON (1995 - 2020)

YEAR	GROSS EXTENT HARVESTED ('000 HECTARES)		AVERAGE YIELD (Kg PER NET HECTARE)		TOTAL PRODUCTION ('000MT)		
	MAHA	YALA	MAHA	YALA	MAHA	YALA	Total
1995	549	340	3,467	3,183	1,761	1,049	2,810
1996	425	235	3,246	3,216	1,331	730	2,061
1997	443	247	3,489	3,241	1,457	782	2,239
1998	563	266	3,325	3,290	1,781	911	2,692
1999	539	333	3,419	3,508	1,736	1,121	2,857
2000	526	306	3,617	3,495	1,781	1,079	2,860
2001	471	294	3,610	3,655	1,613	1,082	2,695
2002	499	321	3,810	3,477	1,774	1,086	2,860
2003	560	351	3,664	3,444	1,895	1,172	3,067
2004	469	251	3,784	3,863	1,670	958	2,628
2005	570	345	3,826	3,647	2,013	1,233	3,246
2006	586	314	3,882	3,836	2,135	1,206	3,341
2007	512	284	3,931	4,161	1,973	1,158	3,131
2008	568	464	3,904	3,990	2,125	1,750	3,875
2009	605	337	4,164	3,969	2,384	1,268	3,652
2010	643	417	4,371	4,200	2,630	1,671	4,301
2011	613	489	3395	3,995	1,996	1,898	3,894
2012	685	305	4,159	3,784	2,717	1,129	3,846
2013	742	447	4,223	4,177	2,846	1,774	4,620
2014	580	301	4,065	4,015	2,236	1,145	3,381
2015	735	476	4,303	4,238	2,877	1,942	4,819
2016	743	380	4,165	4,084	2,903	1,517	4,420
2017	383	237	4,071	3,895	1,474	909	2,383
2018	620	363	4,148	4,377	2,397	1,533	3,930
2019	724	346	4,567	4,366	3,073	1,519	4,592
2020	740		4,531		3,197		

Rice production and consumption

Rice is cultivated in more than 100 countries with a total area of about 158 million hectares, producing 700 million tons (470 million tons of milled rice) annually. About 640 million tons of rice are cultivated in Asia, accounting for 90% of the world's production. Sub-Saharan Africa produces about 19 million tons, and Latin America produces about 25 million tons. In Asia and sub-Saharan Africa, almost all rice is grown on small farms of 0.5 to 3 hectares.

Yields range from less than 1 t / ha under very poor rain conditions to more than 10 t / ha in intensive temperate irrigation systems. The shrinking size of farmers in many small areas is responsible for the low incomes of rice families. Rice grows in a variety of environments and is productive in many situations where other crops fail.

Traditionally, the best rice cultivation has come from planting in high latitude areas where long days and intensive agricultural techniques are practiced, or in low latitude desert areas with high levels of solar energy. Typical examples are South West Australia, Hokkaido, Japan, Spain, Italy, Northern California, and the Nile Delta.

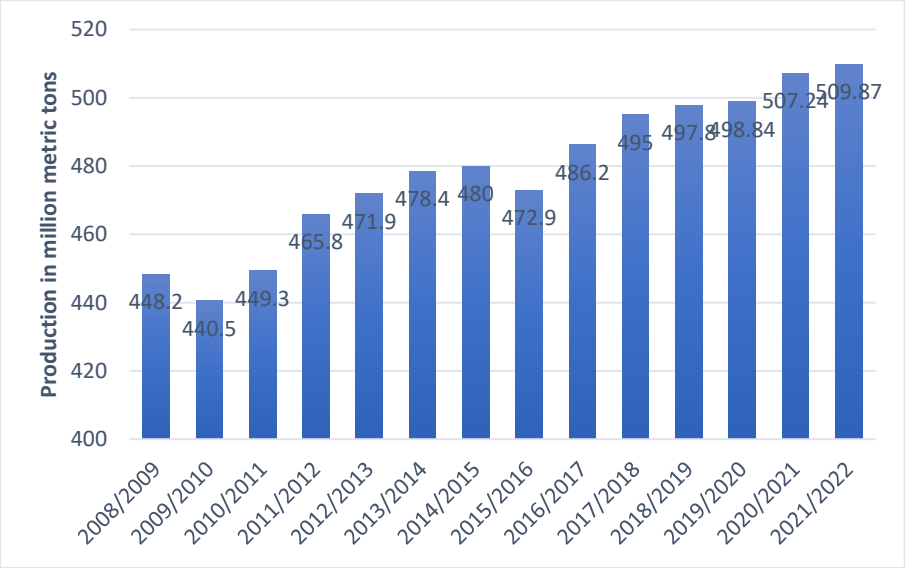
Production

Global paddy rice production in 2017 was 769.7 million tonnes (848.4 million tonnes) [39], led by China and India, accounting for 49% of the total. [1] Other major producers were Indonesia, Bangladesh and Vietnam. In 2017, the top five producers accounted for 72% of total production and the top 15 producers accounted for 91% of the world's total production (see table on the right). Developing countries account for 95% of total production. [40]

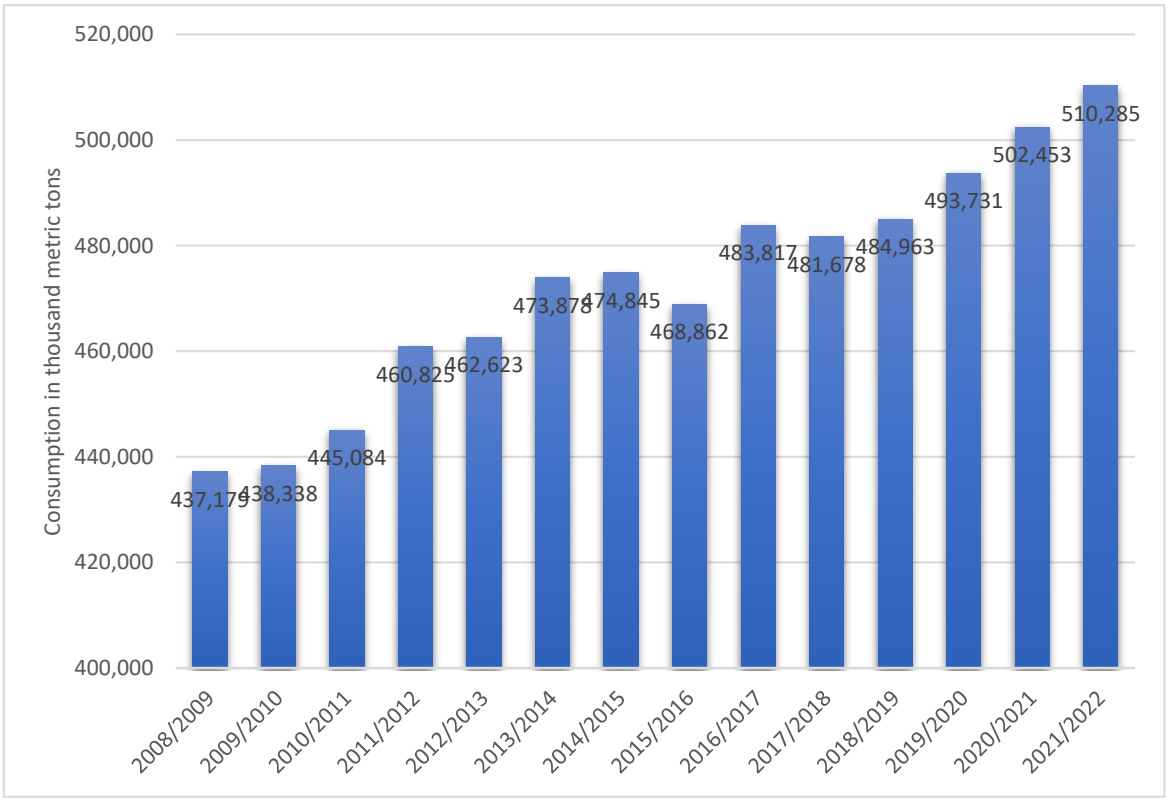
Rice is an important staple food and the center of rural people and their food security. It is mainly grown by smallholders on less than 1 hectare farms. Rice is also a cash crop and a wage product for workers in the non-agricultural sector. Rice is an integral part of the diet of many people in Asia, not just Latin America, the Caribbean and Africa. It is the center of food security for more than half of the world's population.

Many countries that produce rice grains face significant post-harvest losses on farmland, with poor roads, inadequate storage technology, inefficient supply chains, and retail dominated by small shopkeepers. This is because agricultural products cannot be delivered to the market. According to a World Bank and FAO study, developing countries lose an average of 8% to 26% of rice each year due to post-harvest problems and poor infrastructure. Some sources claim that post-harvest losses exceed 40%. [40] [42] Not only do these losses reduce global food security, but farmers in developing countries such as China and India have avoidable post-harvest losses, inadequate transportation and proper storage.

World production volume of milled rice from 2008/2009 to 2021/2022(in million metric tons)



Total rice consumption worldwide from 2008/2009 to 2021/2022 (in 1,000 metric tons)



Cooking

Rice varieties are usually classified as long, medium and short. [4] Long (high amylose) rice grains tend to remain intact after cooking. Medium grain rice (rich in amylopectin) is sticky. Medium grain rice is used in desserts, in Italy for risotto, and in Spain for many rice dishes such as Arròs negre. Some types of amylopectin-rich long-grain rice, known as Thai glutinous rice, are usually steamed. [5] Sticky short grain rice is used for sushi. [6] Because it is sticky, it can keep the shape of rice when cooking rice. [7] Short-grain rice is widely used in Japan [8] and is also used as an adjunct to delicious dishes. [9] Short grain rice is often used for rice pudding

nstant rice has a great effect on flavor and texture, but it differs from parboiled rice in that it is completely cooked and then dried. Rice flour and starch are often used in batters and bread crumbs to enhance their crispness

Preparation

Rinsing rice before cooking removes much of the starch and reduces the degree to which individual grains stick together. This makes the rice fluffy, but without rinsing, the result is sticky and creamy. [10] Rice made in the United States is usually fortified with vitamins and minerals and loses nutrients when rinsed.

You can soak rice to reduce cooking time, save fuel, minimize exposure to high temperatures, and reduce stickiness. In some varieties, soaking improves the texture of cooked rice by increasing grain swelling. Rice can be soaked anywhere from 30 minutes to several hours.

Soak brown rice in lukewarm water for 20 hours to promote germination. This process [11], called germinated brown rice (GBR), activates enzymes and enhances amino acids such as gamma-aminobutyric acid to improve the nutritional value of brown rice. This method is the result of research conducted for the United Nations International Year of Rice.

Rice is boiled or steamed to cook it, and absorbs water when it is cooked. Absorption method allows rice to be cooked with an amount of water equal to the amount of dried rice plus evaporation loss. [12] In the rapid boil method, rice is cooked with a large amount of water, drained, and then cooked. For fortified rice, quick cooking is not desirable, as discarding water will result in the loss of many of the fortified additives. Popular electric rice cookers in Asia and Latin America make it easy to cook rice. Rice (or other grains) may be quickly fried in fats and oils before cooking (such as saffron rice or risotto). This reduces the stickiness of cooked rice and is commonly referred to as pilaf in Iran and Afghanistan and biryani in India and Pakistan

Dishes

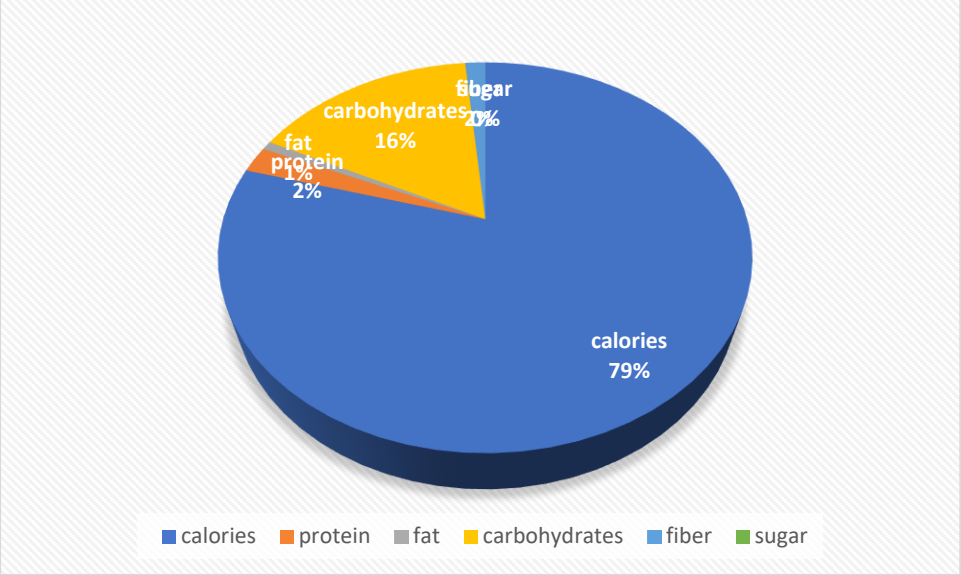
In Arabian cuisine, rice is a component of many soups and dishes with fish, chicken and other types of meat. It is used for stuffing vegetables and wrapping in grape leaves (dolma). Used to make desserts in combination with milk, sugar and honey. In some areas like Tabaristan, bread is made from rice flour. You can turn the rice into rice (also known as congee or congee) by adding more water than usual so that the cooked rice is saturated with water. Porridge is often eaten as breakfast food and is a traditional food for the sick.

Nutrition

Rice is the staple food of more than half of the world's population. It is the leading source of dietary energy in 17 countries in the Asia-Pacific region, 9 in the Americas and 8 in Africa. Rice supplies 20% of the world's food energy, wheat 19% and corn 5%. [13]

Cooked, unstrengthened long-grain white rice is 68% water, 28 carbohydrates, 3% protein, and very little fat (Table). A 100 gram (3 + 1⁄2 ounce) reference serving of this provides 540 kilojoules (130 kcal) of food energy, does not contain significant amounts of micronutrients, and has a total daily intake (DV). Less than 10% of (table). Cooked short-grain white rice provides the same nutritional energy and contains moderate amounts of B vitamins, iron and manganese (10-17% DV) per 100 grams of serving (Table)

Nutrients per rice



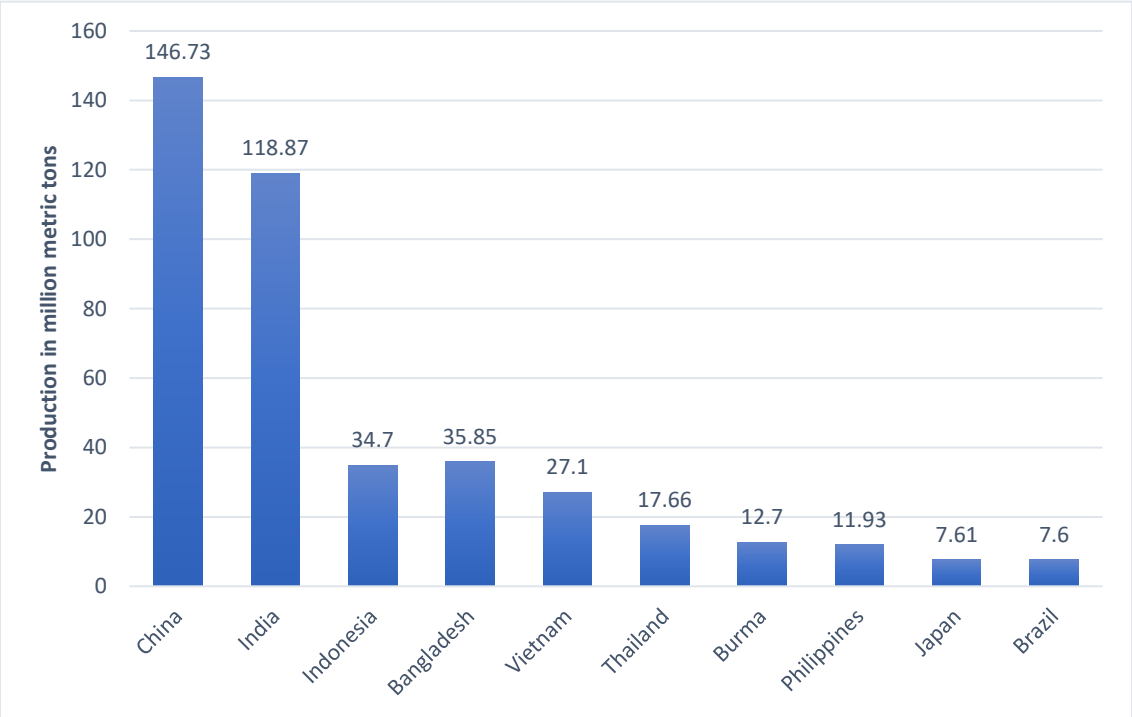
A detailed analysis of the nutritional content of rice suggests that the nutritional value of rice varies based on many factors. It depends on the rice varieties that are distributed differently

in the regions of the world, such as white, brown, red and black (or purple) varieties. [14] It is also the quality of the nutrients in the soil in which the rice grows, how the rice is polished, how it is processed, how it is fortified, and how it is prepared before consumption. It depends on the crab

According to the 2018 World Health Organization (WHO) guidelines, fortifying rice to reduce malnutrition can include iron only, iron containing zinc, vitamin A and folic acid, or other B vitamins such as thiamine and niacin. It has been shown that various micronutrient strategies including iron, including B vitamins, can be included with vitamin B6 and pantothenic acid. [14] A systematic review of clinical studies on the effectiveness of rice fortification has shown that this strategy has the main effect of reducing the risk of iron deficiency by 35% and increasing blood hemoglobin levels. rice field. The guidelines make important recommendations. "Rice fortification is recommended as a public health strategy to improve the iron status of the population in an environment where rice is the staple food." [14]

Rice experimentally cultivated under high levels of carbon dioxide, similar to what was predicted in 2100 by human activity, has low levels of iron, zinc and protein, thiamine, riboflavin, folic acid and pantothenic acid. Level was low. [16] The table below shows the nutrient content of rice and other major staple foods on a dry weight basis, taking into account the differences in water content. [1

Leading countries based on the production of milled rice in 2019/2020 (in million metric tons)



Global rice industry review

Production

During the last three decades of the twentieth century, rice output reached new highs. Between the 1940s and the late 1960s, the Green Revolution resulted in a rise in agricultural production in emerging countries, primarily due to the transfer of a number of research and technology efforts. Rice output growth in Asia climbed from 2.2 percent per year between 1950 and 1965 to 2.9 percent per year between 1965 and 1980, outpacing annual population growth of 2.23 percent. From 1980 to 1990, growth slowed to 2.6 percent, then to 1.8 percent from 1987 to 1997. Despite a predicted drop in per capita rice consumption, total rice demand is expected to rise by roughly 50% between 1990 and 2025. Per capita rice consumption is predicted to fall as income rises, as consumers replace rice with high-cost, high-quality foods that include more protein and vitamins, such as processed rice, vegetables, bread, fish, and meat. Japan and the Republic of Korea have already completed this shift, and the rest of Asia will follow suit in proportion to their economic development rates. However, population increase and additional wealth will offset these decreases, bringing the net demand for rice to nearly 700 million tonnes by 2025. It's alarming to see that the rice production growth rate of 3.2 percent in 1975-85 has dropped to 1.8 percent in 1987-97. As a result, most Asian countries would struggle to be self-sufficient in the next 10 to 20 years, and will likely become net rice importers, thanks to trade liberalization under the General Agreement on Tariff and Trade (GATT). Several countries that are now rice self-sufficient may find that importing rice is more advantageous in exchange for redirecting production resources to more lucrative pursuits. But who will produce this rice is yet another question that must be resolved.

The Demand Response to Incomes and Prices for Rice (Estimates for Selected Asian Countries)

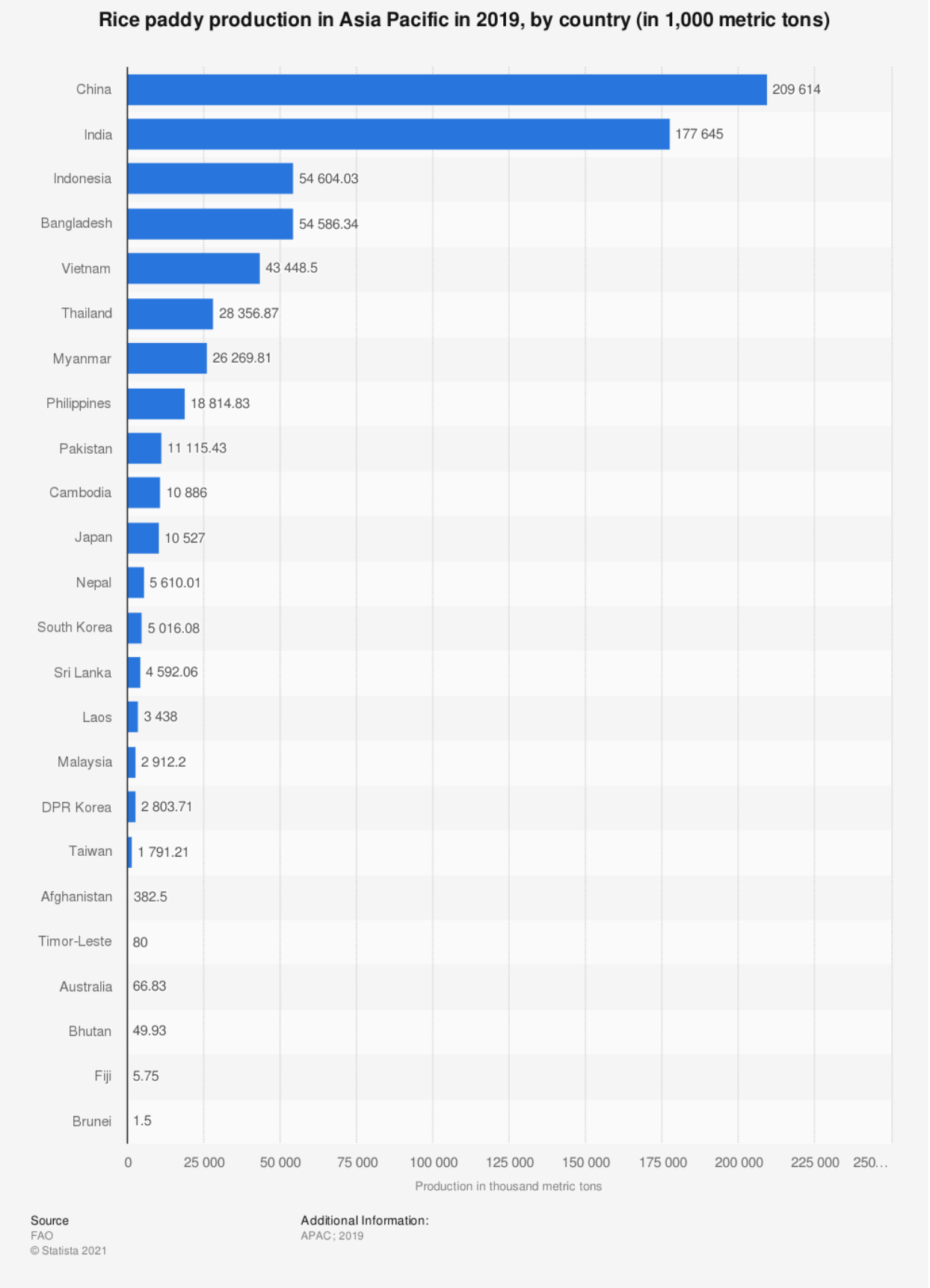
Country	Percent Increase in Demand from 1% Increase in Income	Percent Increase in Demand from 1% Increase in Prices
China	0.09	-0.26
India	0.06	10.23
Indonesia	0.11	N/A.
Bangladesh	0.41	-0.2
Thailand	0.08	-0.93
Philippines	0.08	-0.93
Japan	-0.25	-0.17

Rep. of Korea	-0.11	N/A

Rice Production, Yield, Area and Growth Rates in Production (P), Yield (Y) and Area (A) in the Asia-Pacific Region (1987-1997)

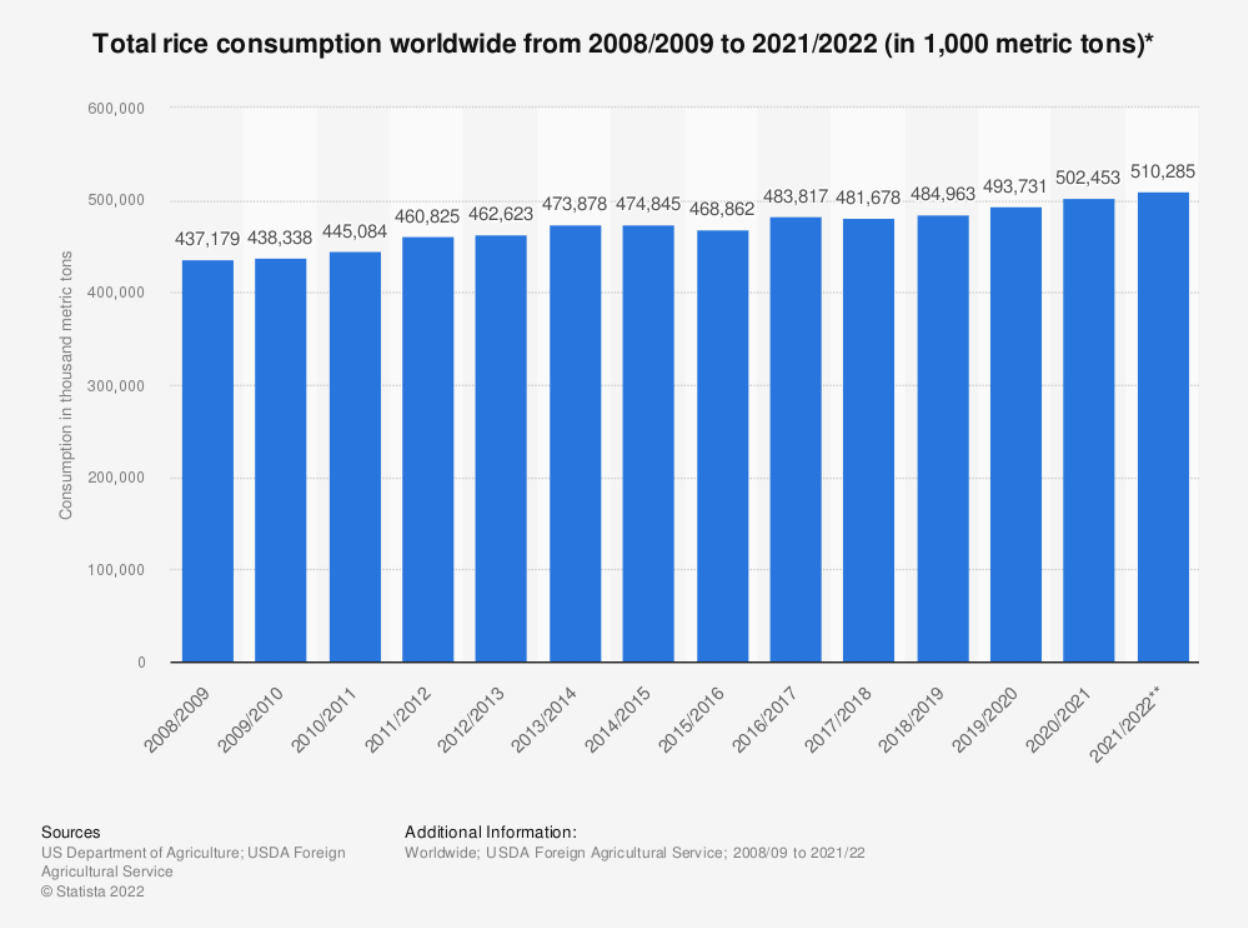
Country	Production (P) (000 tonnes) in 1997	Area (A) (000 ha) in 1997	Yield (Y) (kg/ha) in 1997	Growth Rate (%) (1987-1997)		
				P	A	Y
Australia	1,352	164	8,244	6.2	4.5	1.6
Bangladesh	28,183	10,177	2,769	1.1	-0.4	0.7
Bhutan	50	30	1,667	-0.2	0.1	-0.2
Cambodia	3,390	1,950	1,771	4.4	2.4	2.2
China	198,471	31,348	6,331	1	-0.7	1.6
DPR Korea	2,347	611	3,841	-5.1	-1.7	-3.3
Fiji	18	7	2,246	-5.5	-7.1	0.8
India	123,012	42,200	2,915	2.6	0.5	2.1
Indonesia	50,632	11,100	4,449	2.2	1.2	0.8
Iran	2,600	550	4,240	4.9	1.5	2.8
Japan	12,531	1,953	6,416	-	-0.5	0.5
Laos	1,414	554	2,902	2.1	-	2.8
Malaysia	1,970	655	3,008	1.6	0.1	1.5
Myanmar	18,900	6,070	3,064	4	3.3	0.6
Nepal	3,711	1,511	2,455	1.3	0.5	0.9
Pakistan	6,546	2,316	2,827	3.3	1.2	2.1
Philippines	11,269	3,842	2,933	2.7	1.8	1
Rep. of Korea	7,100	1,045	6,794	-1.8	-2.3	0.5
Sri Lanka	2,610	660	3,954	1.3	-	1.3
Thailand	21,280	9,932	2,143	1.3	0.2	1.1
Vietnam	26,397	7,021	3,760	5.5	2.4	3.1
Total	523,784	133,696	3,918	1.8	0.4	1.4
Rest of World	49,479	16,115	3,070	2	0.3	1.7

World	573,263	149,811	3,827	1.8	0.4	1.4



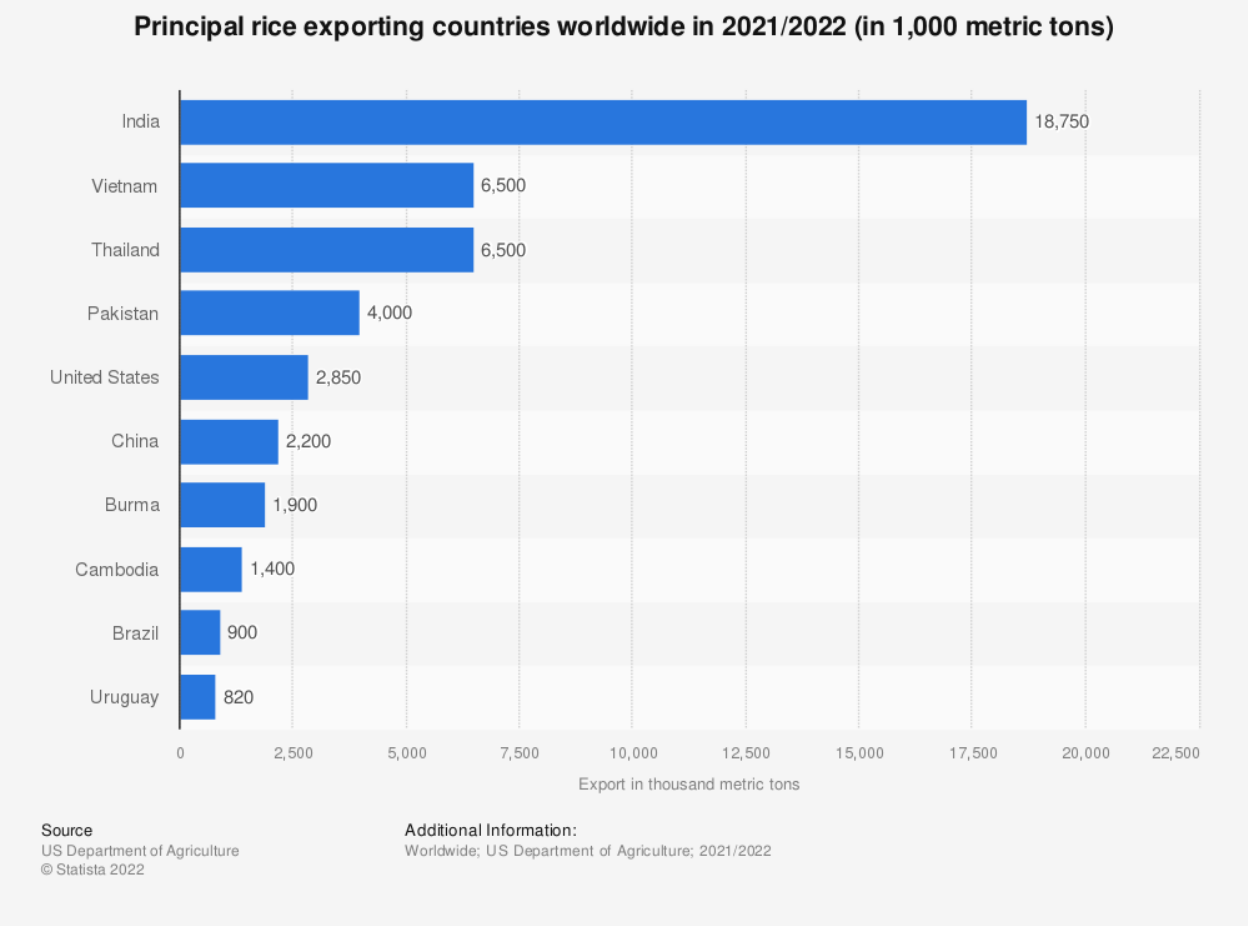
Total global rice consumption

Over the last few years, global rice consumption has increased little. Rice consumption increased to 509.87 million metric tons in the 2021/2022 crop year, up from 437.18 million metric tons in the 2008/2009 crop year.



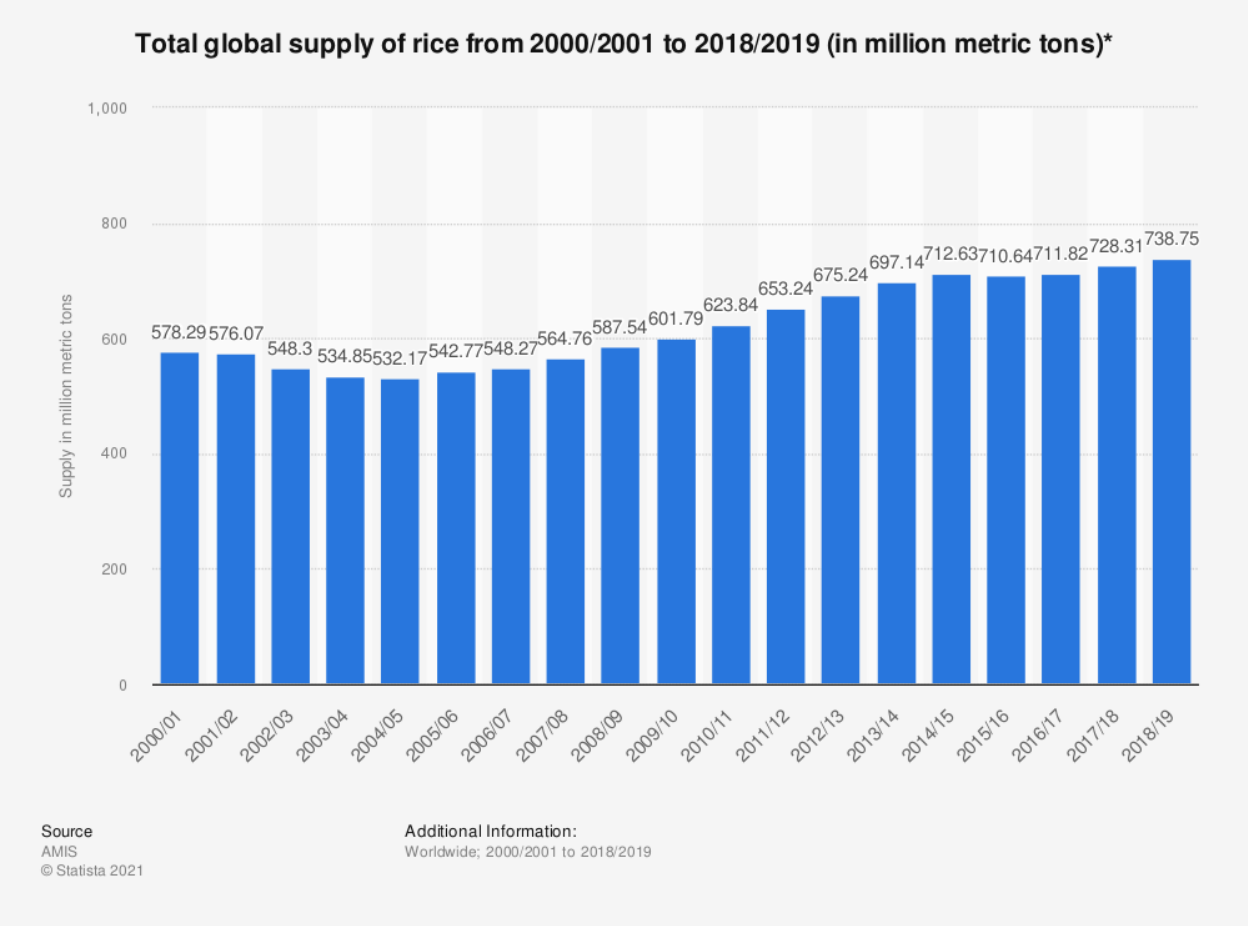
Principal rice exporting countries worldwide

As of 2021/2022, India has the greatest rice export volume in the world, with 18.75 million metric tons. With around 6.5 million metric tons of rice exported worldwide in that year, Vietnam was the second largest rice exporter.



Total global supply of rice

From 2000/2001 to 2018/2019, this statistic depicts the total supply of rice around the world, measured in million metric tons of milled equivalent. The entire global supply of rice in 2018/2019 was around 738.75 million metric tons.



Export prices of rice worldwide

This graph depicts rice export prices worldwide from 2011 to 2019, broken down by variety. In 2019, the average export price of one metric ton of California Medium Grain rice in the United States was 850 dollars.

Characteristic	U.S. Long Grain 2.4%	U.S. California Medium Grain 1.4%	Thai Parboiled 100%	India 25%	Pak Basmati*
2011	577	821	563	409	1,060
2012	567	718	594	391	1,137
2013	628	692	530	402	1,372
2014	571	1,007	435	377	1,324
2015	490	857	392	337	849
2016	438	651	410	333	795
2017	456	673	421	361	1,131
2018	531	888	431	374	1,023
2019	500	850	428	361	982

Issues and priority for the agriculture in Sri Lanka - Barrier and solution

The rural and estate sectors are home to 92% of the poor in the country .Agriculture's share in Sri Lanka's economy has progressively become less than 7.3% Nearly three-quarters of Sri Lankan families depend on rural incomes. The majority of Sri Lankan poor (about 77.4%) are found in rural areas. Sri Lanka's food security depends on producing paddy, as well as increasing its production of fruits, vegetables and milk to meet the demands of a growing population with rising incomes

The COVID-19 pandemic has brought unprecedented disruption to our agriculture and food systems, increasing pressure on farmers and agribusinesses in our country and around the world. Historically, agriculture has been the most important sector of the Sri Lankan economy. Even though its contribution to the gross domestic product declined substantially during the past three decades (from 30% in 1970 to 7.3% in 2020), it is the most important source of employment.

Nationally, approximately 2,140,000 persons or 25.5% of the total employed population are engaged in agriculture, inclusive of forestry and fishery. However, in the rural areas, agriculture is of even greater importance as over half of the workforce in rural areas is employed in agriculture. Nationally, of those employed in agriculture, about 1.3 million (65%) are also engaged in activities other than crop production. However, the sector has been undergoing many changes over the decades. Climate change, new policy changes, globalization, technological change, competitiveness and many other daily changes are causing many challenges and developments. Beyond that, many measures are being taken by the Government from time to time.

The rural and estate sectors are home to 92% of the poor in the country. However, despite the dominance of agriculture-based livelihoods, the non-agricultural sector is the main source of employment in rural areas. Although Sri Lanka is a fertile tropical land with the potential for cultivation and processing of a variety of crops, issues such as productivity and profitability hamper the growth of the agricultural sector. There has been low adoption of mechanization in farming. The lack of private investment in agriculture due to uncertain policies limits the expansion of the sector. While agriculture's share in Sri Lanka's economy has progressively declined to less than 7.3% due to the high growth rates of the industrial and services sectors, the sector's importance in Sri Lanka's economic and the apparel and textile industry contributes 6% to Sri Lanka's GDP while accounting for 40% of the country's total exports.

In the subsistence sector, rice is the main crop and farming rice is the most important economic activity for the majority of the people living in rural areas. During the last five decades the rice sector grew rapidly. To guarantee a productive, competitive, diversified and sustainable agricultural sector will need to emerge at an accelerated Sri Lanka's agriculture sector has also so far been affected by the COVID-19 outbreak, just like all other economic sectors. Even though the sector is only loosely integrated with global supply chains. From the outset of the COVID-19 pandemic, the Government adopted timely measures to minimize the impact on agriculture.

Challenges (barriers)

This pandemic is unprecedented, causing tremendous uncertainty and hardship across the country — not only on the public health front but also in terms of people's social and economic wellbeing, their access to food and nutrition. What makes this situation so challenging is the enigma of how unpredictable it is. While the crisis is slowing down in some countries, it is resurging or continuing in others. Restrictions on movement, quarantines, trade barriers and shipping delays have disrupted food supply chains, trade and logistics, with food supply chains in developing countries disproportionately affected. The agricultural barrier, which once contributed to more than half of Sri Lanka's GDP, is now facing a number of challenges. Due to this pandemic and other various problems, the estimated 2.1 million agricultural households are at a risk of losing their livelihoods despite various measures taken by the Government to safeguard agricultural supply chains.

Ineffective labor force

Around 25.5% of the population in Sri Lanka engage in agriculture, though the sector's contribution to GDP is as low as 7.3% (2020 data). Industrial work contributes 27% to GDP; in effect, an industrial worker is four times as productive as someone working in agriculture. Services sector workers are also around four times more productive.

Rice is the main food crop with (40%) grown in Sri Lanka followed by the plantation crop sector (38%), comprised mainly of tea, rubber and coconut. The sector has been affected by low productivity, water and land use inefficiency and high post-harvest losses for a long time. The picture below clearly shows the continuing decline in the contribution of labor force of this sector.

Dependence on traditional agriculture

There is not much modern agriculture practiced in our region. Most of them basically have traditional experiences and skills on agriculture, even though they are very poor in producing goods and services using traditional practices in this business. Modern agriculture is being shaped by many of the same technologies transforming other industries. This is most apparent at either end of the agribusiness supply chain; seed producers and supermarkets where technology has made a huge difference.

Climate change

The Sri Lankan agricultural sector has also been experiencing the effects of changing climate and natural disasters and being the 2nd in the Global Climate Risk Index. This has, however, given an incentive for the farmers to shift towards climate smart agriculture. In line with this emerging trend, Government adopted many measures to modernize the agricultural sector with support from donor agencies.

Climate variation is one of the major impacting issues for paddy cultivation. It also highly impacts the harvest. Therefore, many researchers try to understand the relationships between climatic factors and harvest using numerous methods. Sri Lanka is still titled as a country with an agricultural-based economy and thus identifying the impact of climate variability on agriculture is very important. However, previous studies reveal a little information in the context of Sri Lanka on the impact of climate variabilities on agriculture. Therefore, this study showcases an artificial neural network (ANN) framework; that is an ordinary machine learning algorithm based on the model of the human neuron system, to evaluate the relationships among the climatic components and the paddy harvest in the North-Western province of Sri Lanka. This on-going study helps to analyze the relationships between the paddy harvest of the North-Western province and climate, including rainfall minimum atmospheric temperature and maximum atmospheric temperature. Correlation coefficient (R) and mean squared error (MSE) are used to test the performance of the ANN model. The results obtained from the analysis revealed that the predicted and real paddy yields have a significant correlation with rainfall, maximum temperature and minimum temperature.

Lack of market information

During the last 50 years, agriculture has become large scale, intensive and specialized, in the rich world. Argentina, Brazil and China have led developing countries in creating globally competitive agriculture. However, countries like Sri Lanka can't match Brazil or China's gains as it lacks an obvious resource, land. Most of Sri Lanka's farms are smallholder controlled and less than two hectares (4.9 acres). Lack of market information and logistical difficulties prevent smallholders from accessing markets efficiently. If the product is to be exported, the logistics and financing requirements are beyond their capability.

Will increasing yields by half of Sri Lanka's highland tea gardens and rice paddies require a doubling of inputs? Not really. It will undoubtedly require more capital and labor. However, the land, one of the most significant inputs, will not change.

Policy level challenge

The biggest impediment to agricultural development is not at policy level; the Government often comes up with good policies, the flaw is at implementation level. Another impediment faced by the agricultural sector is the weak functioning of our agricultural research and development programs. It appears, that many research programs are confined to laboratories and do not adequately reach the farm lands.

The way forward

Sri Lanka needs industrial structural transformation that all countries experience as they develop and shift towards manufacturing and services. The solution for Sri Lanka, as for all other countries, is to make the needed investments so that agricultural production, foreign exchange earnings and farm incomes do not collapse as a consequence of the loss of labor in the process of economic structural transformation. Meeting the challenges will mean adopting technology to increase labor productivity, improving farm-market linkages, investing in value chains and also generating off-farm employment to absorb excess labor in the rural areas.

In order to meet the climatic challenges new irrigation systems, pest control, maintenance as well as harvesting could be digitalized. Furthermore, post harvesting must be a serious concern for value addition even with obtained agricultural wastes.

The new technologies can be introduced to agriculture to enhance productivity, efficient land use and reduce post harvesting losses. In addition, bridging the information gap and improving the efficiency of risk management tools and procedures using ICTs to reduce the individual risks of agriculture sector stakeholders will be added value for their entire products.

We must encourage universities and academia to strengthen research and capability to develop applications and services. So, the relevant agencies must facilitate availability of timely data and platforms for development and delivery of these services.

Generally, the solution lies in the restructuring of the entire agricultural system, including education, it is time the Government seriously considered that its agriculture policies should change from farming-centric to farmer-centric. It makes a big difference to farmers. Being relevant, we must improve the awareness, education and skills of farmers, extension workers, livestock herders and other sector end-users by creating and disseminating credible agricultural knowledge remotely.

We must reduce the demand-supply gap, and enhance outreach and profitability of Sri Lankan products and services through vibrant e-agriculture market places and efficient logistics. To reach the outcome of this sector is to create tools for analyzing and linking nationwide demand and supply of agricultural produce. Unfortunately, with the current situation, achieving the Sustainable Development Goals (SDGs) by 2030, especially zero hunger and poverty, will be even harder now. We need to redouble our efforts to build sustainable agriculture food systems that are better able to withstand crises and shocks.

Some problems and solutions under precentages

Problems	% farmers	Solution(s)
Lack of knowledge about new crop variety/technology	85	Demonstration, Training, Field day
Lack of quality seeds / fingerlings / duck links	75	Education, Information/ Training
Lack of cash money for buying inputs	62	Easy credit system
Lack of knowledge about fish feed and pond management	82	Demonstration, Training, Field day
Lack of knowledge about vaccination, de worming, feed of livestock and poultry	65	Demonstration, Training
Lack of credit facility	75	Easy credit system
Lack of knowledge about homestead vegetables production	70	Demonstration, Training, Field day
High price of inputs	80	Increase subsidy in agricultural inputs
Infestation of insect/pests/weeds	65	Increase knowledge by training

Modern agriculture has many complex challenges

What kind of problems do farmers face in agriculture ?

- Farmers need to deal with many problems, including how to:
- Cope with climate change, soil erosion and biodiversity loss
- Satisfy consumers' changing tastes and expectations
- Meet rising demand for more food of higher quality
- Invest in farm productivity
- Adopt and learn new technologies
- Stay resilient against global economic factors
- Inspire young people to stay in rural areas and become future farmers

Farmers must adapt to climate change

The effects of climate change affect farmers' ability to grow the food we all need. Increasingly volatile weather and more extreme events – like floods and droughts – change growing seasons, limit the availability of water, allow weeds, pests and fungi to thrive, and can reduce crop productivity.

Soil erosion is reducing the amount of land available for agriculture, and declining biodiversity affects the pollination of crops. At the same time, farmers are under pressure to conserve water and use fewer agricultural inputs.

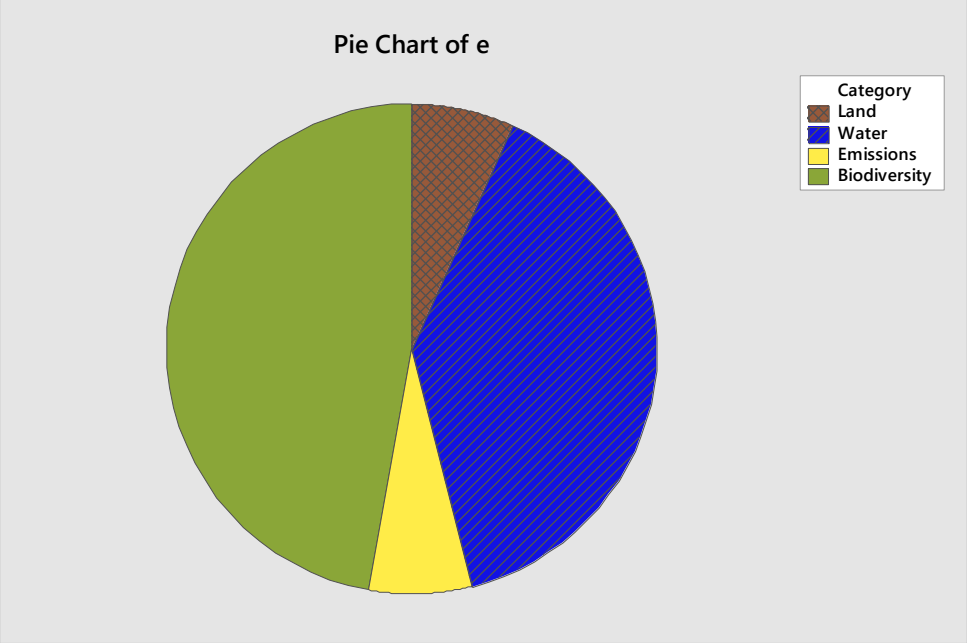
As they adapt to these changes, farmers also need to mitigate the greenhouse gas emissions contributed by agriculture through adopting climate-smart practices – a new learning journey for many.

Land - Only 12% of the world's land can be used for farming

Water - Farming uses 70% of the world's fresh water

Emissions - Farming generates 12% of greenhouse gas emissions every year

Biodiversity - 84% of crop species in the European Union depend at least partly on pollination by wildlife



Upcoming Problems in future

70% MORE FOOD WILL BE NEEDED BY 2050 TO FEED A GROWING POPULATION

Because 180,000 PEOPLE LEAVE RURAL COMMUNITIES EVERY DAY TO LIVE IN CITIES

80% OF FOOD FOR THE DEVELOPING WORLD IS PRODUCED BY SMALLHOLDERS

Problems in Agriculture and solutions

Think about how much food you eat each day. Now, think about how big the human population is and how much food is needed to feed all of those people. Since the development of agriculture, most of the food needed to feed the population has been produced through industrialized agriculture. Since the 1960s, the amount of food produced through this type of agriculture has increased drastically, and currently there is enough food produced to feed every human on Earth.

Although industrialized agriculture has been successful in producing large quantities of food, the future of food production is in jeopardy due to problems in agriculture. Two of the most major problems in agriculture are the loss of agricultural land and the decrease in the varieties of crops and livestock produced.

Loss of Agricultural Land

One of the major problems facing agriculture is the loss of agricultural land, because as more land is lost, it will become more difficult to produce the amount of food needed to feed the growing human population. When discussing the area of land, the term hectare is often used, and this term is a unit of area that is equivalent to 10,000 square meters, or around 2.5 acres.

Worldwide, around three million hectares of agricultural land are lost each year because the soil degrades and becomes unusable due to erosion, which is when soil components move from one location to another by wind or water. An additional four million hectares are lost each year when agricultural land is converted and used for highways, housing, factories, and other urban needs. In the United States, around 140 million hectares of agricultural land has been lost in the last 30 years as a result of soil degradation and conversion for urban use.

The trends in the loss of agricultural lands do not look promising for the future of agriculture in the United States. It is estimated that over 40 million hectares of agricultural land in the United States is in danger of being lost due to exposure to erosion by wind or water. If this land is lost, people may find it more difficult to find produce, and prices may also rise.

Decreased Varieties

Another major problem in agriculture is the overall decrease in the varieties of crops and livestock produced. In the early years of agriculture, farmers grew a wide variety of crops and raised many different types of livestock. Since the development of industrialized agriculture, the number of different types of crops and livestock has decreased. This decline in variety is due to the fact that it is cheaper to produce large quantities of the same type of crop or livestock than to produce smaller batches of multiple types. For livestock production, it is cheaper and easier to buy or produce only one type of feed for animals and invest in only one type of slaughter and processing. For crops, if farmers plant monocultures, which are when a single crop is planted on a large scale, the production is cheaper because the entire process of planting, growing, and harvesting is more streamlined.

It is estimated that there are over 50,000 plant species that can be safely consumed by humans. Interestingly, around 90% of the average human diet is comprised of only 15 different plant species. In the United States and worldwide, the three most produced crops are corn, soy, and wheat. Although you may not eat these crops directly, they are used in the production of other foods and used to feed livestock, so you are consuming many of these crops without even realizing it.

Study the Status of the Rice Industry in Sri Lanka

Introduction

Rice is the world's most important staple food and will continue to be so in the coming decades, be it in terms of food security, poverty alleviation, youth employment, use of scarce resources, or impact on the climate (IRRI, 2016). Rice is the basic grain consumed as a staple food in Sri Lanka which is found in every Sri Lankan kitchen and is the only staple food grain, providing a reasonable amount of food nutrients and nearly half of the calories in the Sri Lankans diet. Rice is the most important crop in Sri Lanka and this sector received utmost attention from governments since it involves the majority of farmers on one hand and all citizens are rice consumers on the other hand.

The paddy/rice industry includes which is nearly 3.6 million farmers and their families, thousands of input and service providers, millers, retailers, and individuals employed in the production, processing, and marketing of its related products. Owing to its significant contribution to the country's economic development, the government has initiated programmed to increase productivity and improve the competitiveness of the rice sector. The rice industry is vital for food security and the economic development of Sri Lanka as its economy relies on the agricultural sector. Promoting the marketing capability of farmers especially the smallholders is the key challenge of increasing farm investment. According to the importance of the rice sector, fluctuations in rice prices are considered a threat to political stability, and this may be one reason why governments tend to intervene in their country's rice market. Like most Asian governments, Sri Lanka still views rice as a strategic commodity because of its importance in the diet of the poor and as an occupation and a source of income generation of farmers.

A study in Ghana shows that multi-crops are more efficient than single crops in coco farming (Ofori-Bah and Asafu-Adjaye, 2011). Other studies show that crop diversification improves efficiency and minimizes the impacts of climate change (Hossain et al., 2019; Khanal et al., 2018). Given the above background, this study aims to examine smallholder farmers' technical efficiency in rice production in Sri Lanka. More than 25% (1.8 million) of the total labor force is engaged in agricultural activities in Sri Lanka (CBSL, 2020),Rice is generally produced in two cropping seasons, the 'Yala' and the 'Maha' which are related to the dry and wet seasons. The majority of the cultivation is based on irrigated agriculture. Approximately 45% of this cultivated area is fed by major irrigation schemes, 25% by minor irrigation schemes and 30% is rain-fed. The total production of rice was 4.1 million metric tons in 2019/2020 (Ayoda and Mark, 2020). It is important to note that cultivation of rice is not just an economic activity but a way of life that has shaped Sri Lankan society and culture for centuries (see, Figure 1). The per capita consumption of rice is 107kg per person per annum, and this provides 45% of the total calories and 40% of the total protein requirements for Sri Lanka's population (Liu et al., 2020; Senanayake and Premaratne, 2016). Given the increasing demand for rice in the country, increased rice productivity can, potentially, improve Sri Lanka's food security situation and the standard of livelihoods of a large percentage of the country's population. At present, Sri Lanka imports 0.7 million metric tons of rice (US$400 million) annually due to the growing demand for rice (Rathnayake et al., 2020)

Rice plantation

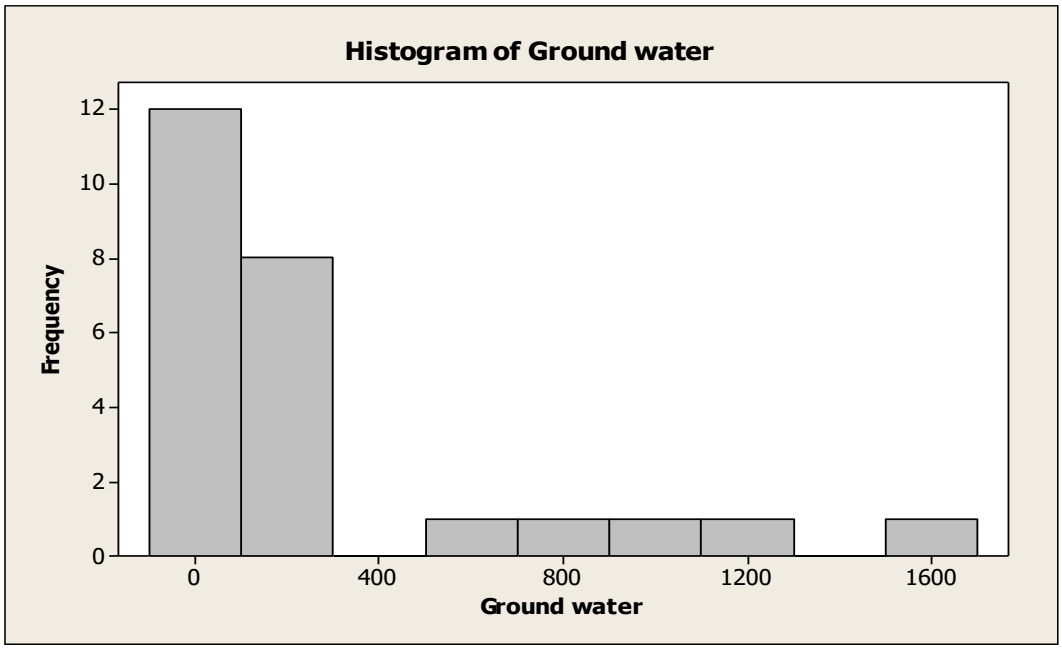
The total land devoted for paddy is estimated to be about 708,000 Hectares at present. Paddy extent namely, Asweddumized (land prepared for cultivation), sown, and harvested on a complete enumeration basis was commenced in 1951. This method of data collection has since being continued each season with the active cooperation of the Agricultural Research and Production Assistants A.R.P.O)/Grama Niladari (GNN) who are acting as primary reporters. where rice is one of the most important cereal crops accounting for about 16% of the total land area and contributing 7% to agricultural GDP (CBSL, 2020).The 2020 Yala minor season output was estimated at 1.83 million metric tonnes.

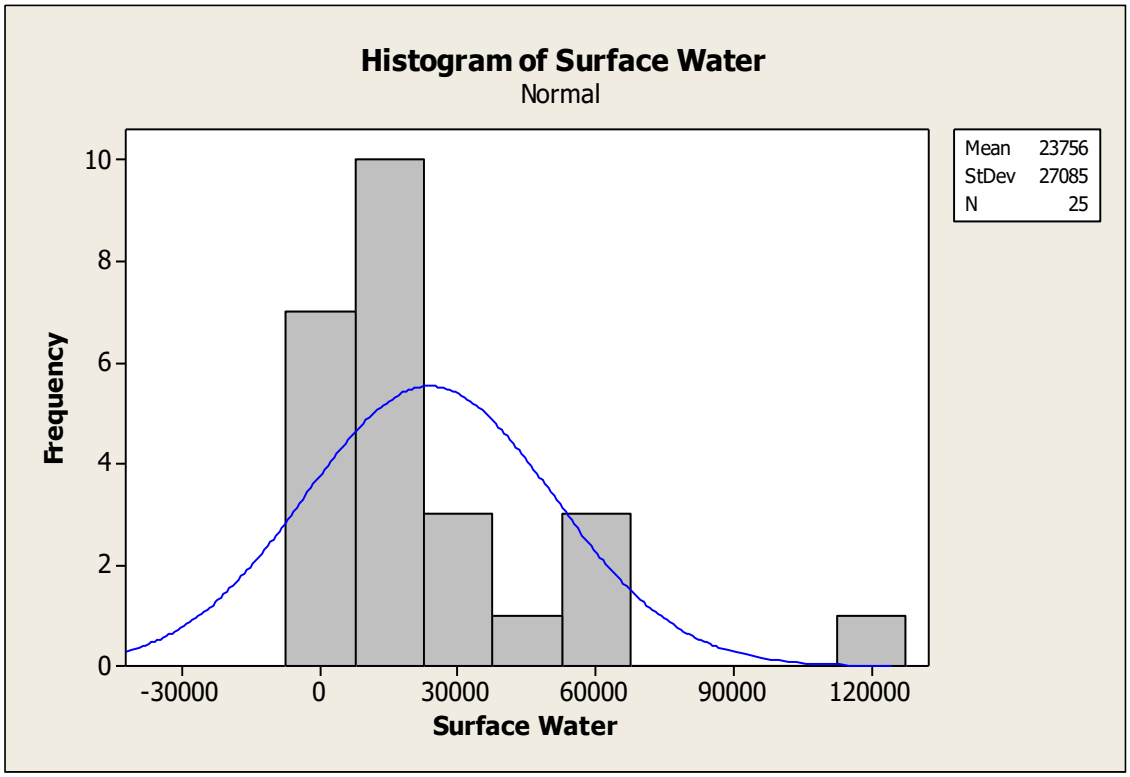
Sri Lanka has a target paddy cultivation of 841,000 hectares for Maha 2021 of which 583,704 hectares had been cultivated up to the end of November.

Water

Area equipped for irrigation increased from 457 200 ha in year 1980 to 570 000 ha in year 1995 and was assumed to be constant at this level until year 2011 [LK01]. Subnational information on total area equipped for irrigation was not available. Area equipped for irrigation was estimated therefore at the division level based on the irrigated paddy land extracted from an inventory related to year 2010 [LK02] and an inventory of irrigated land for crops different from paddy rice for each district related to season 1990-1991 [LK03]. Total irrigated paddy rice area was 556 630 ha while the area of other irrigated field crops was 60 916 ha in season 1990-1991 and then scaled to the area of 44 100 ha reported for year 2006. Total area equipped for irrigation estimated this way was 600 730 ha.

District	Area equipped for irrigation (ha)		
	total	with groundwater	with surface water
Ampara	66 831	44	66 787
Anuradhapura	119 130	1 536	117 594
Badulla	24 810	152	24 658
Batticaloa	27 648	33	27 615
Colombo	1 392	12	1 380
Galle	157	2	155
Gampaha	6 039	50	5 989
Hambantota	40 438	169	40 269
Jaffna	3 203	122	3 081
Kalutara	2 883	15	2 868
Kandy	11 111	20	11 091
Kegalle	2 982	10	2 972
Kilinochchi	12 040	245	11 795
Kurunegala	58 928	1 206	57 722
Mannar	13 288	52	13 236
Matale	17 919	507	17 412
Matara	7 744	3	7 741
Moneragala	19 030	200	18 830
Mullaitivu	13 987	270	13 717
Nuwara Eliya	6 559	30	6 529
Polonnaruwa	63 640	180	63 460
Puttalam	20 935	785	20 150
Ratnapura	14 138	60	14 078
Trincomalee	25 628	223	25 405
Vavuniya	20 271	903	19 368
Sri Lanka total	**600 730**	**6 829**	**593 901**

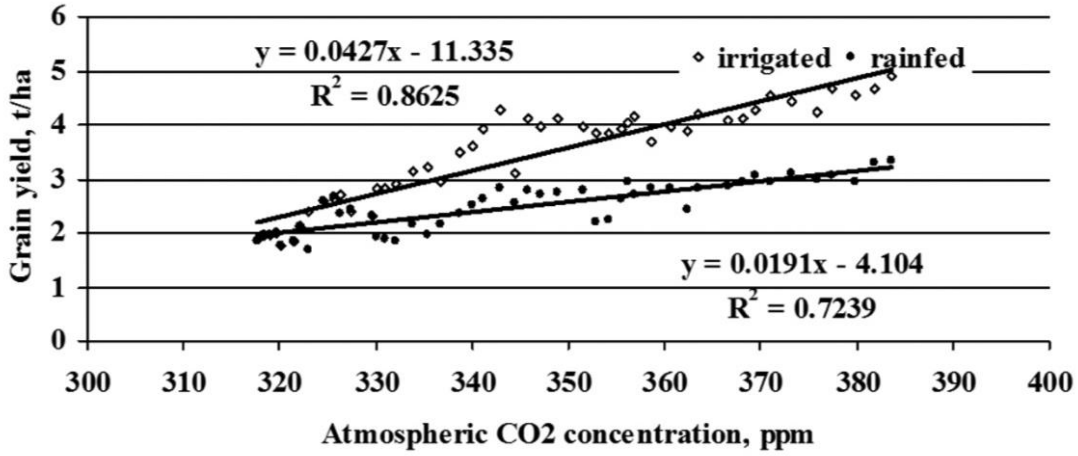

Histogram of Ground water
Frequency
12
10
8
6
4
2
0
0
400
800
1200
1600
Ground water


Histogram of Surface Water
Normal
Mean 23756
StDev 27085
N 25
Frequency
10
8
6
4
2
0
-30000
0
30000
60000
90000
120000
Surface Water

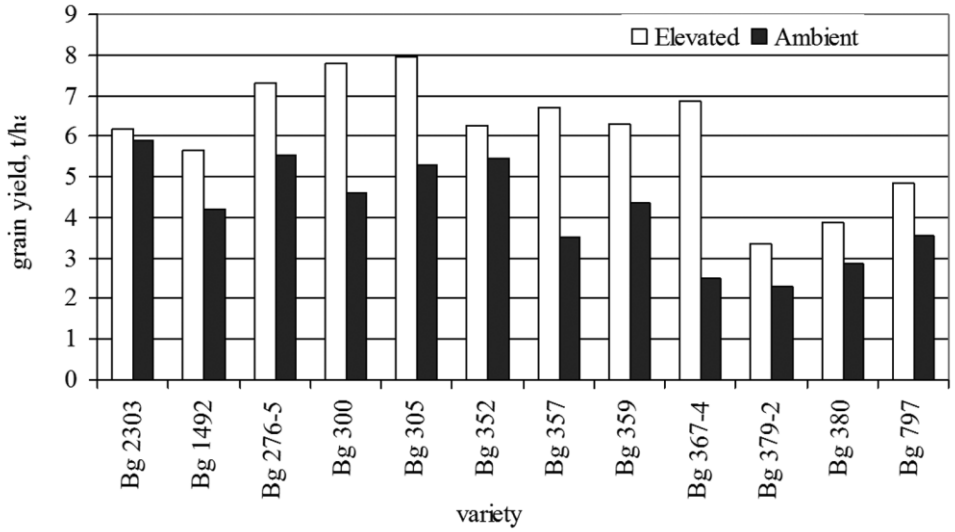
Relationship of CO_2 for paddy cultivation

We investigated the benefit gained by cultivated rice varieties in terms of productivity with the increase in atmospheric [CO_2] from 1960 to 2007. The change in atmospheric [CO_2] since 1960 was obtained from the records of the Maunaolao observatory. In the irrigated system, the increase in grain yield per unit increase in atmospheric [CO_2] over the years was 0.042 t/µmol of CO_2 while in the rainfed system it was 0.019 t/µmol of CO_2 (Fig. 6). This suggests that varieties and technologies developed in Sri Lanka since 1960 were able to effectively capture the beneficial effect of increased atmospheric [CO_2] in the irrigated rice ecosystem effectively.

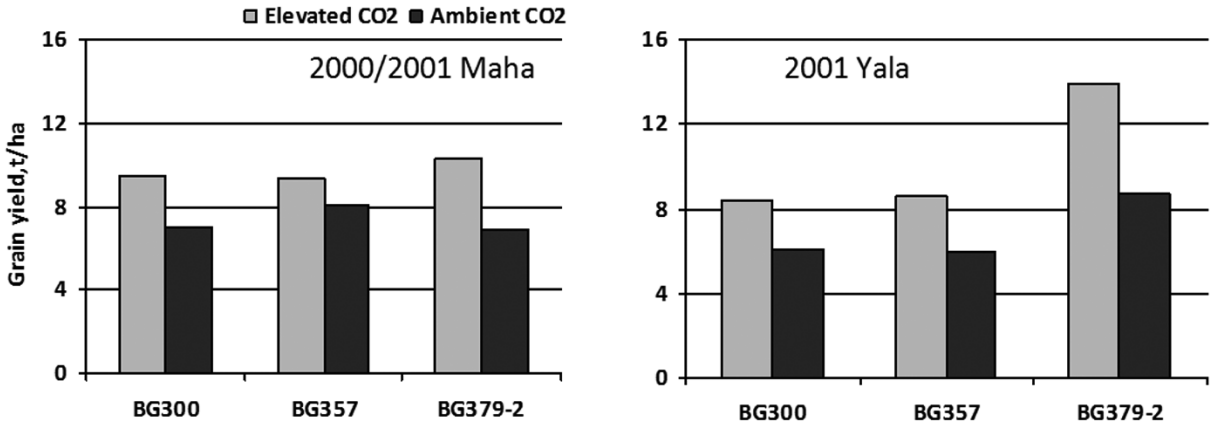
However, the beneficial effect of increased atmospheric [CO_2] was not effectively utilized in increasing grain yield of rice in the rainfed ecosystem. This could be mainly because of the high heterogeneity in the abiotic factors in the rainfed ecosystem and the rice varieties developed so far were mainly targeted for the non-stressed environments. However, the rainfed system will be more vulnerable to climate change, thus the future productivity from these rice lands could be severely affected. Therefore, there is an urgent need to pay equal or more attention to develop varieties and technologies for rainfed ecosystems in order to maximize the potential yield gains with future increases in atmospheric [CO_2].



Change in grain yield of different rice lines with enhanced atmospheric [CO2].

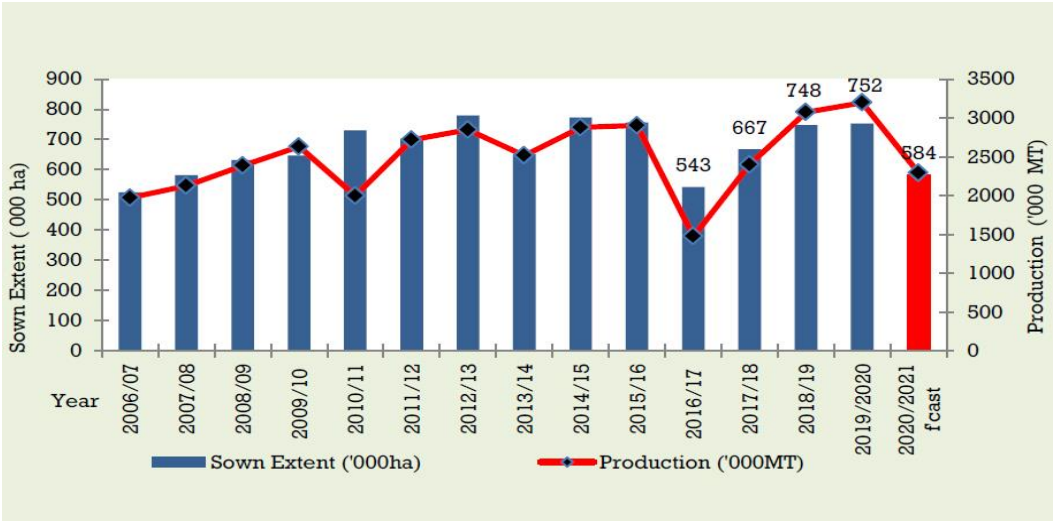


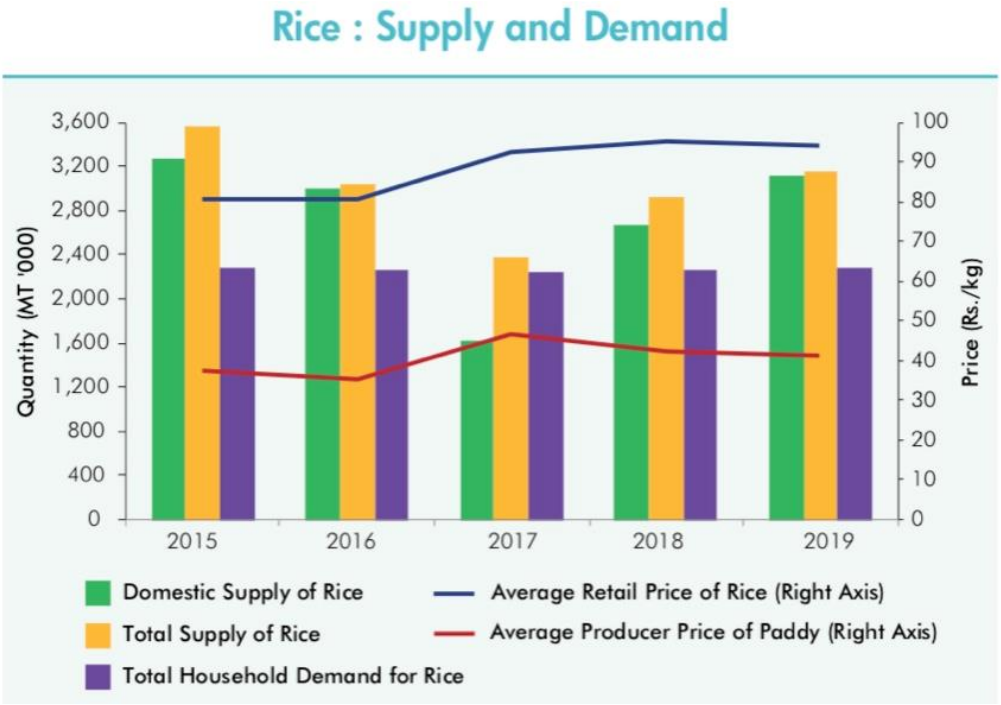
Moreover, longer duration varieties have a greater positive response to increased atmospheric [CO2]. Therefore, increasing atmospheric [CO2] will have a definite positive effect on rice production in Sri Lanka.



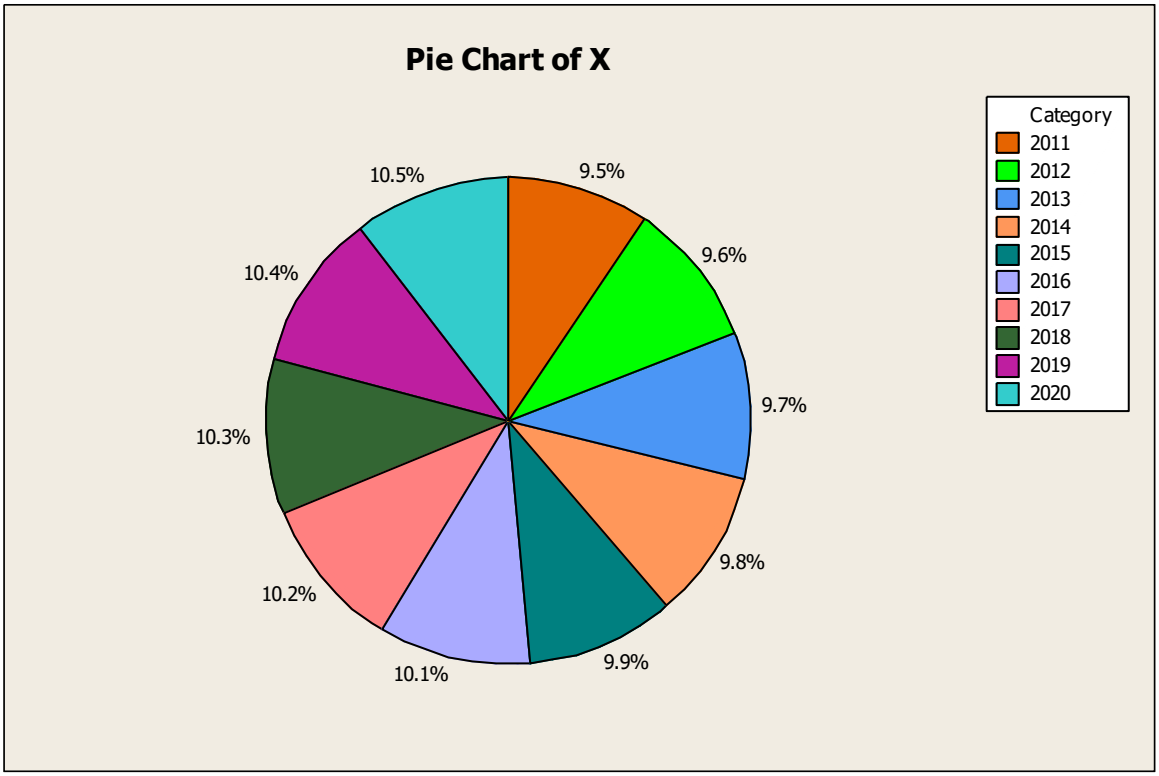
Average yield of paddy

Average yield of paddy in Sri Lanka at district level is estimated by means of a sample survey which is popularly known as the crop cutting survey initiated with the assistance of FAO in 1951. At present a sample of 3,000 villages for the main season (Maha) and 2,000 villages for the second season (Yala) are selected to carry out experiments. Estimate of paddy production is obtained for each season as a product of the average harvested and the average yield.


Sown Extent (000 ha)
Production ('000 MT)
Year
543
667
748
752
584
2006/07
2007/08
2008/09
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
2019/2020
2020/2021 fcast
Sown Extent ('000ha)
Production ('000MT)


Rice : Supply and Demand
Quantity (MT '000)
Price (Rs./kg)
2015
2016
2017
2018
2019
Domestic Supply of Rice
Total Supply of Rice
Total Household Demand for Rice
Average Retail Price of Rice (Right Axis)
Average Producer Price of Paddy (Right Axis)

Year (X)	Estimated Annual paddy Production in ‘000 M Ts (Y)
2011	3283.67
2012	3322.36
2013	3361.06
2014	3399.76
2015	3438.46
2016	3477.15
2017	3515.85
2018	3554.55
2019	3593.24
2020	3631.94



Status of the Rice industry in Sri Lanka

Yala is the minor season where planting is done from April to May while harvesting is done from August to September annually. This season's harvest usually fills 30% of the total annual paddy harvest. It depends on the southwest monsoon rainfall. The major season that cultivates paddy in Sri Lanka is the Maha season. Its cultivation process starts from October to November and the harvesting happens from February through March. It fills 70% of the annual total paddy harvest of the country. Further, the Maha season depends on the northeast monsoon rainfall.

Among the districts that cultivate paddy in Sri Lanka, Ambara, Polonnaruwa, and Kurunegala districts provide the first, second, and third highest amount of paddy harvest respectively. In addition to these 3 districts, the following is the descending order of the list of districts with higher paddy harvest in the country. Hambantota, Anuradhapura, Batticaloa, Trincomalee, Monaragala, Puttalam, Badulla, Kilinochchi, Ratnapura, Matara, Matale, Kalutara, Gampaha, Kandy, Mulativu, Galle, Kegalle, Nuwara Eliya, Colombo, Mannar, Vavuniya.

The Rice industry has played a significant role in the Sri Lankan economy as a key sector. Regardless of the COVID-19 outbreak, the Department of Census and Statistics along with the Department of Agriculture of Sri Lanka declared that the highest paddy production of Sri Lanka was recorded in the last year (2020). The total rice production for the year 2020 is 5,037 million metric tons. Accordingly, 3,197 million metric tons of the harvest are from the Maha season and 1,840 million metric tons are from the Yala season.

During the literature review, Market share of Sri Lanka's rice is steadily declined during past year (2010 - 2015). However, The rice production in Sri Lanka in the year 2020 has been increased by 9.7% when compared to the rice production in 2019. Similarly, there is an increase of 28.2% in rice production in 2020 in relation to rice production in 2018. Surprisingly, the rice production in Sri Lanka has doubled in 2020 compared to that in 2017. So, all these facts, again and again, prove that the paddy cultivation in Sri Lanka is at a good status even at present.

In 2020, rice, paddy production for Sri Lanka was 5.12 million Tonnes. Though Sri Lanka rice, paddy production fluctuated substantially in recent years, it tended to increase through 1971 - 2020 period ending at 5.12 million Tonnes in 2020.

Sri Lanka used to provide about 2000 indigenous varieties of rice to the world. However, in the 1980s, the introduction of semi-dwarf seeds happened in parallel to the introduction of chemical fertilizer. Therefore, at present 95% of rice production in Sri Lanka contains hybrid rice varieties. Farmers produce these with the use of chemical fertilizers and pesticides to increase the harvest. At present, there are several types of traditional rice grown in Sri Lanka.

Sri Lanka's paddy farming in the 2021 Maha (main) season is below average, the state agricultural office said, forecasting a 10 percent drop from average rough rice production based on the cultivation progress so far. Based on the cultivation progress so far Maha output is projected at 2.27 million metric tonnes, which is 10 percent below average, with about 69 percent of the fields sown.

In the 2020 Maha season Sri Lanka produced 3,051 million metric tonnes of rice, with 752,000 metric tonnes cultivated. "The sown extent reported are reaching the targets in Eastern Province, Mahaweli systems and Western Province, where as the sown extent reported Central Province, North Central

Province, and Uwa Province are far below the tar-gets," the agricultural office said in its December report.

"When compared with the sown ex-tent up to end November 2018 and 2019 , sown extent reported up to end November 2020 is 11% and 4% lower respectively. "About 1.8 million farmers are cultivating paddy using the land area of 870,000 hectares-34% of cultivable land area. About 98% of paddy production is locally consumed. Paddy production is no longer a profitable business, and farmers have become massive debtors.

Political

The political economy of rice is changing, and this shapes rice production and consumption. Even though there has been a long history of state engagement in rice stockholding and trading, the state's role is declining sharply. However, rice remains a strategic food security crop for policymakers and voters. There are tremendous variations in tastes and preferences for rice across the world. European consumers are increasingly interested in special rice varieties such as organic rice, waxy rice, jasmine rice, wild rice, and color pericarp (Ferrero and Nguyen, 2004). The demand for rice is shifting from lower-quality rice to higher-quality rice.

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