

Unit 1



Introduction to Paddy Cultivation

INTRODUCTION

Paddy, also known as 'rice paddy', is cultivated in southern and eastern Asia. Paddy fields must always be irrigated and the crop be cultivated in standing water. Paddy plants are cultivated in impermeable subsoil and are bordered by earthen bunds to hold an average of 10–15 cm water in a field for three quarters of the growing season.

The plants produce rice, an edible starchy cereal grain. Roughly, one-half of the world population, including almost the entire East and Southeast Asia, is solely dependent on rice as a staple food. Ninety-five per cent of the world's rice is consumed by humans. The cultivated rice plant, *Oryza sativa*, is an annual grass of the *Gramineae* family.

Paddy cultivation probably started between the fifteenth and twentieth century B.C. in the Himalayan and submontane regions. The domestication of paddy is considered as one of the most important developments in human history. Rice first finds mention in the *Yajur Veda* (1500–800 B.C.), followed by many Sanskrit texts. Rice is consumed by a majority of the Indian population as a staple food. Paddy is a monocot annual plant belonging to *Poaceae* (*Gramineae*)



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Fig. 1.1: *Oryza sativa* (Asian rice)



Fig. 1.2: *Oryza sativa* with small flowers



Fig. 1.3(a): *Indica* paddy plant



Fig. 1.3(b): *Japonica* paddy plant

family and the number of its chromosomes is $2n=24$. The height of paddy plants, usually, vary from half-a-metre to two metres. Paddy cultivation is labour intensive and the plants need enough water for irrigation.

SUB-SPECIES OF PADDY

Rice grain can be of different colours and sizes. Rice is a grain belonging to the genus *Oryza*. This genus has two important species — *Oryza sativa* (Asian rice) and *Oryza glaberrima* (African rice). Species is not the only factor that differentiates between living beings. Variation exists among populations of the same species based on various other factors. Sub-species, race and breed are used to describe the different types of variation. Rice species are further grouped into three sub-species — *Indica*, *Japonica* and *Javanica*.

Indica

Paddy crop cultivated in India belongs to the *Indica* sub-species. It either does not have awns or possesses short and smooth awns. *Indica* is a major eco-geographical sub-species of paddy, primarily grown in tropical and subtropical regions, covering major south and south-east Asian countries. The leaves of the plant are mostly light green in colour, narrow or broad. The plant is medium or tall (except the semi-dwarf gene, which has been introduced into this group of genotypes recently). *Indica* rice varieties have profuse tillering, and slender and flat grains.

Japonica

Named after Japan, this group of paddy plant is characterised by narrow, dark green leaves, medium height tillers, oval and round grains, and short to intermediate plant stature. The panicles may be with or without awns.



Javanica

It denotes the *bulu* and *gundil* varieties of Indonesia mostly suitable for upland paddy cultivation. *Javanica* paddy plants are characterised by broad, stiff and light green leaves, stiff straw and long panicles with awned grains. They, generally, have poor tillering. The spikes of the plant may be with or without awns with long duration maturity.



Fig. 1.3(c): Javanica paddy plant

RICE VARIETIES

Aerobic rice

Aerobic rice varieties are grown in well-drained, non-puddled and aerated soils, and have an average yield of 4–5 tonne per hectare. Paddy plants, yielding such varieties, are mostly cultivated on levelled and flat lands, where rains, with or without supplementary irrigation, are sufficient to support the crop for a full season.

Hybrid rice

Varieties produced by crossing between two different parents are known as hybrids. Hybrid varieties of rice have been found to be more robust, tillering, nutrient responsive, higher yielding and better than common high yielding varieties (HYVs). Hybrids are less susceptible to diseases, drought and other agronomic vagaries.

Basmati rice

These are characterised by thin and longer grains, and have an aroma with a distinct taste. Such rice varieties are extensively grown and consumed across the world. The rice grains have a light and fluffy texture on cooking. India produces the world's finest *basmati* rice varieties.



Fig. 1.4: A mixture of brown, white and red Indica rice (including wild rice)





Fig.1.5: Golden rice

Golden rice

This is a Genetically Modified (GM) variety of rice that carries a gene for biosynthesis of β -carotene, which is converted to Vitamin A on consumption. However, being a GM crop, there are several impediments for its cultivation in many Asian countries.

Boro rice

It refers to the cultivation of rice between November and May, especially, in the eastern parts of India, i.e., West Bengal, Odisha, Assam, etc. The cultivation of *boro* rice is practised in areas, generally, left fallow during winters due to excessive soil moisture conditions after harvesting of the crop. *Boro* crop planted after the cultivation of *Kharif* crop matures before the onset of next monsoon and fetches higher market price.

Organic rice

Organic rice farming denotes paddy cultivation without the use of fertiliser and chemical pesticides. Such a variety totally depends on Farm Yard Manure (FYM), compost, animal wastes or by-products like cattle and poultry, green manure, mineral nutrients and biological pests, which are important to maintain soil health and check insect-pests, diseases and weeds.

INTEGRATED RICE AND FISH FARMING

Fish rearing in paddy fields without impacting the rice quality and yield is known as 'integrated rice and fish farming'. It helps in earning extra income, i.e., apart from the main crop (rice) yield. Rice and fish farming is widely practised in Asian countries.

SESSION 1: IMPORTANCE OF PADDY CULTIVATION

India is the second largest producer of rice in the world after China and has the largest area under paddy cultivation. Therefore, rice is the principal staple food crop in India. Data on area earmarked for paddy cultivation and production of rice indicate



a considerable increase in the area dedicated to its cultivation 1950–51 to 2016–17 (Table 1.1). Within a span of 66 years, rice production in India has increased by about five times, while the productivity (yield/ha) has increased by about four times. The country has HYVs. India has achieved this enhanced production due to the use of advanced and effective agricultural technologies.

Table 1.1: Area, production and yield of rice in India

Year	Area (million hectare)	Production (million tonne)	Yield (kg/hectare)
1950–51	30.8	20.6	668
1960–61	31.1	34.6	1,013
1970–71	37.6	42.2	1,123
1980–81	40.1	53.6	1,336
1990–91	42.7	74.3	1,740
2000–01	44.7	85.0	1,901
2010–11	42.9	96.0	2,239
2016–17	43.4	104.3	2,404

(Source: *Agricultural Statistics at a Glance 2017*,
Directorate of Economics & Statistics)

Economic importance of rice in India

Rice is the staple food crop in India. It plays a significant role in the national food and livelihood security system, as well as, helps earn significant foreign exchange as it is exported to other countries. In India, the contribution of rice in the total agricultural export was 20 per cent in 2014–15 and 17.7 per cent in 2015–16 (Directorate of Economics and Statistics, 2016). Rice export (*basmati* and non-*basmati*) reported by the Ministry of Commerce and Industry, Government of India, during 2015–16 is given in Table 1.2.



Table 1.2: Rice (*basmati* and non-*basmati*) export during 2015–16

<i>Basmati</i>			<i>Non-basmati</i>		
Country	Quantity (million tonne)	Value (US \$ million)	Country	Quantity (million tonne)	Value (US \$ million)
Saudi Arabia	0.949	842.22	Senegal	0.888	1603.97
Iran	0.695	571.19	Benin	0.623	1411.12
UAE	0.612	475.18	Nepal	0.504	1182.85
Iraq	0.418	340.97	Coted'Ivoire	0.449	984.77
Kuwait	0.181	211.68	Guinea	0.396	866.95
UK	0.188	143.14	UAE	0.234	747.78
USA	0.121	131.55	Bangladesh	0.294	617.43
Yemen	0.142	110.49	Somalia	0.269	605.27
Oman	0.105	92.84	South Africa	0.261	570.64
Canada	0.036	38.49	Saudi Arabia	0.152	506.68
Other countries	0.597	519.64	Other countries	2.296	6031.61
Total	4.045	3477.39	Total	6.366	15129.09

(Source: Directorate General of Commercial Intelligence and Statistics 2016,
Ministry of Commerce and Industry, Government of India)

Rice straw is used as fodder, fuel, and for making thatched rooftops, mats, hats and straw boards. It is treated with urea to make feeds for ruminants. Rice bran contains 20 per cent oil and other nutritious minerals. Rice bran oil is considered better than other vegetable oils for its low cholesterol level.

Nutritional value of rice

Rice is the predominant dietary source of energy. Starch is the main constituent of rice grain, providing instant energy. Because of higher starch content, it is used for preparing various food items, such as rice flour, rice flakes, canned rice, popped or puffed rice and fermented products. The major nutrients in rice is given in Table 1.3.



Table 1.3: Major nutrients in rice

Nutrients	Rice (white) (per 100 g)	Rice (brown) (per 100 g)
Water (g)	12	10
Energy (kJ)	1528	1549
Protein (g)	7.1	7.9
Fat (g)	0.7	2.9
Carbohydrates (g)	80	77
Calcium (mg)	28	23
Magnesium (mg)	25	143
Phosphorus (mg)	115	333
Potassium (mg)	115	223
Thiamin (B ₁) (mg)	0.07	0.4
Riboflavin (B ₂) (mg)	0.05	0.09
Niacin (B ₃) (mg)	1.6	5.09
Pantothenic acid (B ₅) (mg)	1.01	1.49
Vitamin B ₆ (mg)	0.16	0.51
Vitamin E (mg)	0.11	0.59

NOTES**Practical Exercise****Activity**

Prepare a bar diagram, depicting the area under rice cultivation and its production in India.

Material required: pen, pencil, eraser, A4-size plain paper, etc.

Procedure

- Collect data on area under rice cultivation in India.
- Arrange the data year-wise for three years.
- Draw a bar diagram, indicating the area under rice cultivation, and its production in the country.



Check Your Progress

A. Fill in the Blanks

- Rice is the _____ food crop of India.
- The botanical name of Asian rice is _____.
- _____ rice a genetically modified variety.
- Boro* rice cultivation is practised in _____ parts of India.
- The major nutrient found in rice is _____.

B. Multiple Choice Questions

- How many chromosomes (2n) are there in rice?
(a) 20 (b) 22
(c) 24 (d) 26
- Which one of the following sub-species of rice is cultivated in India?
(a) *Japonica* (b) *Indica*
(c) *Javanica* (d) None of the above
- A by-product prepared from rice is _____.
(a) oil (b) wax
(c) glue (d) soft drink
- The main constituent of rice is _____, which provides energy.
(a) starch (b) fat
(c) protein (d) vitamin

C. Match the Columns

A	B
1. Sub-species	(a) <i>Oryza glaberrima</i>
2. <i>Indica</i>	(b) From November to May
3. Golden rice	(c) Describes types of variation in rice crop
4. African rice	(d) Genetically modified variety
5. <i>Boro</i> rice	(e) Profuse tillering

D. Subjective Questions

- Describe the economic importance of rice.
- Write about the following in brief.
(a) Aerobic rice
(b) *Basmati* rice
(c) Golden rice
(d) *Boro* rice



SESSION 2: CLIMATIC REQUIREMENTS AND PADDY GROWING REGIONS

NOTES

Paddy is a semi-aquatic plant. Tropical climate is most suitable for its cultivation. But paddy crop is also grown extensively in subtropical and temperate climates. In India, paddy cultivation is done almost round the year in different regions, spanning three seasons — *Kharif*, *Rabi* and *Zaid*, depending on the cultivar, climate and availability of water.

Conditions for paddy cultivation

Rainfall

Paddy is, generally, cultivated in areas receiving a rainfall of 750–1250 cm annually.

Temperature

The optimum temperature required for paddy cultivation is 30°C in the day and 20°C in the night. But the plant can tolerate higher temperatures up to 40°C for a short period.

Day length or sunshine

Sunlight significantly influences the growth of paddy crop. Sunshine with low temperatures during the ripening stage improves the grain quality, helps in the development of carbohydrates, and also results in overall better yield.

Soil

Paddy is cultivated in soils with variable characteristics but grows well in soils having a pH of 5.5 to 6.5. Soils with optimum water holding and drainage capacity are suitable for paddy cultivation.

Rice cropping seasons

Paddy cultivation can be carried out throughout the year in the eastern and southern parts of India by taking two–three crops annually. It is mostly cultivated during the *Kharif* season in northern and western India like Jammu and Kashmir, Himachal Pradesh, Punjab,



Haryana, Uttarakhand, Uttar Pradesh, Gujarat, Rajasthan and Maharashtra. Here, only one crop is grown in the *Kharif* season as the temperatures during winters are too low for paddy cultivation. The crop duration, time of sowing and harvesting of the crop is presented in Table 1.4.

Table 1.4: Time of sowing and harvesting paddy crop in India

Local name	Crop season	Sowing	Harvesting
<i>Aus</i> (autumn rice)	Pre- <i>Kharif</i>	May-June	September-October
<i>Aman</i> (winter rice)	<i>Kharif</i>	June-July	November-December
<i>Boro</i> (summer rice)	<i>Zaid</i>	November-December	March-April

Rice growing regions in India

Uttar Pradesh has the largest area under paddy cultivation, followed by West Bengal, Odisha, Chhattisgarh, Andhra Pradesh, Telangana, Bihar and Punjab. These States collectively account for about 92 per cent of the total area under paddy cultivation in the country (Table 1.5). A classification of the regions primarily under paddy cultivation is as follows.

- Arid Western Plains
- Semi-arid Lava Plateau and Central Highlands
- Humid to semi-arid Western Ghats and Karnataka Plateau
- Humid western Himalayan region
- Sub-humid Sutlej-Ganga alluvial plains
- Sub-humid to humid eastern and south-eastern uplands
- Humid Bengal-Assam Basin and humid eastern Himalayan region

Table 1.5: Top 10 rice producing States in India (2014-15)

S. No.	State/UT	Rice (million tonne)	Area (million hectare)	Average yield (kg/ha)
1.	West Bengal	14.7	5.4	2731
2.	Uttar Pradesh	12.2	5.9	2082
3.	Andhra Pradesh and Telangana	11.6	3.8	3036
4.	Punjab	11.1	2.9	3838



5.	Odisha	8.3	4.2	1989
6.	Bihar	6.4	3.3	1951
7.	Chhattisgarh	6	3.8	1581
8.	Tamil Nadu	5.8	1.8	3191
9.	Assam	4.9	2.3	2135
10.	Haryana	4	1.3	3113

(Source: <http://www.mospi.gov.in/statistical-year-book-india/2016/177>)

Rice ecologies

Ecology refers to the relationship between different organisms and that with their physical surroundings. Paddy is cultivated in different agro ecological zones across India. No other country in the world has such diversity in rice ecosystem as India. There are four distinct ecosystems in India.

Irrigated rice ecosystem

This ecosystem is primarily found in eastern Asia and provides 75 per cent of the global rice production. In India, irrigated paddy is cultivated in bunded fields (an earthen wall around a field) and occupies a total area of about 22 million ha (49.5 per cent). This type of paddy cultivation is mainly practised in Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, Jammu and Kashmir, Sikkim, Andhra Pradesh, Tamil Nadu, Karnataka and Gujarat.

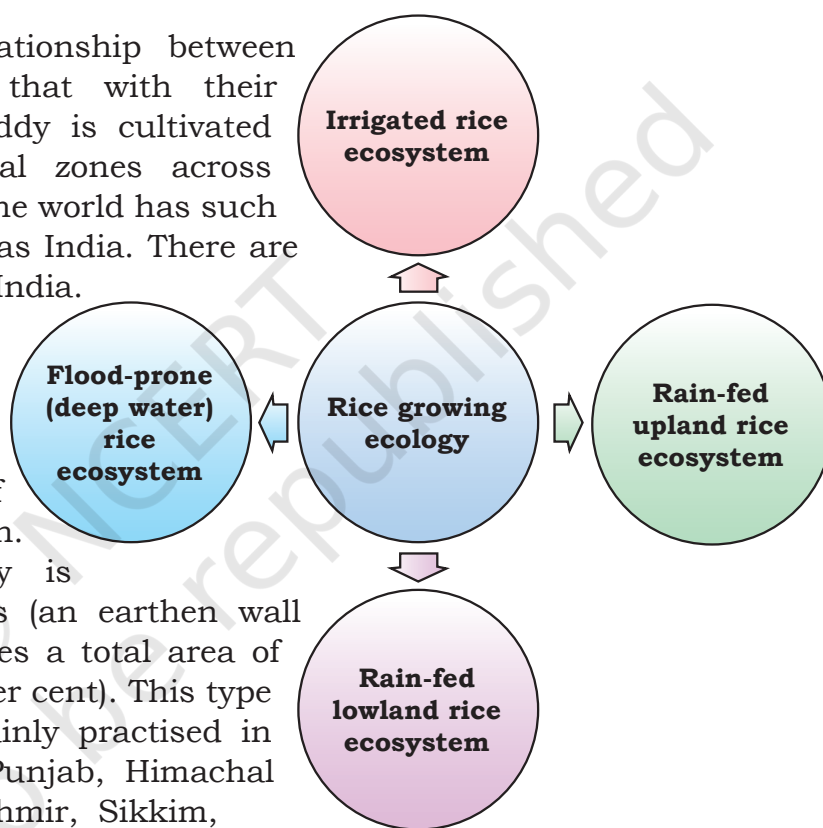


Fig. 1.6: India has four distinct rice ecosystems

Rain-fed upland rice ecosystem

This system is prevalent in Asia, Africa and Latin America. In India, the total area under rain-fed upland paddy cultivation is about six million ha (13.5 per cent). It is grown extensively in eastern and north-eastern States, often seeded in dry seedbed on rolling or sloping land.



NOTES

Rain-fed lowland rice ecosystem

About 25 per cent of the global paddy cultivation is under rain-fed lowland ecosystem. India has over 33 per cent area under this ecosystem. The major constraints in this ecosystem include poor soil health, frequent droughts and floods, resulting in poor yield.

Flood-prone (deep water) rice ecosystem

Flood-prone ecosystem is prevalent in South and south-east India, and the central Gangetic plains of Uttar Pradesh and Bihar. Flooding, usually, occurs during June to September, mostly preceded and followed by drought. Paddy varieties to be cultivated in this ecosystem are selected on the basis of their tolerance to water submergence. Their yields are low.

Practical Exercise

Activity 1

Prepare a pie chart, depicting the five largest paddy producing States in India. Indicate these States on the political map of India.

Material required: pen, pencil, A4-size plain paper, compass, India's political map, etc.

Procedure

- Collect State-wise data on paddy production in the current year and arrange it in descending order.
- Select five largest rice producing States in India.
- Indicate these States on the political map of India.
- Calculate the percentage contribution of each State with regard to the total rice production in India.
- Draw a pie chart, indicating the States that are the largest paddy producers.

Activity 2

List the States, where paddy is cultivated under irrigated ecosystem and also indicate them on the political map of India.

Material required: pen, pencil, A4-size plain sheet, India's political map, etc.

Procedure

- Make a list of the States where paddy is cultivated under irrigated ecosystem.
- Indicate these States on the political map of India.



Check Your Progress

NOTES

A. Fill in the Blanks

1. Rice is a semi-aquatic plant that prefers a _____ climate.
2. There are _____ distinct rice ecosystems in India.
3. Uttar Pradesh comes under _____ rice ecosystem.
4. Rice grows well in soils having a pH of _____.

B. Multiple Choice Questions

1. Paddy is grown in India in the season(s) of _____.
(a) *Rabi* only (b) *Kharif* only
(c) *Zaid* only (d) All of the above
2. The grain quality of rice mainly depends on _____.
(a) bright sunshine hours (b) low temperature
(c) Both (a) and (b) (d) humidity
3. Irrigated rice ecosystem provides _____ per cent of the global rice production.
(a) 85 (b) 65 (c) 95 (d) 75
4. Optimum day-night temperature requirement of rice is _____, respectively.
(a) 30 and 20°C (b) 35 and 25°C
(c) 40 and 30°C (d) 25 and 15°C

C. Match the Columns

A	B
1. Autumn	(a) <i>Boro</i>
2. Winter	(b) <i>Aus</i>
3. Summer	(c) <i>Aman</i>

D. Subjective Questions

1. List the rice growing regions of India.
2. Write a note on rice ecological regions in India.

