Rice is the most important world cereal. It is a staple for over half of the human population and is eaten three times a day in Asia. Unhusked rice is called paddy rice; (paddy also refers to the growing crop). Husk is removed by milling (mortar & pestle still used in some areas). However, unlike wheat where “flour” is used for baking bread and other products, rice grains are usually consumed whole.

History

An ancient crop, native to SE Asia. Cultivated in China for 5000 years. Originated from forms of *Oryza perennis*. Plays an important part of ancient customs, religions, and magical rites. Rice is a symbol of fecundity and plenty; the custom of throwing rice at newly-weds is borrowed from an ancient eastern fertility rite.
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Uses
Food uses: boiled rice, rice flakes, puffed rice, rice pudding, risotto, ground rice for confectionery, glutinous rice for sweet meats.
Nonfood uses: rice powder, starch, sake (wine), Husks are used as a mix for concrete, rice oil for cooking, straw is used for thatch (poor for feeding). Note: rice paper is not made from rice.

Types of Rice
Hill rice:
   Upland or dryland rice
   Need good rains for 3–4 months
Swamp rice:
   Lowland rice
   Grown in irrigated or flooded areas
Floating rice:
   Grown in areas of deep flooding (up to 0.5 m or more) keeping pace with flooding
Texture

Hard (vitreous): the main rice of commerce.
Soft dextrinous: glutinous rice (does not contain gluten the protein that causes wheat to rise in bread)
   Sticky and cloying in cooking, e.g. pearl rice grown in Japan.
   Used for sweetmeats in Japan, molded for sushi.
Americans do not like sticky rice.
   (First cooking lesson of new American brides used to be to make each grain of rice abhor it neighbor.)
Instant rice: this rice is precooked, unsticky.

Grain Shape

<table>
<thead>
<tr>
<th>Grain Shape</th>
<th>Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra long</td>
<td>&gt; 7mm</td>
</tr>
<tr>
<td>Long</td>
<td>6–7</td>
</tr>
<tr>
<td>Middling</td>
<td>5–6</td>
</tr>
<tr>
<td>Short</td>
<td>&lt; 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Season</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very early</td>
<td>&lt;110 days</td>
</tr>
<tr>
<td>Early</td>
<td>110–140 days</td>
</tr>
<tr>
<td>Late</td>
<td>150–170 days</td>
</tr>
<tr>
<td>Very late</td>
<td>&gt;180 days</td>
</tr>
</tbody>
</table>

2001 World Production

<table>
<thead>
<tr>
<th>Continent</th>
<th>1000 tonnes</th>
<th>Chief countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>592,831</td>
<td></td>
</tr>
<tr>
<td>Africa</td>
<td>16,974</td>
<td>Egypt (5,700), Nigeria (3,298),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Madagascar (2,300)</td>
</tr>
<tr>
<td>North America</td>
<td>12,041</td>
<td>US (9,664), Dominican Rep. (698),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cuba (350)</td>
</tr>
<tr>
<td>South America</td>
<td>19,543</td>
<td>Brazil (10,207), Colombia (2,107),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Peru (2,019)</td>
</tr>
<tr>
<td>Asia</td>
<td>539,842</td>
<td>China (181,515), India (131,900),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indonesia (50,096)</td>
</tr>
<tr>
<td>Europe</td>
<td>3,171</td>
<td>Italy (1,222), Spain (888),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Russian Federation (497)</td>
</tr>
<tr>
<td>Oceania</td>
<td>1,261</td>
<td>Australia (1,239), Fiji (16),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Solomon (5)</td>
</tr>
</tbody>
</table>
Botany
Diploid (2n = 24) but triploids and tetraploids also exist.
Freely tillering grass, usually 50–150 cm tall.
Normally self pollinate with outcrossing 0–4.5%.
Indica and other photoperiodic rices have a slow seed dormancy, require 1–3 months rest for maxim germination.
Optimum germination temperature is 30–35°C (86–95°F)

Two Subspecies

**Indica**
- Tall leafy
- High tillering
- Lodges easily
- Low response to N
- Photoperiod sensitive
- Short day plants
  (requires short days to flower)

**Japonica**
- Short stiff straw
- Low tillering
- Resistant to lodging
- High response to N
- Photoperiod insensitive
- Hardy
- Disease resistant

Culture
A tropical crop but grown extensively in subtropical and warm temperate climates.
Requires 4–6 months of 68–77°F (20–25°C) and minimum of 50°F (10°C)

Water Requirements
Lowland rice
Requires 800–2400 mm (72–96”) of rain, requires 750 mm (30”) over 3–4 months.
Cannot tolerate desiccation.
Upland rice
Requires 500–1200 mm (24–48") of rain.
Typically short day plant but some photoperiod insensitive types (“Green Revolution” rices) are photoperiod insensitive.
Requires 8–10" of soil for root penetration.
Less important than paddy rice.
Popular in Brazil.
Typically is grown under shifting cultivation.
Seed is broadcast or dibbled in.

Floating rice
Grown under deep flooding, can grow 53 cm in 4 days, crop requires 7 months or more.
In Bangladesh can be harvested from boats.

In paddy or swamp rice (wet rice) land is inundated; crop grown in water by flooding.
Usually grown by small holders with 1–5 acres requiring 400 person hours per acre.
Grown during the monsoon in Am climates; 2–3 crops can be grown, in some cases as a ratoon crop, that is, by repeat tillering.
There is little fertilization in Asia because a blue-green algae fixes nitrogen with *Azotobacter*, thus wet rice can be grown continuously in a sustainable system.
Soil structure is not a problem.
Planting is usually by transplants which are direct seeded in a nursery.

Two Systems of Wet Rice Cultivation

Traditional Systems
Traditional wet rice is completely grown with hand labor.
Seed (50–60 kg/ha) is sown in small nursery.
Seedlings are transplanted by hand in 30 cm rows when 2 months old in paddies separated by dikes in which water flows by gravity in sluggish current.
Dikes are usually permanent and can be planted to fruit trees in to hold earth in place (China).
Harvest by hand, panicle by panicle.
Mechanized Systems
Seeded by airplane, or transplanted by machine.
Weeded by chemicals, harvested by combine.
Presoaked seed is planted in fields flooded 2.4–5 cm (1–2") and maintained until plant is 15–20 cm.
Water level is then raised to bring depth to 10–15 cm.
Fields are drained a week before grain is ripe, approximately 3 weeks after flowers.
High fertilization is carried out and good weed control is essential.
Many weeds will not sprout if the field is kept flooded.

Processing (Milling)
Husk must be separated from the seed.
This can be done in a mortar and pestle type apparatus or by machinery.
Grain consists of seed coat and aleurone layers (= bran) and embryo and starchy endosperm.
Vitamin B₁, thiamin is found in the aleurone layers.
Lack of vitamin B₁ leads to the beri-beri disease.
Unpolished rice is called brown rice; does not store as well as white polished rice.

Polishing removes last of the bran and the embryo and thus eliminates all of vitamins.
White polished rice contains starch and little else.
Parboiling is a system to boil the rice in the husk (paddy rice).
This gelatinizes the outer layers of starch and allow it to absorb part of vitamins.
Stores better than unpolished rice.
Storage
White polished rice stores the best
Polished > parboiled > milled unpolished.
Rice Improvement

Main agency is the International Rice Research Institute (IRRI), Los Banos, Philippines.

IR8 = miracle rice (indica × japonica), fertilizer responsive, lodging resistant, photoperiodically insensitive.

Similar varieties developed in Taiwan by Japanese between 1900–1930.

Rice Paddies, Bangkok, Thailand

Rice Paddies, Thailand, near Bankok
Plowing rice paddy with water buffalo, Ceylon

Leveling rice field with water buffalo, Ceylon

Cooperation in plowing, Ceylon
Plowing rice with water buffalo, Ceylon

“Land Master” rotivator replaces water buffalo, Ceylon

Plowing & leveling with tractor, Ceylon
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Hand leveling of rice paddy, Ceylon

Hand weeding rice, Ceylon

Peace Corps workers cleaning paddy ridge, Ceylon
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Dusting rice with malathion for paddy bugs, Ceylon

Dusting rice with malathion, Ceylon

Harvesting rice with sickle, Ceylon
Harvesting rice with sickle, Ceylon

Hauling rice, Ceylon

Carrying rice to threshing floor, Ceylon
Cleaning paddy burm for forage, Ceylon

Harvesting grass for water buffalo, Ceylon

Feeding grass to water buffalo, Ceylon
Drying cooked rice, Ceylon

Hauling dried rice, Ceylon

Rice farming near Bandung
Carrying rice to dry after harvest, West Java

Drying rice, Sumatra

Mechanical rice planting, Korea
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Korea

Dryland Rice

Upland rice, dry land plowing, Ceylon

Upland rice clearing in forest for rice, Maranhao
De-husking rice, Ze-Doca, Moranhao

Separating rice & chaff, Ze-Doca, Maranhao

Cleaning rice, Ceylon
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Germinating rice, Ceylon

Seed cleaning, Ceylon

Seed separation, Ceylon