# FURTHER INFORMATION

The NARI Rice and Grain Programme at Bubia is undertaking research into rice and grains and will be able to assist farmers upon request.

For more information about rice, do visit NARI Bubia or contact us at the address below:


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# Morphology and Growth of Rice Plant


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RPG001

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# RICE (***ORYZA SATIVA***): THE PLANT & HOW IT GROWS

Whenever we see rice, either as polished ready to cook grains or as grains on typical plants growing out in the field, we may ask such questions as what's inside a rice grain? How long does it take a rice plant to grow? What kind of soils do rice plants like? What kind of insects eat the rice plants? To answer some of these questions and many more, the NARI Rice Research Team at Bubia Research Centre has decided to reproduce an article from the International Rice Research Institute (IRRI) for school children. It gives information about the morphology and growth of rice plant. Information about rice soils, pest and diseases will be produce as separate pamphlets in future.



Reproduced by the Research staff of the NARI Rice and Grain Programme.

For those who have a computer with Internet access, you can search for further information from the RiceWeb located in the World Wide Web at the address given at the end of the article.



# MORPHOLOGY

Cultivated rice is generally considered a semi aquatic annual grass, although in the tropics it can survive as a perennial, producing new tillers from nodes after harvest (ratooning). At maturity the rice plant has a stem and a number of tillers. Each productive tiller bears a terminal flowering head or panicle. Plant height varies by variety and environment conditions, ranging from approximately 0.4 m to over 5 m in some floating rices. The morphology of rice is divided into vegetative phases (including germination, seedling, and tillering stages) and the reproductive phases (including panicle initiation and heading stages).

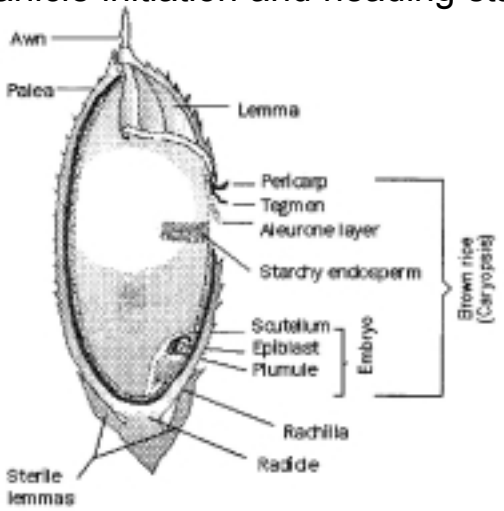


Figure 1. Structure of the rice grain

**Seeds.** The rice grain, commonly called a seed, consists of the true fruit or brown rice (caryopsis) and the hull, which encloses the brown rice. Brown rice consists mainly of the embryo and endosperm. The surface contains several thin layers of differentiated tissues that enclose the embryo and endosperm.

The palea, lemmas, and rachilla constitute the

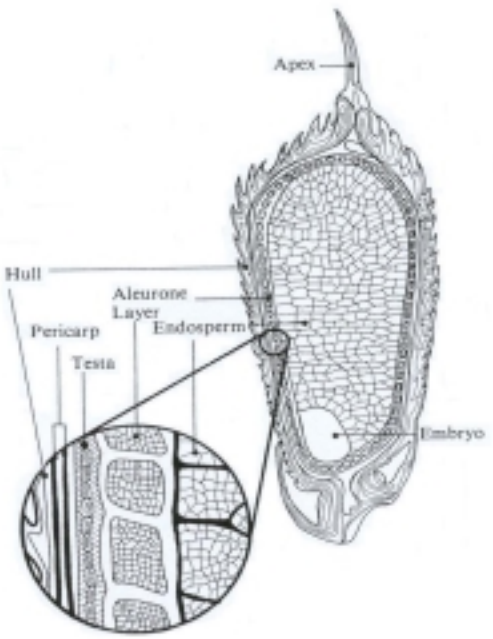


Figure 2. Structure of the rice kernel



**Reproductive phase.** The reproductive growth phase is characterized by culm elongation (which increases plant height), decline in tiller number, emergence of the flag leaf (the last leaf), booting, heading, and the flowering of the spikelets. Panicle initiation is the stage about 25 days before heading when the panicle has grown to about 1 mm long and can be recognized visually or under magnification following stem dissection.

Spikelet anthesis (or flowering) begins with panicle exsertion (heading), or the following day. Consequently, heading is considered a synonym for anthesis in rice. It takes 10-14 days for a rice crop to complete heading because there is variation in panicle exsertion among tillers of the same plant and among plants in the same field. Agronomically, heading is usually defined as the time when 50% of the panicles have exserted.

about 30 days in the tropics to 65 days in cool, temperate regions such as Hokkaido, Japan, and Yanco, NSW, Australia.

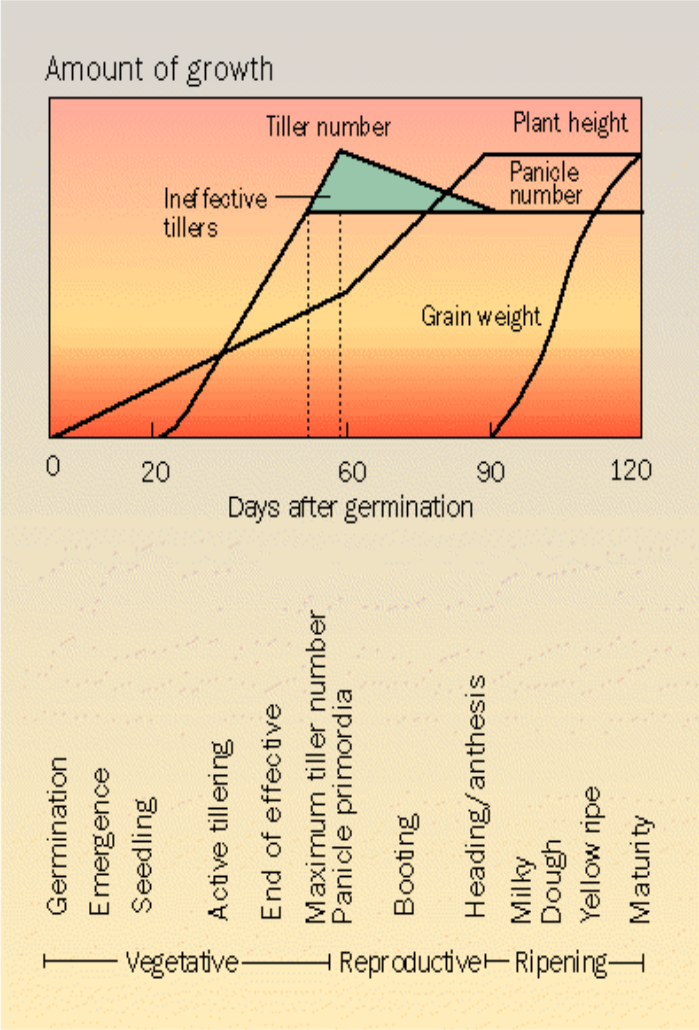


Figure 9. Chart showing growth stages and development of a 120- day rice variety



hull of indica rices. In japonica rices, however, the hull usually includes rudimentary glumes and perhaps a portion of the pedicel. A single grain weighs about 10-45 mg at 0% moisture content. Grain length, width, and thickness vary widely among varieties. Hull weight averages about 20% of total grain weight.

**Seedlings.** Germination and seedling development starts when seed dormancy has been broken and the seed absorbs adequate water and is exposed to a temperature ranging from about 10-40°C. The physiological definition of germination is usually the time when the radical or coleoptile (embryo shoot) emerges from the ruptured seed coat. Under aerated conditions the seminal root is the first to emerge through the coleoptile from the embryo, and

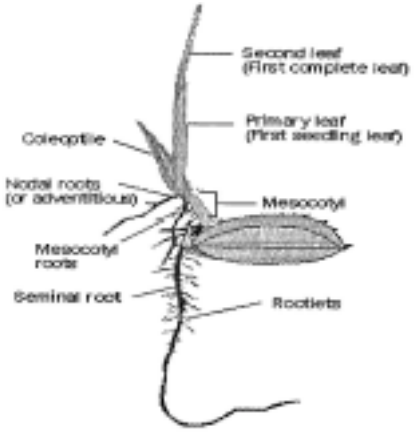


Figure 3. Parts of a rice seedling

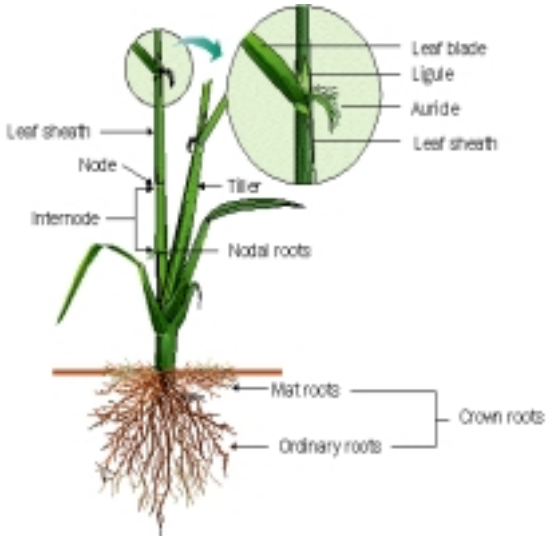


Figure 4. Components of a primary tiller

this is followed by the coleoptile. Under anaerobic conditions, however, the coleoptile is the first to emerge, with roots developing when the coleoptile has reached aerated regions of the environment. If the seed develops in the dark as when seeds are sown beneath the soil surface, a short stem (mesocoty) develops, which lifts the crow of the plant just below soil surface. After the coleoptile emerges, it splits and the primary leaf develops.

Tillers growing from the main stems are called primary tillers. These may generate secondary tillers, which may in turn generate tertiary tillers. These are produced in a synchronous



agronomically it is convenient to regard the life history of rice in terms of three phases: vegetative, reproductive, and ripening. A 120-day variety, when planted is a tropical environment, spends about 60 days in the vegetative phase, 30 days in the reproductive phase, and 30 days in the ripening phase.

**Vegetative phase.** The vegetative phase is characterized by active tillering, gradual increase in plant height, and leaf emergence at regular intervals. Tillers that do not bear panicles are called ineffective tillers. The number of ineffective tillers is a closely examined trait in plant breeding since it is undesirable in irrigated varieties, but sometimes an advantage in rainfed lowland varieties where productive tillers or panicles may be lost due to unfavourable conditions.

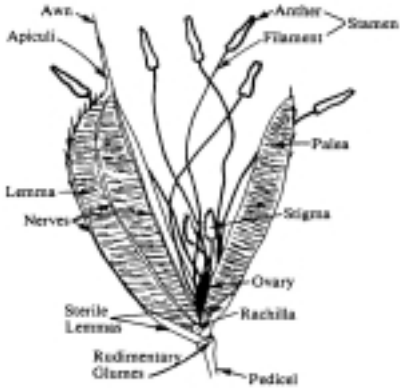


Figure 7. Parts of a spikelet

Pedicels develop from the nodes of the primary and secondary branches; the spikelets are positioned above them. Since rice has only one fully developed floret (flower) per spikelet, these terms are often used interchangeably. The flower is enclosed in the lemma and palea, which may be either awned or awnless. The flower consists of the pistil and stamens, and the components of the pistil are stigma, styles, and ovary.

## GROWTH

The growth duration of rice plant is 3-6 months, depending on variety and the environment under which it is grown. During this time, rice completes two distinct growth phases: vegetative and reproductive. The vegetative phase is subdivided into germination, early seedling growth, and tillering; the reproductive phase is subdivided into the time before and after heading, i.e., panicle exsertion. The time after heading is better known as the ripening period (see chart below).

Potential grain yield is primarily determined before heading. Ultimate yield, which is base on the amount of starch that fills the spikelets, is largely determined after heading. Hence,



manner. Although the tillers remain attached to the plant, at later stages they are independent because they produce their own roots. Varieties and races of rice differ in tillering ability. Numerous environmental factors also affect tillering including spacing, light, nutrient supply, and cultural practices.

**Tillering plants**. Each stem of rice plant is made up of a series of nodes and internodes. The internodes vary in length depending on variety and environmental conditions, but generally increase from lower to upper part of the stem. Each upper node bears a leaf and a bud, which grow into a tiller. The number of

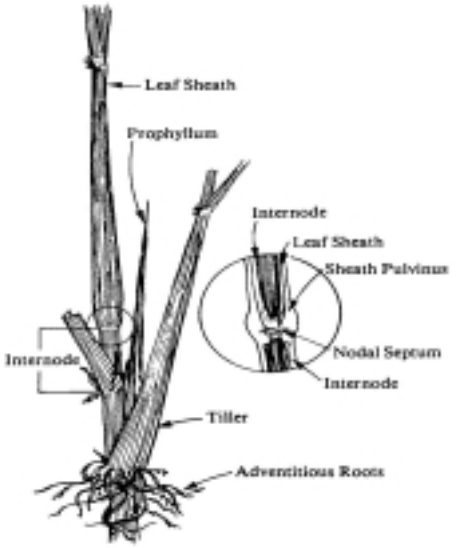


Figure 5. Parts of a primary tiller and its secondary tiller

nodes varies from 13 to 16 with only the upper 4 or 5 separated by long internodes. Under rapid increase in water level some deepwater rice varieties can also increase the lower internode length by over 30 cm each. The leaf blade is attached at the node by the leaf sheath, which encircles the stem. Where the lead blade and the leaf sheath meet is a pair of clawlike appendages, called the auricle, which encircle the stem. Coarse hairs cover the surface of the auricle. Immediately above the auricle is a thin, upright membrane called the *ligule*. The tillering stage starts as soon as the seedling is self-supporting and generally finishes at panicle initiation. Tillering usually begins with the emergence of the first tiller when seedlings have five leaves. This first tiller develops between the main stem and the second leaf from the base of the plant. Subsequently when the 6$^{th}$ leaf emerges the second tiller develops between the main stem and the 3$^{rd}$ leaf from the base.

The rice root system consists of two major types: crown roots (including mat roots) and nodal roots. In fact both these roots develop from nodes, but crown root develop from nodes below the soil surface. Roots that develop from nodes above the soil surface usually are referred to as nodal roots. Nodal roots are often



found in rice cultivars growing at water depth above 80 cm. Most rice varieties reach a maximum depth of 1 m or deeper in soft upland soils. In flooded soils, however, rice roots seldom exceed a depth of 40 cm. That is largely a consequence of limited oxygen ($O_2$) diffusion through the gas spaces of roots (aerenchyma) to supply the growing root tips.

**Panicle and spikelets.** The major structures of the panicle are the base, axis, primary and secondary braches, pedicel, rudimentary glumes, and the spikelets. The panicle axis extends from the panicle base to the apex; it has 8 – 10 nodes at 2- to 4-cm interval from which primary branches develop. Secondary branches develop from the primary branches.

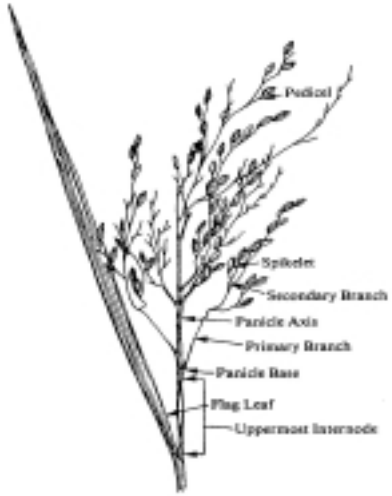


Figure 6. Component parts of a panicle