

PENANG SANGAM HIGH SCHOOL
P.O.BOX 44, RAKIRAKI
LESSON NOTES

School: Penang Sangam High School
Subject: Agricultural Science
Year/Level: 11

Week 19

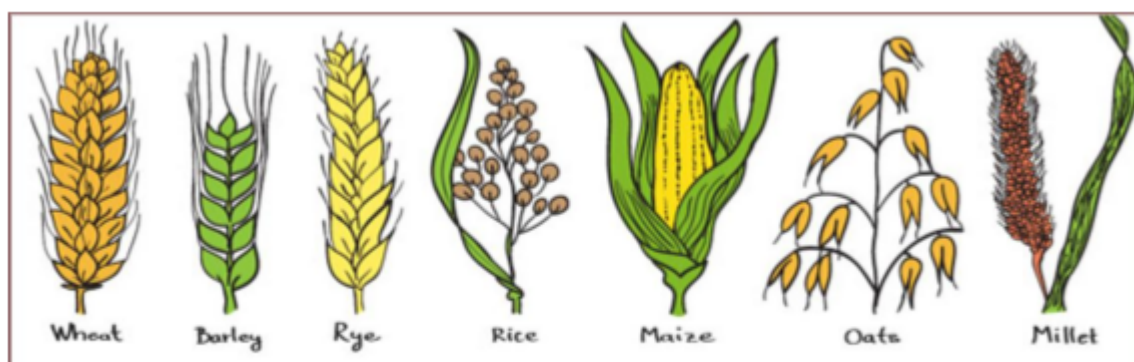
Strand	Strand as 11.3 Agronomy
Sub Strand	Sub-strand 11.3.2.3 FIELD CROPS
Content Learning Outcome	Students will research and elaborate on: one field crop traditionally cultivated in the area

LESSON 1: cultivation of rice

LESSON OUTCOME: discuss the cultivation of rice

OVERVIEW OF CEREALS

The word cereal derives from Ceres, the name of the Roman goddess of harvest and agriculture. A cereal is a grass, a member of the monocot family Poaceae, which is cultivated for the edible components of its grain (botanically, a type of fruit called a caryopsis). This grain is composed of the endosperm, germ, and bran. Cereal grains are grown in greater quantities and provide more food energy worldwide than any other type of crop so are therefore classified as staple crops. In their natural form, as in whole grain, cereals are a rich source of vitamins, minerals, carbohydrates, fats, oils, and protein. However, cereal grains are refined by removing the bran and germ. The remaining endosperm is mostly carbohydrate. In some developing nations, grain in the form of rice, wheat, barley, rye, maize, oats and millet constitutes a majority of daily sustenance. In developed nations, cereal consumption is moderate and varied but still substantial.



Source: <http://www.mondeleznutritionscience.com>

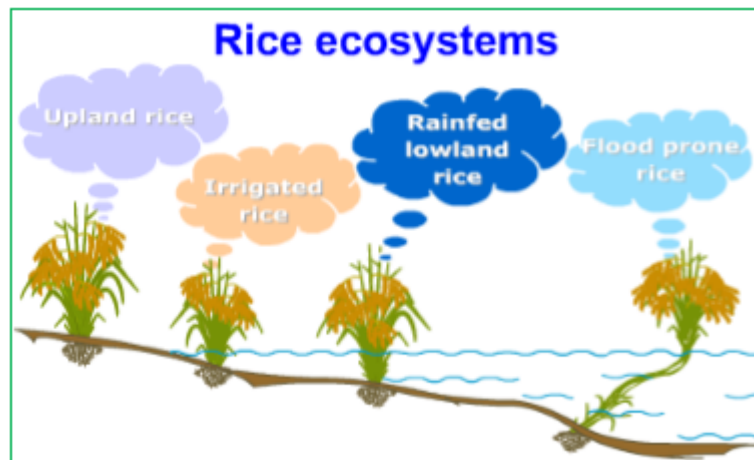
OVERVIEW OF RICE

Rice is the seed of the grass species *Oryza sativa* (Asian rice) or *Oryza glaberrima* (African rice). Genetic evidence has shown that rice originated from a single domestication 8,200–13,500 years ago in

the Pearl River Valley region of China. As a cereal grain, rice is the most widely consumed staple food for a large part of the world's human population, directly feeding more people than any other crop. In 2012, nearly half of world's population – more than 3 billion people – relied on rice every day. It is the agricultural commodity with the third-highest worldwide production, after sugarcane and maize, according to data of FAOSTAT 2012. Rice is available in a variety of colors, including white rice, brown rice, black rice, purple rice, and red rice. Rice is eaten daily in almost every household in Fiji, however, Fiji imports close to 90% of her rice needs.

ADVANTAGES OF RICE

1. Convenient – rice is available in all shops in Fiji.
2. Versatile – rice can be prepared in a number of ways e.g. steamed, boiled, fried, boiled in coconut cream; as a separate dish, as an ingredient in other dishes.
3. Shelf life – rice can be stored as seeds and in its polished form.
4. Nutritious – brown rice contains magnesium, selenium, phosphorus, manganese, copper and Vitamin B3.
5. Acclimatised – rice grows well in Fiji. Rice is adapted to various growing environments, as illustrated below.



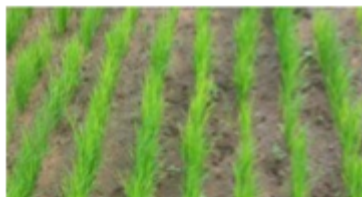
Source: <http://www.knowledgebank.irr.org>

There are two types of rice cultivated in Fiji.

1] Dry land rice

- also referred to as upland rice.
- water is needed during planting but fields are not flooded
- this rice was traditionally grown in the Western and Northern Divisions mainly for home consumption.

Dry land rice



2] Wetland rice

– this is also referred to as irrigated rice.

This rice is cultivated in flooded rice fields and was traditionally grown for sale in the irrigation schemes situated near major rivers in Fiji. The irrigation schemes included

- i) Lakena - near Rewa River
- ii) Navua – near the Navua River
- iii) Dreketi – near the Dreketi River

Rice plants take around 3–6 months to grow from seeds to mature plants, depending on the variety and environmental conditions. They undergo three general growth phases: vegetative, reproductive, and ripening.

Wetland rice



<http://www.featurepics.com>

OR RICE

The area which you choose to plant rice depends on the type of rice which you plan to grow. Wetland rice needs to grow in waterlogged soil so level land close to a source of fresh water is important.

	Dry land rice	Wetland rice
Location	Anywhere in Fiji but is usually associated with sugarcane and vegetable farms on the drier sides of Viti and Vanua Levu.	A constant source of water is required throughout the growing period so is usually suitable for the river valleys in the wet zone of Viti and Vanua Levu namely Navua, Nausori and Dreketi
Climate	Precipitation needed during the transplanting phase	Precipitation needed throughout the growing phase from sowing seeds to before harvesting.
	Gentle breezes are tolerated.	
	Direct sunlight required during the growing period for maximum photosynthesis.	
Topography	Level to gently rolling slopes	Level land
Soil type	Free drainage and high water retention required so fertile clay loam soil with adequate organic matter is recommended.	Soil with high water holding capacity required so fertile loamy to clay soils are recommended.
Infrastructure	The size of the farm and type of rice cultivated will depend on the availability of a road and suitable water supply.	

VARIETIES OF RICE

There are 40,000 recorded varieties of rice in the world. Customers use the following criteria to choose rice varieties:

1. Grain length – rice is classified as long grain, medium grain and short grain
2. Grain colour – cultivated rice may be brown, white, red, black/purple.
3. Translucence – rice grain range from translucent to opaque
4. Aroma – rice aroma includes nutty and floral.

Rice varieties should have:

1. Good grain quality
2. High market price
3. Optimum yield potential and stability over seasons
4. Maximum tillering capacity for coping with weed competition
5. Resistance or tolerance to major diseases, insects, and other stresses (i.e. drought and flood) of the area
6. Resistance to lodging under normal farm management
7. The right growth duration (maturity length) to match the season

Factors affecting crop management, such as soil type, planting method (e.g. some varieties are better for direct seeding), fertilizer efficiency, amount of rainfall, climate and disease pressure should also be considered in selecting varieties. There are many traditional and recommended varieties of rice grown in Fiji and these varieties depend on the environment in which the rice is cultivated.

Dry land rice varieties	Wetland rice varieties	
Plant from Nov to Feb <ul style="list-style-type: none">▪ Bold Grain▪ Star▪ Maleka▪ Totoka▪ Uttam▪ Nuinui▪ Deepak	Improved Varieties: planted from Nov to Feb <ul style="list-style-type: none">▪ Star▪ Deepak▪ Uttam▪ Nuinui▪ Bold Grain	Traditional Varieties: can be planted year round. <ul style="list-style-type: none">▪ BG 75▪ Saraya-6 Months▪ China Motka▪ Lalka Motka▪ Takur Ram▪ Ram Kajra

SELECTION OF RICE SEEDS

Seed is the foundation of any rice crop. It must be grown, harvested, and processed correctly for best yield and quality results.

Good quality seeds are free from:

1. Weed seeds
2. Seed borne diseases
3. Insects
4. Pathogens
5. Other extraneous matter
6. Damage

Sowing good quality seeds leads to:

1. Lower seeds rate
2. Higher seed germination rate [80% viability]
3. Uniformity in purity
4. Less replanting
5. Early vigorous growth
6. Resistance to pests and diseases [including weeds]

Seeds are to be purchased from a reliable source.

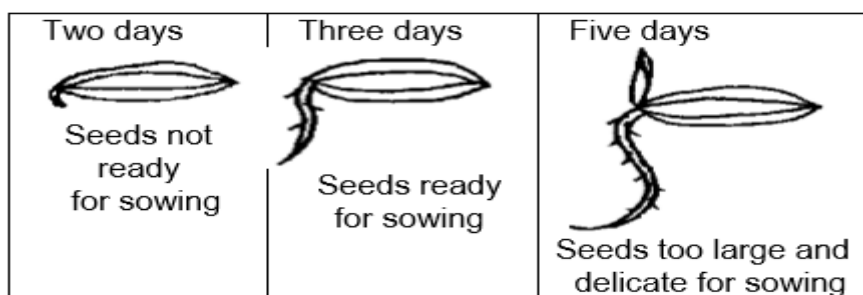
PREGERMINATION OF RICE SEEDS

Rice seeds are encased within a husk which protects the content of the seed and delays germination.

- 1) Sun bathing rice seeds – stored seeds are spread out evenly in the sun for one or two days to kill pathogens and weaken the husk. The seeds are continuously raked to turn them so that they do not overheat and kill the embryo.



- 2) Sorting seeds - Seeds are spread in water, stirred gently and left to settle. Seeds which float are rejected.
- 3) Seed soaking – seeds are soaked in a ratio of 1 part seeds to 5 parts water for about 24 hours. This allows the water to soak into the seed and cause the embryo to grow.
- 4) Incubating seeds - Pour away the water and spread the seeds thinly over a clean surface. Cover the seeds with jute sack or clean straw for 3 days to allow the seeds to germinate



- 5) Broadcast seeds The germinated seeds can be broadcast into:
- 6) Prepared paddy fields where they take root and grow into wetland rice crop
- 7) Prepared seedbeds where they grow until ready for transplanting



Source; <http://www.flickr.com>

RAISING RICE SEEDS SEEDLINGS

Rice seedlings are raised in specially prepared seedbeds which are usually located near the rice fields.

Steps in raising rice seedlings:

1. Locate an area near a water source which is exposed to full sunlight. A total of 350-500 sq.m of seedbed area is needed to grow enough seedlings to plant 1 hectare of rice paddy.
2. Prepare the seedbed 30-35 days before the scheduled time of transplanting. Plough and harrow the field thoroughly
3. Construct raised seedbeds - 1.5 m wide, 4-5 cm high and of any convenient length.
4. Sow the pre-germinated seeds uniformly at 1 kg/10 sq.m.
5. After 4 days, irrigate the seedbed to 3 cm deep.
6. Gradually increase the water level to 5 cm to control weeds and to make lifting of seedlings easier.
7. If you observe nitrogen deficiency (yellowing of the lower leaves) broadcast 50-100 g ammonium sulphate/m² or 40g urea/m² of seedbed 10 days after sowing.
8. Place a scarecrow in the plot to protect the seedlings from birds.
9. The seedlings are ready for transplanting in:
 - 16 days for varieties which mature in 115 days
 - 20 days for varieties which mature in 116-125 days
 - 25 days for varieties which mature in 126 days or more

Seedbed of rice seedlings



Source: <http://www.knowledgebank.irr.org>

Maintaining rice seedbed



CES

SOIL PREPARATION

A well-prepared field controls weeds, recycles plant nutrients, provides a soft soil mass for transplanting and a suitable soil surface for direct seeding. Dry land rice is grown in rainfed fields while wetland rice favour flooded fields.

	DRY LAND RICE	WET LAND RICE
CLEARING	Remove all vegetation, including crop residues, by slashing or ploughing under	
REPAIR BUNDS	Bunds or dikes enable the field to hold water. This is important especially in areas where water supply is not reliable. Construct no wider and taller than 50 cm x 30 cm bunds, around the field. Make sure that bunds are well compacted and properly sealed, with no cracks, holes, etc. This will minimize water losses through seepage	
TILLING	Turn and pulverise soil to a fine tilth then level soil surface	Irrigate field to soften soil then turn and puddle waterlogged soil before levelling the soil surface

TRANSPLANTING RICE SEEDLINGS

Although some farmers direct seed their rice crops, many farmers prefer to transplant their rice seedlings based on the following advantages and disadvantages.

ADVANTAGES	DISADVANTAGES
Less seeds are required per unit area transplanted	Larger areas required for the seedbed
Transplanting seedlings can be delayed	Preparation of seedbed, care of seedlings and lifting seedlings are laborious
Transplanting older seedlings shortens the crop's stay in the field, thereby reducing crop exposure to field risks	Seeds are easily carried away by raindrops if heavy rain occurs shortly after sowing
Gives the rice seedlings a head start over the weeds after transplanting	

STEPS IN TRANSPLANTING RICE SEEDLINGS

There are four stages in the transplanting of rice seedlings:



LIFTING	<p>Decide on the amount of seedlings needed so as not to waste seedlings</p> <p>Flood seedbed- increase the irrigation water depth to 10cm one day before lifting seedlings</p> <p>Lift seedlings - hold the base of the plant and gently pull it out of the soil to avoid damaging the roots and root hairs</p> <p>Remove dirt- wash the roots carefully to remove soil</p> <p>Tie the seedlings in bundles and place the bundles in the seedbed with the roots soaking in water.</p>
TRANSPORTING	<p>i. Due to the proximity of the seedbeds to the paddy fields, seedlings can be carried across.</p> <p>ii. If transport is necessary then lay the seedlings in the wheelbarrow or carrier and cover the roots with wet jute sacks to minimise dehydration.</p>
PLACEMENT	<p>Place the bundles of seedlings at intervals in the rice field so they are within easy reach of the workers.</p> <p>Avoid throwing the bundle of seedlings to minimise shock.</p>
PLANTING OUT	<p>i. Untie the bundle of seedlings and remove two or three seedlings.</p> <p>ii. Break off the top of the leaves</p> <p>iii. Hold the seedlings in one hand with roots against the extended thumb.</p> <p>iv. Working backwards and across, place the seedlings in the soil at the recommended spacing.</p> <p>v. Irrigate the field.</p>

STAGE 1 LIFTING

Do not hit the roots against hard surfaces when trying to dislodge the soil as it will cause shock and result in poor establishment.

CROP CARE

Rice crops take from 115 to 126 days to grow, depending on the variety. During the growing period farmers carry out husbandry practices to help the crop grow to its potential. This care includes the application of fertilizing material, weed control, pest control, disease control and water control.

FERTILIZING MATERIALS

Farmers can dynamically adjust fertilizer use by supplying optimum amounts of nutrients at critical time points in the crop's growth. Soil analysis is carried out before a crop is planted to determine the type and amount of fertilizing material to apply. However, it is recommended that fertilizer should be applied at the following stages of rice development:

1. At planting , two fertilizers are broadcasted and mixed into the soil
 - a. Superphosphate is at 20kg/ha

b. Muriate of potash at 75kg/ha

2. 20 days after seeding – Nitrogen is top-dressed at 25kg/ha

3. In between panicle initiation and booting stages -Nitrogen is top-dressed at 25kg/ha

WEEDS

Weeds are a major competitor of rice especially during the first 30 days of growth so farmer's time weed control measures with this in mind.

Weeds are controlled:

1. During the development of seedlings in the seedbed.
 - Weeds remaining in the soil of the seedbeds and weed seeds contaminating rice seeds will grow while the rice seedlings are developing.
 - Weed control is essential at this stage to reduce competition and the introduction of the weeds to the fields during transplanting.
 - Land preparation should start 3 – 4 weeks before planting.
 - Ploughing and harrowing two or more times destroys weeds and remaining stubble from the previous crop, however weed seeds and underground storage organs may remain viable.

Therefore, weeds should be allowed to emerge and grow for at least two weeks between tillage operations, especially ploughings. This reduces the number of weed seeds remaining in the soil and future weed problems.

2. 30 to 40 days after direct sowing or transplanting seedlings

Any weeds which survived would have emerged by now so need to be controlled. The following weed control methods are used

METHODS OF WEED CONTROL

- A. Manual weed control - where weeds are cut or pulled out of the soil However, this is labour intensive and is not practical for large areas
- B. Chemical weed control - where herbicides are either sprayed onto the plants or added to the irrigation water
- C. Cultural weed control – in which weed control is integrated into the husbandry practises planned and used.

Some chemicals used are:

Nutrazine,	a pre-emergence herbicide which is applied soon after planting at a rate of 200ml/15 l of water.
MCPA	a post -emergence herbicide that targets broad leaf weeds and which is applied 4 weeks after transplanting at a rate of 2.82 l/ha or 95 ml/15 l of water.

STAM F34	a post-emergence herbicide that controls broad leaf weeds and which is applied at the 3 – 4 leaf stage [21 days after sowing] at a rate of 11.2 l/ha
Saturn	a pre-emergence herbicide that targets narrow leaf weeds and which is applied 3 to 7 days after planting or transplanting at a rate of 5.61 l/ha .
Propal	a post-emergence herbicide that is non-specific and which is applied at a rate of 510 ml/10 l of water when weeds are a problem.
Basagram	a post-emergence herbicide that is non-specific and which is applied at a rate of 4 l/ha

–However, the environment is at risk from the chemicals.

Some forms of cultural weed control are as follows:

Timing	Weeds need to be controlled from planting until the crop canopy closes.
Land preparation and levelling	Use land preparation to control growing weeds and to allow weed seeds to germinate. Kill newly emerging weeds by repeat tillage at 10-day intervals.
Reduce weed entry into fields	Prevent the introduction of weeds into fields by: <ul style="list-style-type: none"> a) using clean good quality seed b) keeping seedling nurseries free of weeds to make sure weeds are not planted with the rice seedlings c) keeping irrigation channels and field bunds free of weeds to prevent weed seeds or vegetative parts entering the fields d) using clean equipment to prevent field/crop contamination e) rotating crops to break weed cycles. Prevent the introduction of weeds into fields by: <ul style="list-style-type: none"> a) using clean good quality seed b) keeping seedling nurseries free of weeds to make sure weeds are not planted with the rice seedlings c) keeping irrigation channels and field bunds free of weeds to prevent weed seeds or vegetative parts entering the fields d) using clean equipment to prevent field/crop contamination e) rotating crops to break weed cycles.
Fallow management:	Kill weeds in fallow fields (e.g. use tillage) to prevent flowering, seed-set and the build-up of weed seeds in the soil (remember: “1 year seeds, 7 year weeds”).
Crop-weed competition:	<ul style="list-style-type: none"> a) Select a weed-competitive variety with early seedling vigour, and high tillering to suppress weeds. Transplanted crops tend to have fewer weeds and less yield loss than direct seeded crops. b) Transplant healthy, vigorous seedlings that can better compete with weeds in early stages. c) Maintain an adequate plant population that closes its canopy by maximum tillering to shade out weeds. d) Apply N fertilizer just after weeding to minimize rice-weed competition for Nitrogen.

Water management:	Water is the best control for weeds. Many weeds cannot germinate or grow under flooded conditions (e.g. most grasses and some sedge). Maintain a 2 to 5 cm water level in the field to minimize weed emergence and lower weed pressure. If water is sufficient, fields can be continuously flooded from the time of transplanting to when crop canopy covers the soil completely. Good land levelling is critical to avoid high spots where weeds can become established.
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However, cultural weed control:

needs good knowledge and understanding of various cultural practices that can reduce weed pressure

continuous vigilance and monitoring are essential to control weeds by cultural methods

some practices are labour intensive.

PESTS

Farmers lose an estimated average of 37% of their rice crop to pests every year. Timely and accurate diagnosis can reduce losses.
