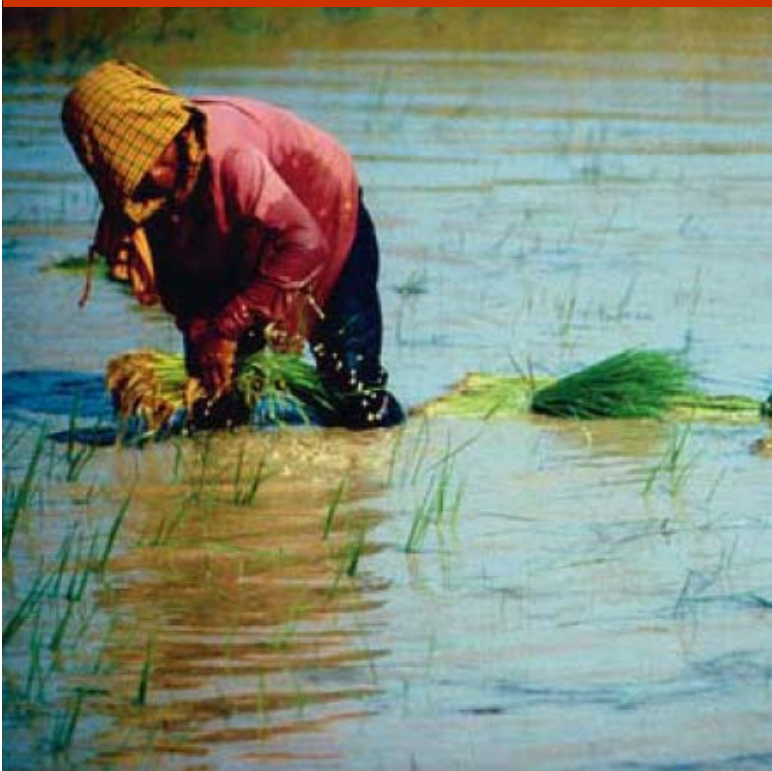


# Best Management Practices for rainfed lowland rice in Lao PDR



**Step by Step**  
to higher rice yields

**Recommendations for rice farmers  
and extension officers**

## Table of contents

Page

STEP 1: Choose the most suitable variety for each field	1
STEP 2: Use seed of high quality	3
STEP 3: Prepare and manage the seedbed well	5
STEP 4: Prepare the field with care	7
STEP 5: Keep your field weed free	9
STEP 6: Fertilizer is essential to achieve high yields	11
STEP 7: Timely harvest to avoid grain losses	15
Annex 1: Characteristics of weed types	17
Annex 2: Calculations for fertilizer use	19
Annex 3: Frequent nutrient problems in Laos	21
Annex 4: Nutrient removal at harvest and nutrient content of organic fertilizer	23
Annex 5: Direct seeding: another option to establish rice	25
Annex 6: Alternate Wetting and Drying (AWD)	27
Annex 7: General recommendations on insecticide use	28



# STEP 1

## Choose the most suitable variety for each field.

### *Why suitable varieties?*

Because fields differ in their soil quality, the risk of flooding, or the risk of drought, a suitable variety must be selected for each field.

Using suitable varieties minimizes the risk of crop loss or failure and ensures good yields.

### *What are suitable varieties?*

A suitable variety should give good yields, taste good, have a high market price, and many things more. General important criteria are:

- Plant height: In most fields, varieties of medium height (1-1.2 meter tall) are preferable. Tall varieties (about 1.4 meter tall) give low yields. Very short varieties (less than 1 meter tall) should only be used on favorable fields with low drought or flooding risk.
- Duration: Late varieties (more than 150 days) are preferable in lower flood-prone fields, early varieties (less than 120 days) are better suited for upper, drought-prone fields.
- Traditional varieties: usually tall, have few tillers, bold grains, lodge easily, and are low yielding. But they can be the better choice on very poor soils or in flood-prone fields.
- Improved varieties: usually of medium height, have many tillers, slender grains, respond to inorganic fertilizer, and can give high yields. They are preferable in most fields.

### *Example of suitable varieties*

Chose a variety according to your experience, local recommendations, and the field situation. Good varieties are:

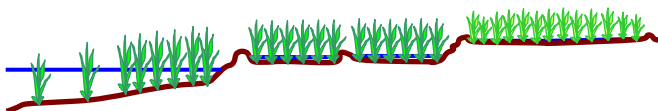
- Late varieties: RD6, RD8, KDML105, TDK1sub1, Chao Deng, Khao Iloop, Black Rice. Good for lower fields, best seeding date is end May to early June.
- Medium late varieties: TDK1, TDK2, TDK3, TDK8, RD10, NTN1, PNG2, PNG3, PNG5, PNG6, TSN2, TSN3, TSN4. Good for medium fields, best seeding date is early to mid June.
- Medium short varieties: PNG1, TDK5, TDK11, SK12, CR203, Aerobic Rice, Kao Do. Good for upper fields, best seeding date is mid July.

## Variety types, their characteristics and best use:



**Traditional varieties/landraces:** usually tall, have few tillers, bold grains, lodge easily, and are low yielding (for example KDML105). But they can be the better choice on very poor soils or in flood-prone fields.

**Improved varieties:** usually of medium height, have many tillers, slender grains, respond to inorganic fertilizer, and can give high yields. They are preferable in most fields.



Lower fields	Medium fields	Upper fields
Late varieties, 150 days and more	Medium late varieties, about 120-150 days	Medium short varieties, less than 120 days
Example: RD6, RD8, KDML105, TDK1sub1, Chao Deng, Khao Iloup, Black Rice	Example: TDK1, TDK2, TDK3, TDK8, RD10, NTN1, PNG2, PNG3, PNG5, PNG6, TSN2, TSN3, TSN4	Example: PNG1, TDK5, TDK11, SK12, CR203, Aerobic Rice, Khao Do
Best seeding: end of May to early June	Best seeding: early to mid June (this is also the best seeding time with irrigation)	Best seeding: mid July

## STEP 2

### Use seed of high quality (pure, clean, and healthy)

#### *Why use good seed?*

Good seed reduces the necessary seed rate, provides healthy and strong seedlings, gives a uniform crop stand in the field, and results in higher yields.

#### *What is good seed?*

Good seed is:

- clean (contains no stones, soil particles, weed seed),
- pure (contains only grains from one variety),
- healthy (full big grains, same color, no cracks)



Dirty seed

Impure seed

Clean, pure, and healthy

#### *How to get good seed?*

Buy certified seed that is pure and labeled, or produce your own good seed:

1. Choose a good field to ensure low risk and high yield;
2. If available, use clean, pure, and healthy seed to start with.
3. Use good management practice (STEPS 3, 4, 5 and 6), put extra effort in weeding;
4. Around flowering, remove all rice plants that clearly look different (different height, plant color, flowering time, panicle type, grain shape). Also remove sick and insect damaged plants/panicles.
5. Harvest at full maturity (80-85% of the grains are straw-colored).
6. Thresh and dry best within 2 days after harvest. Clean thoroughly by winnowing. If a machine is used, clean the thresher before use.
7. Use a separate container for the seed, label it with the name of the variety, and store the seed in a cool, dry, and clean area.

## How to produce your own good seed:

1. Choose a good field: fertile soil with low flooding or drought risk.
2. Use clean, pure, and healthy seed to start with.
3. Manage the crop well (see STEP 3, 4, 5, and 6).
4. Remove all plants that differ in height, plant color, flowering time, panicle type, or grain shape. Remove also sick plants and insect-damaged panicles.
5. Harvest at maturity when 80-85% of the grains are straw colored (see STEP 7).



Much too early

Too early

Correct time

Too late

- 6 and 7. Thresh and dry quickly after harvest. If a machine is used, clean the thresher before use. Clean the seed thoroughly by winnowing. Label the seed and store it in a cool, dry, and clean area.



## STEP 3

# Prepare and manage the seedbed well (transplanted rice).

### *Why is seedbed management important?*

Good seed together with a well prepared and managed seedbed give the crop a better start.

After transplanting, the seedlings will grow faster, and cope better with poor soils, weeds, insects, and diseases.

### *What is good seedbed management?*

1. Choose a spot with good soil, water availability, and protected from farm animals.
2. Prepare the seedbed well and keep it weed free.
3. Use good seed (see STEP 2).
4. Apply some fertilizer.
5. Use the right amount of seed (seeding density).
6. Transplant the seedlings at the right time.

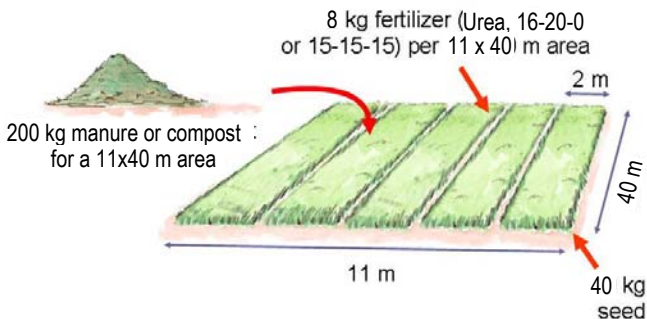
### *How to manage the seedbed well?*

- **Seedbed preparation:** Plow 3 times and level the seedbed well. The soil in the seedbed should be soft and powdery.
- **Seed rate and seedbed size:** For a 1 hectare rice field use 40-50 kg seed. For 40 kg seed, the seedbed size is 10x40 meter plus a walking row every 2 meter. If old seedlings (40-50 days) are used frequently, a bigger seedbed (40 kg seed for 15x40 meter area) gives healthier seedlings and higher yields.
- **Seedbed nutrient management:** Apply 200 kg manure or compost (2 cart loads) before the plowing. If available, apply 8 kg fertilizer (Urea, 16-20-0 or 15-15-15) at around 10 days after sowing.
- **Seed soaking** for 24 hours, then 24 hours incubation, then sow uniformly. Avoid seedbed flooding at sowing, if possible keep a shallow water layer after emergence.
- **Transplanting age:** Transplant short duration varieties best between 20 and 30 days after seeding. Transplant medium and long duration varieties best between 20 to 40 days after seeding.
- Transplanting old seedlings gives low yields because they are less healthy and do not produce many tillers. Closer transplanting (more seedlings per area) can partly compensate for this. **Avoid transplanting seedlings older than 40 days.**



## How to prepare and manage the seedbed well:

1. Choose a spot with good soil and water availability, safe from farm animals.
2. Plow 3 times and level the seedbed well. Keep the seedbed weed free.
3. Use good seed (see STEP 2).
4. Use 40 kg seed for a 1 hectare rice field. For 40 kg seed, the seedbed size is 10x40 meter plus a walking row every 2 meters.



5. If late transplanting (more than 40 days) is used frequently, a bigger seedbed (40 kg seed for 15x40 meter area) gives healthier seedlings and higher yields.
6. Apply some organic fertilizer and if possible also inorganic fertilizer (basal).
7. Soak the seed for 24 hours, incubate for 24-48 hours, then sow uniformly. Avoid seedbed flooding at sowing, if possible keep a shallow water layer after emergence.
8. **Transplanting age:** Transplant short duration varieties best between 20 and 30 days after seeding. Transplant medium and long duration varieties best between 20 to 40 days after seeding. Avoid transplanting seedlings older than 40 days.
9. Treat the seedlings with care, uproot carefully and transplant soon after uprooting, transplant 1-3 seedlings per hill, not more;

## STEP 4

Prepare the field with care - level the field, repair bunds and apply organic fertilizer.

### *Why is field preparation important?*

A well prepared field provides the rice crop with good conditions to grow.

A careful field preparation helps to make best use of available water and nutrients, reduces weeds, and organic fertilizer maintain soil quality.

### *What is good field preparation?*

1. Apply organic fertilizer to provide plant nutrients and keep the soil healthy.
2. Plow twice and harrow at least once to incorporate crop residues and weeds, and to make the soil soft.
3. Level the field well to ensure even crop growth, reduced weed growth, and a uniform water layer depth.
4. Repair bunds to reduce water losses and to destroy rat burrows.

### *How to prepare the field well?*

**Organic fertilizer (manure, compost, rice husk, straw, tree leaves):** uniform application across the field, best short before land preparation. A good rate is 2 tons per hectare (about 20 cart loads). But it is usually not profitable to buy organic fertilizer.

**Plowing:** Plow under weeds, stubbles, and organic fertilizer at the beginning of the cropping season (best 3-4 weeks before transplanting). Plow a second time 10-20 days later.

**Harrowing:** Harrow the field at least once. Harrowing breaks the clods, incorporates organic residues, and kills weeds which have germinated after plowing.

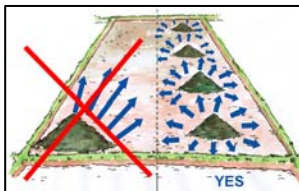
**Leveling:** can best be done with a shallow water layer in the field. After leveling, the water level should be equally deep in the whole field and no mounds of soil should be visible above a shallow water layer.

**Bund repair:** compact the bunds, repair gaps, and destroy rat burrows.

## Important components of good field preparation:

### 1. Apply organic fertilizer.

A good rate of organic fertilizer is 2 tons per hectare (about 20 cart loads). Apply uniformly across the field, and only a few days before land preparation.



### 2. Plow at least twice before harrowing: this helps to incorporate crop residues and weeds, and makes the soil soft.

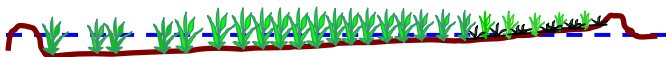
First plowing + second plowing 10-20 days later + one harrowing



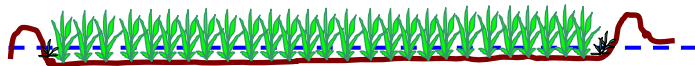
Level the field well before transplanting to ensure even crop growth and reduced weed growth.



### 3. Repair the bunds and destroy rat burrows.



**Unlevelled field:** Rice growth is bad in the deep and high parts of the field, many weeds grow in the high part. The crop does not ripen at the same time in the whole field, **the yield will be low.**



**Well levelled field:** Rice grows well and evenly in the whole field, and weed problems are minimal. The crop will ripen at the same time in the whole field and **the yield will be high.**

### *Why is weeding important?*

Weeds take away space, light, nutrients, and water from the rice plants, resulting in a lower rice yield.

Weeds do most damage early - during the first 30 - 40 days after transplanting. But later control is also important to prevent seed setting of weeds.

### *What is effective weed management?*

Effective weed management is achieved by:

1. All crop management favoring strong crop growth including choice of a suitable variety, clean seed, and healthy seedlings (STEP 1-3).
2. Land preparation reducing the weed infestation and favoring crop growth (STEP 4).
3. Weed control measures through hand weeding and/or appropriate use of herbicides (chemicals that only kill weeds).

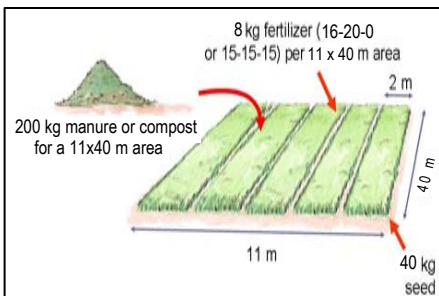
### *How to minimize weed infestation?*

- Prefer varieties of medium height and which grow fast.
- Use clean rice seed - free of weed seeds.
- Plowing and harrowing should be timed (10-20 days between plow passes) so that weeds germinate in between operations and are thus killed by the following operation.
- Good land leveling significantly reduces weed growth because most weeds can not germinate under water.
- Conduct the first hand weeding 3-4 weeks after transplanting, the second 6-7 weeks after transplanting. Always weed before fertilizer application.
- Chemical weeding with herbicides. ALWAYS READ and FOLLOW the instructions on the product label. Use herbicides early (before or short after transplanting), at the recommended rate, and use the right herbicide for your weed problem (see Annex 1 for further advice).

**Herbicides are poisonous; if they are not used properly they can cause health and environment problems. Label them clearly and keep them out of children's reach.**

## How to reduce weeds.

1. Use a good variety, clean seed, and healthy seedlings (STEPS 1 to 3)



2. Plow at least twice with 10-20 days between passes so that weeds germinate in between operations and are killed by the succeeding operation. Harrow once after plowing.

First plowing + second plowing 10-20 days later + one harrowing



3. Before transplanting, level the field well, best with a shallow water layer in the field (STEP 4).



**Well leveled field: less weeds, homogeneous ripening, and higher yield.**

4. Conduct the first weeding 2-3 weeks after transplanting, the second 5-6 weeks after transplanting. Weed before fertilizer application and remove flowering weeds.



## STEP 6

# Fertilizer is essential to achieve high yields and keep the soil healthy.

### *Why is fertilizer important?*

Plants need nutrients to grow. Most soils only provide small amounts of nutrients, causing limited crop growth and low yields.

Fertilizers supply additional nutrients to the crop and improve crop growth and yield. Fertilizers can also improve soil health.

### *What is fertilizer?*

1. **Organic fertilizer:** materials like manure, compost, rice husk, straw, tree leaves. They are cheap and improve the soil health, but they need much labor and their nutrient content is low.
2. **Inorganic fertilizer:** have high nutrient contents and improve plant growth fast, but they are expensive.
3. The most important nutrients are **nitrogen (N)**, makes the plant big and green), **phosphorus (P)**, increases the tiller number), and **potassium (K)**, makes the plant healthy and strong).

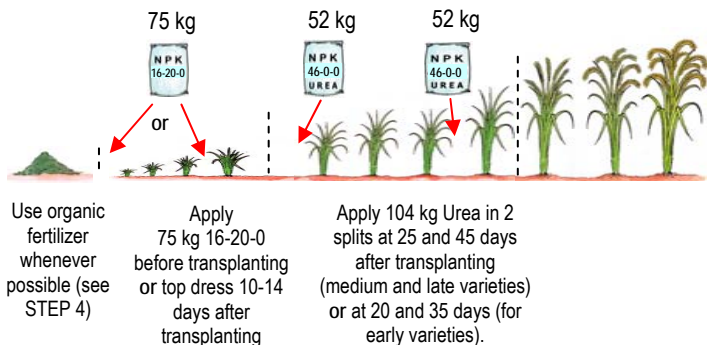
### *How to manage fertilizer properly?*

- Use organic fertilizer (manure, compost, straw, husk, tree leaves) whenever possible (see STEP 4), preferably on upper, sandy soils.
- A high recommended fertilizer rate for 1 hectare is 60-15-15 N-P-K. Only half this rate should be used for traditional varieties, for very early varieties (less than 110 days), or on upper/sandy fields. Do not apply inorganic fertilizer if the risk of drought or flooding is high.
- Apply all P and K fertilizer (and little N) early, just before transplanting (incorporate into the surface soil) or 10-14 days after transplanting;
- Apply Urea in 2 equal portions at 25 and 45 days after transplanting (medium and late varieties), or at 20 and 35 days after transplanting for early varieties. Do not apply Urea at or after booting stage.
- If urea cannot be applied at the recommended time (because there is no water in the field or constant rain), you can apply Urea up to 7 days before or after the recommended optimal time.
- Use inorganic fertilizer preferably for improved varieties (STEP 1) and on good fields. Do not apply high rates for traditional varieties.
- Do not use inorganic fertilizer if you need much more than 2.5 kg paddy to pay for 1 kg fertilizer.

**Inorganic fertilizers must be stored in a dry and cool place. They are not poisonous but keep them out of children's reach.**

## How to use organic and inorganic fertilizers:

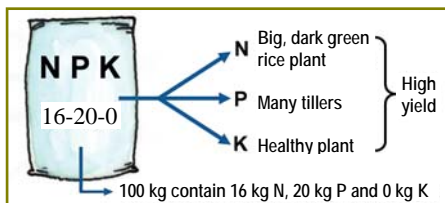
1. Use organic fertilizer (manure, compost, straw, husk, tree leaves) whenever possible (see STEP 4), but preferably on upper fields and on very sandy soils.
2. Use inorganic fertilizer to increase rice yields (rates below are for a 1 hectare field).



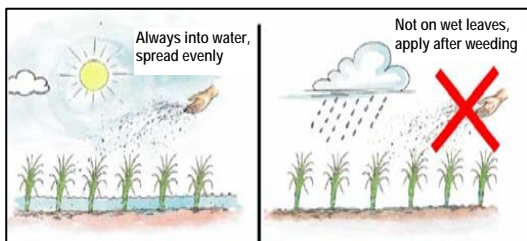
- Alternatively use 100 kg 15-15-15 plus 100 kg Urea or 200 kg 16-8-8 plus 60 kg Urea per hectare.
- The inorganic fertilizer rate above is a good recommendation for good fields with a low drought or flooding risk.
- Apply only half this rate for traditional varieties, for very early varieties (less than 100 days), or on drought-prone fields.
- Apply no or little inorganic fertilizer if the drought or flooding risk is high.
- In many fields use of N and P fertilizer is sufficient (use 16-20-0). Use 18-8-8 or 15-15-15 NPK fertilizer preferably on very sandy soils or when K deficiency occurs (see Annex 4).
- Do not use inorganic fertilizer if you need more than 2.5 kg paddy to pay for 1 kg fertilizer.
- If urea cannot be applied at the recommended time (because there is no water in the field or constant rain), you can apply Urea up to 7 days before or after the recommended optimal time.
- Do not apply Urea at or after booting, it is too late and will not increase yields.
- In rice, "biofertilizers" may or may not increase yields, they are therefore not generally recommended.

## General knowledge on inorganic fertilizer

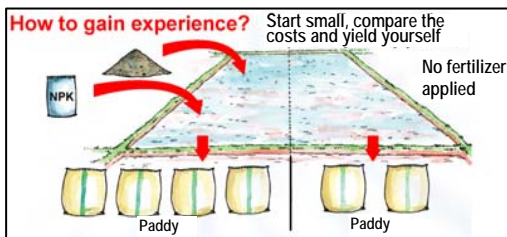
1. The most important nutrients for rice are nitrogen (N), phosphorus (P), and potassium (K).



2. The NPK content of inorganic fertilizer is written on the bag, for example "NPK 16-20-0" means that 100 kg contain 16 kg N, 20 kg P, and 0 kg K.



3. Topdress inorganic fertilizer only into shallow water and when rice leaves are dry.
4. Do not use inorganic fertilizer on fields with a high risk of drought or flooding; do not use high rates for tall traditional varieties.
5. If you have not enough fertilizer for all your fields, apply it to good fields (low risk) and improved varieties first.



5. To gain experience, use inorganic fertilizer on half of your field. Compare the yield with the other half where no inorganic fertilizer was used.

Note: NPK rates are actually given in  $N-P_2O_5-K_2O$  but for simplicity we used N, P, and K in the text above;



## Calculating fertilizer rates for a field of a specific size

Example: Your field is half a hectare (0.5 ha) big, the available fertilizer is Urea (46-0-0 NPK) and mixed fertilizer (16-20-0 NPK), and the recommended fertilizer rate is 60-15-23 kg NPK/ha.

1. First, calculate the quantity of mixed fertilizer that you need:

Recommended rate (15 kg P ha) multiplied by the area (0.5 ha) divided by the P in the mixed fertilizer (20) multiplied by 100 = 37.5 kg mixed fertilizer.

2. Then, calculate the quantity of Urea that you need:

The mixed fertilizer already contains some N: 37.5 kg mixed fertilizer multiplied with the N in the mixed fertilizer (16) divided by 100 = 6 kg N

The remaining N rate is the recommended rate (60) multiplied by the area (0.5 ha), minus the N in the mixed fertilizer (6) divided by the N in urea (46) multiplied by 100 = 52 kg Urea

So for 0.5 ha you need 37.5 kg 16-20-0 fertilizer and 52 kg urea to apply the recommended rate of 60-15-23 kg NPK/ha.

If the application of K is important for your site, use a mixed fertilizer which contains K (15-15-15 or 16-8-8 NPK) but use the same calculation. If you use a pocket calculator, the symbols for calculating are multiplied ( $\cdot$ ), divided ( $/$ ), minus ( $-$ ), and plus ( $+$ ).

Note: NPK rates are actually given in  $N-P_2O_5-K_2O$  but for simplicity we used N, P, and K in the text above;

## Timely harvest to avoid grain losses, maximize milling recovery and ensure high grain quality.

### *Why is timely harvest important?*

Harvest too early: many grains will be immature, slender and chalky – causes large amounts of bran and broken grains during milling.

Harvest too late: many grains will be lost because of shattering and the grains become too dry – this causes cracking during threshing and cracked grains will break during milling.

### *What is timely harvest?*

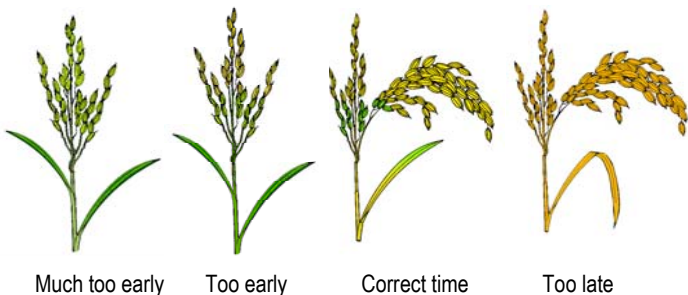
- usually about 30 days after flowering.
- when 80-85% of the grains are straw colored.
- grains in the lower part of the panicle are hard, not soft.
- when the grains are firm but not easily broken when squeezed between the teeth.

### *How to ensure high grain quality?*

1. Use pure seed – contains only one variety as explained in STEP 2.
2. Prepare your field well so that the crop matures uniformly. Good field leveling is essential for homogenous crop ripening (STEP 4).
3. Harvest when 80-85% of the grains are straw colored.
4. Minimize the time that cut panicles remain lying in the field; field drying causes low grain quality. Make sure that the panicles do not touch the ground and stay dry.
5. Threshing should be done as soon as possible after cutting
6. Dry the grains as quickly as possible after threshing. If sun drying is used: a) turn or stir the grains at least once every hour to achieve uniform drying, b) keep the thickness of the grain layer at 3-5 cm, c) on hot days cover the grain during mid-day to prevent over-heating, d) cover the grain immediately if it starts raining.
7. Clean the dried paddy thoroughly by winnowing.
8. Store the rice in a cool, dry, and clean area, preferably in a sealed container.

## How to ensure high grain quality?

1. Use pure seed – contains only one variety and no weed seeds as explained in STEP 2.
2. Good field leveling is essential for homogenous crop ripening (STEP 4);
3. Harvest when 80-85% of the grains are straw colored.



4. Minimize the time that the harvested plants remain in the field and avoid field drying. Make sure that the panicles stay dry.

5 to 8. Thresh and dry quickly after harvest. Sun drying is best on a mat or plastic sheet, keep the thickness of the grain layer at 3-5 cm. Clean thoroughly by winnowing. Store the rice in a cool, dry, and clean area, preferably in a sealed container.

If a sealed container or air-tight plastic bag is used for storage, make sure the paddy is dried well, otherwise the paddy might spoil.

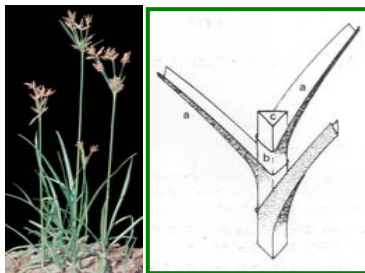


# Annex 1

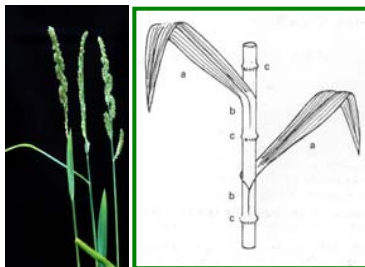
## Characteristics of weed types for optional herbicide use.

Dominant weed types have to be identified to select the correct herbicide for the weed treatment.

**Sedges:** narrow leaves and triangular stems.



**Grasses:** narrow leaves and round stems.



**Broadleaves**



## Selected herbicides for transplanted rice and their use.

Follow STEPS 1 to 5 to minimize weed infestation. If you want to control weeds with herbicides, use them at the recommended time, at the recommended rate, and use the correct herbicide for the dominant weeds in your field (see opposite page). ALWAYS READ and FOLLOW the instructions on the product label.

Active ingredient (in %) *	Weed type	Amount (g ai / ha)	Time of application	Remarks / spray volume (amount of water to be mixed with the chemical)
Pretilachlor (30)	sedges, grasses, broadleaves	300	0-3 days after transplanting	Apply to shallow water layer and retain water for 2-3 days. Spray volume is 150-200 liter per hectare.
Butachlor (80)	sedges, grasses, broadleaves	750	2-5 days after transplanting	Apply on saturated soil. Spray volume is 150-200 liter per hectare.
Butachlor + propanil (35)	sedges, grasses, broadleaves	600	6-10 days after transplanting	Apply on saturated soil. Spray volume is 150-200 liter per hectare.
2,4-D (40)	sedges, broadleaves	320	15-21 days after transplanting	Weeds need to be above the water. Re-flood within 2-3 days after application.
Metsulfuron methyl (20)	sedges, broadleaves	4	20-25 days after transplanting	Apply on saturated soil. Spray volume is 150-200 liter per hectare

\* The active ingredient (a.i.) is the chemical killing the weeds and the name is written on the label of the container, the product may have a different name. The list above is not complete but covers some common herbicides useful in transplanted rice.

### Further instructions:

1. Spray herbicides when there is a little wind, avoid spraying in strong winds;
2. Spray products from a height of about 50 cm above the soil or plants;
3. Spray with the wind in your back so that the herbicide is not blown in your face;
4. **Herbicides are poisonous: if they are not used properly they can damage your health, the crop, and the environment. Label them clearly and keep them out of children's reach.**

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# Annex 2

## Calculations for fertilizer use

The profitability of fertilizer use depends also on the ratio between fertilizer and paddy price at the farm. Do not use inorganic fertilizer if you need more than 2.5 kg paddy to pay for 1 kg fertilizer.

## Calculations to compare prices of fertilizers

For rice, usually two types of fertilizers are used: urea which contains only N, and mixed fertilizers containing N, P and sometimes K. Different mixed fertilizers are available and you may need to calculate which one is the cheapest (this is an example, real prices might be different):

### Fertilizer 1

Price	120 000 Kip	How much P is in this sack of fertilizer?
Sack weight	50 kg	50 kg multiplied by 46 P divided by 100 =
Fertilizer type	DAP 18-46-0	23 kg P
		How much costs 1 kg P of this fertilizer?
		120 000 Kip divided by 23 kg P = 5217 Kip for 1 kg P

### Fertilizer 2

Price	40 000 Kip	How much P is in this sack of fertilizer?
Sack weight	20 kg	20 kg multiplied by 20 P divided by 100 =
Fertilizer type	MAP 16-20-0	4 kg P
		How much costs 1 kg P of this fertilizer?
		40 000 Kip divided by 4 kg P = 10000 Kip for 1 kg P

The P in fertilizer 2 is almost twice as expensive as the P in fertilizer 1. You can use these calculations for any two fertilizers you want to compare.

The general rule is that the lower the nutrient content of a fertilizer, the more fertilizer you have to apply for the same nutrient amount. Therefore, compare fertilizer prices based on their nutrient concentration.

Note: All NPK rates are actually given in  $N-P_2O_5-K_2O$  but for simplicity we used N, P, and K in the text;



## Common inorganic fertilizers and their composition

100 kg Urea (46-0-0) contain 46 kg N;

100 kg DAP (18-46-0) contain 18 kg N and 46 kg P;

100 kg MOP (0-0-60) contain 60 kg K.

100 kg Mixed fertilizer 1: (15-15-15) contains 15 kg N, 15 kg P and 15 kg K;

100 kg Mixed fertilizer 2: (16-20-0) contains 16 kg N, and 20 kg P;

100 kg Mixed fertilizer 3: (16-8-8) contains 16 kg N, 8 kg P and 8 kg K;

Note: All NPK rates are actually given in  $N-P_2O_5-K_2O$  but for simplicity we used N, P, and K in the text;

## Common nutrient problems in Lao lowlands and their symptoms in the rice crop:

1. **Nitrogen (N) deficiency:** Widespread; most rice soils have limited amounts of N.

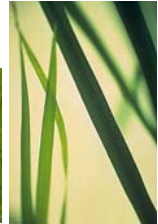
Plant symptoms: stunted, yellowish plants, especially older leaves or the whole plant is yellowish. To test if N deficiency is the cause of poor crop growth, apply urea to a small part of the field.



No N applied



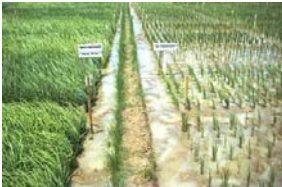
With N applied



No N With N

2. **Phosphorus (P) deficiency:** Second most common deficiency after N, most rice soils contain limited amounts of P. Extreme P deficiency does occur in some areas, for example in parts of the Xieng Khouang Province.

Plant symptoms: stunted, dark green plants with erect leaves and few tillers, and delayed plant growth.



With P applied

No P applied



No P

With P

3. **Potassium (K) deficiency:** K deficiency is not common but occurs on some, very sandy soils. K deficiency is favored by constant removal of rice straw without return of organic fertilizers. Also, constant use of N and P fertilizer only can cause K deficiency.

Plant symptoms: dirty dark green plants with yellowish brown leaf tips. Upper leaves are often short and droopy.



Yellowish brown leaf tips



and droopy leaves.

4. **Iron toxicity:** not common, occurs on lower fields with long flooding periods and on mid terraces where iron-rich groundwater surfaces. Can be stronger if large amounts of organic materials are applied.

Plant symptoms: Small brown spots on lower leaves starting from the tip, or whole leaves colored orange-yellow to brown. Frequently, black coating on root surfaces present.



## Annex 4

### Nutrient removals at harvest and nutrient content of organic fertilizers

Organic and inorganic fertilizers are used to increase yields. But they are also needed to return nutrients removed with grain and straw, and thereby they maintain soil fertility.

Average amount of nutrients (N, P, K) removed from a rice field for each ton of rice paddy harvested (kg nutrients removed per hectare):

	N	P	K
Only the rice grains are removed	10.5	4.6	3.0
Rice grains and straw are removed	17.5	6.9	20.5

Average amount of nutrients (N, P, K) added for each ton of organic fertilizer applied per hectare (kg nutrients added per hectare):

	N	P	K
Fresh cattle manure (60% water)	5.0	3.4	6.0
Pig manure (80% water)	8.5	5.7	7.2
Poultry manure (55% water)	15.0	14.9	9.0
Rice straw	7.0	2.3	17.5

Footnote: NPK rates are actually given in  $N-P_2O_5-K_2O$  on this page but for simplicity we used N, P, and K in the text



## Direct seeding: an alternative to transplanted rice

**What is direct seeding?** In direct seeding (DS), the rice seeds are sown directly in the soil, either as dry grains (dry DS) or pre-germinated grains (wet DS). The seed can be broadcasted or drilled in lines.

**Advantages of direct seeding:** For DS, no nursery seedbed is needed and DS requires much less labor for crop establishment than transplanting.

**Disadvantages of direct seeding:** More seed is needed for DS than for transplanting; animals, drought or water logging can reduce seed germination; and weeds can be a serious problem.

**Dry direct seeding:** In rainfed systems, dry seed may be manually broadcast onto the soil surface and then incorporated by shallow plowing or by harrowing while the soil is still dry. Care must be taken not to incorporate the seed too deep (only 1-3 cm deep), especially on clay soils or where surface “sealing” is a problem. Alternatively, dry seed can be sown in a row with a seed drill. Seeding rates vary between 80 and 200 kg per ha. Some gap filling (transplanting) is normally undertaken within the field after establishment.



**Wet direct seeding:** In irrigated areas, pre-germinated seed is broadcasted or sown in lines with a drum seeder. Seeding rates are 60 -120 kg per hectare. Pre-germinate the seed by soaking in water for 24 hours and incubating for another 24 hours (the little roots should not be too long because they break easily). Seedlings should be broadcasted on recently drained, puddled and leveled fields. If the field is too wet, allow it to dry for 12 to 24 hours before seeding. Avoid flooding the emerging seedlings and keep the field drained for the first few days. If possible, a shallow water layer is re-introduced 7 to 10 days after seeding.



## **Important accompanying management issues:**

The 7 STEPs of good crop management are equally important in direct seeded rice (except STEP 3 on seedbed management).

Good soil preparation and leveling (STEP 4) are essential for direct seeding, otherwise the establishment will be irregular and weeds will cause big yield losses.

Weed management (STEP 5): extra care of weed management is needed for direct seeding. Do not use direct seeding in fields with severe weed problems in the previous season. Otherwise, herbicides can be necessary to reduce weeds. In rainfed rice, post-emergence herbicides are often preferred by farmers. With good soil preparation and leveling, one herbicide application and one manual weeding during the season should be sufficient.

Fertilizer application (STEP 6): basal fertilizer application is usually avoided in direct seeding. The mixed NPK fertilizer can be topdressed at 10-20 days after seeding and after weeding. Only in the case of dry direct seeding, basal fertilizer application with a seed drill is a good option.

In rainfed lowlands: avoid direct seeding in very wet/lower fields where the danger of seeds being washed away or submergence after heavy rainfall is high. Avoid direct seeding on very dry/upper fields where lots of weeds grow.

## **Selected herbicides for wet seeded DS rice and their use.**

Active ingredient (in %) *	Weed type	Amount (g ai / ha)	Time of application	Remarks and spray volume (amount of water to be mixed with the chemical)
Pretilachlor (with safener for DS) (30)	sedges, grasses, broadleaves	300	0-3 days after seeding	Drain and apply to saturated soil. Spray volume is 150-200 liter per hectare.
Butachlor (80)	sedges, grasses, broadleaves	750	6-8 days after seeding	Apply on saturated soil. Spray volume is 150-200 liter per hectare.
2,4 D (40)	sedges, broadleaves	320	15-21 days after seeding	Weeds need to be above water. Re-flood within 2-3 days after application.
metsulfuron methyl (20)	sedges, broadleaves	4	20-25 days after seeding	Apply on saturated soil. Spray volume is 150-200 liter per hectare.

\* The active ingredient (ai) is the chemical killing the weeds and the name is written on the label of the container, the product may have a different name. The list above is not complete but covers some common herbicides useful in direct seeded rice.

## Why Alternate Wetting and Drying (AWD)?

AWD is a water saving technology that can be used to reduce the water needs for rice cultivation. Thus it can help to reduce pumping costs or to increase the cropping area with the same amount of water.

### *What is safe AWD?*

In AWD, flooded field conditions alternate with non-flooded field conditions. Safe AWD is a technique to save water and have the same yield as with full irrigation.

### *Three rules for safe AWD:*

1. For 10 days after transplanting (or 20 days after direct seeding) the field should be flooded to ensure good crop establishment and to suppress weeds.
2. Keep the field flooded from 1 week before to 1 week after flowering to avoid any damage to the rice flowers.
3. For the rest of the season and until 2 weeks before harvest, the water level should never be below 15 cm of the soil surface.

In these periods, the field is flooded with a water layer of 5 cm depth during irrigation. And the next irrigation is only done when the ground water level in the field falls below 15 cm of the soil surface.

To see how deep the water level is below the soil surface, you need to install a pipe in the soil (15 cm deep) which allows you to see the water under ground. **If you can not see the water anymore in the pipe, it is time for the next irrigation.**





## General recommendations on insecticide use

- Insecticides are poisonous for humans and the environment. Therefore, they should be used as little as possible.
- Insecticides should not be used within the first 4 weeks after transplanting or direct seeding. They also should not be used just before harvest.
- Insecticides can help to control insects that reduce rice yields. But insecticides also kill helpful insects and spiders, which might cause even bigger insect problems later in the season.
- If insecticides are used, they must be used according to the instructions on the label. Otherwise, they might not have any effect.
- If you cannot read the label (foreign language), do not use the product.
- Insecticides should be kept out of the reach of children, the living room, the kitchen and eating places. They must be kept in a container with a large warning picture signifying “Poisonous” on the outside.



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