

**SROV PHAL for rainfed  
lowland rice in Cambodia:  
Kampong Cham and  
Siem Reap province**



**Step by Step**  
to higher rice yields

**Recommendations for rice farmers  
and extension officers**

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# 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 (170-200 days) are preferable in lower flood-prone fields, early varieties (about 120 days) are better suited for upper, drought-prone fields.
- Traditional varieties: usually tall, have few tillers, 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, respond to inorganic fertilizer, and can give high yields. They are preferable in most fields.

### *Example of suitable varieties*

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

- Early varieties: SenPidoa, Chulsa, RumPe, IRKesar, IR66, NeangLeav. Good for upper fields, best seeding date is mid July.
- Medium varieties: PhkaRumdoul, PhkaDong, PhkaRomdeng, PhkaRomeat, BanlaPhdoa. Good for medium fields, best seeding date is mid June.
- Late varieties: CAR3, CAR11, RiangChey. Good for lower fields, best seeding date is early June.

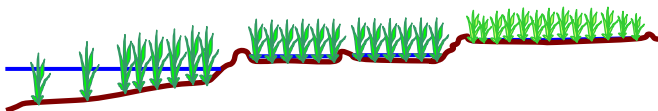
## Variety types, their characteristics and best use:



**Traditional varieties/landraces:** usually tall, have few tillers, 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, respond to inorganic fertilizer, and can give high yields. They are preferable in most fields.



Lower fields	Medium fields	Upper fields
Long duration, late varieties 170-200 days	Medium duration varieties 150-170 days	Short duration, early varieties 120-140 days
Example: CAR3, CAR9, CAR11, CAR12, TongTralach, Riangchey	Example: PhkaRumdoul, PhkaDong, PhkaRomdeng, PhkaRomeat, BanlaPhdoa	Example: SenPidoa, Chulsa, RumPe, IRKesar, IR66, NeangLeav
Best seeding: end of May to early June	Best seeding: beginning to mid June	Best seeding: beginning to 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 to 6), put extra effort in weeding;
4. Remove all rice plants that clearly look different at around flowering (differing in 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 quickly after harvest. Clean thoroughly (repeated winnowing).
7. Use a separate container for the seed, label it with the name of the variety and the year it was harvested, 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. Clean the seed thoroughly by repeated 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.

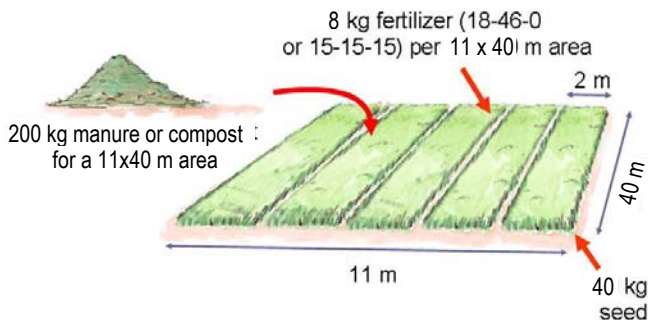
### *How to manage the seedbed well?*

- **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 kg seed. For 40 kg seed, the seedbed size is 10x40 meter plus a walking row every 2 meter. If late transplanting (40-50 days) is 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 (18-46-0 or 15-15-15) at around 10 days after sowing. Do not apply Urea (46-0-0) to the seedbed.
- **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 tiller much. Closer transplanting (more seedlings per area) can partly compensate for this. **Avoid transplanting seedlings older than 50 days.**



## How to prepare and manage the seedbed well:

1. Choose a spot with good soil and water availability, save 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 (40-50 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. Do not apply Urea (46-0-0) to the seedbed.
7. Soak the seed for 24 hours, incubate for 24 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.
9. Avoid transplanting seedlings older than 50 days.

## 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 and harrow twice to incorporate crop residues and weeds, and to make the soil soft.
3. Repair bunds to reduce water losses and to destroy rat burrows.
4. Level the field well to ensure even crop growth, reduced weed growth, and a uniform water layer.

### *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), if possible plow 2 times.

Harrowing: Harrow the field at least twice, best with 10-14 days in between. Harrowing breaks the clods, incorporates organic residues, and allows weeds to germinate and be killed by the succeeding harrowing.

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

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 the water layer.

# 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 uniform across the field, and only a few days before land preparation.



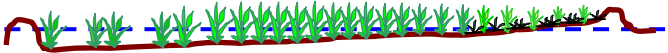
2. and 3. Harrow at least twice after plowing: this helps to incorporate crop residues and weeds, and makes the soil soft.

Plowing + first harrowing + second harrowing  
10-14 days later

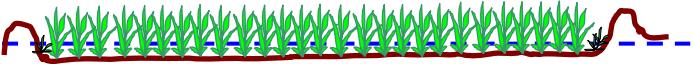


4. Repair the bunds and destroy rat burrows.

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



**Unleveled 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 leveled 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 the 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).

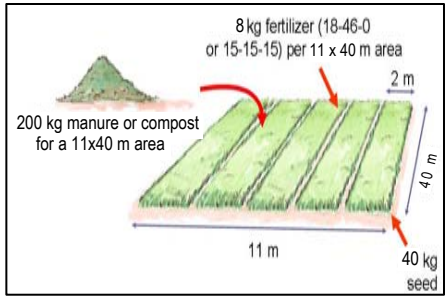
### *How to minimize weed infestation?*

- Prefer varieties of medium height and which grow fast.
- Use clean rice seed - free of weed seeds.
- Plowing and harrowing should be timed (10-14 days between 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 2-3 weeks after transplanting, the second 5-6 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 the 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.**

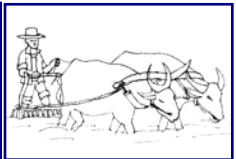
# How to reduce weeds.

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

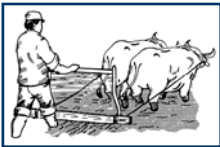


2. Harrow at least twice after plowing with 10-14 days between passes so that weeds germinate in between operations and are killed by the succeeding operation.

Plowing + first harrowing + second harrowing  
10-14 days later



3. 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 green), phosphorus (P, increases the tiller number), and potassium (K, makes the plant healthy and strong).

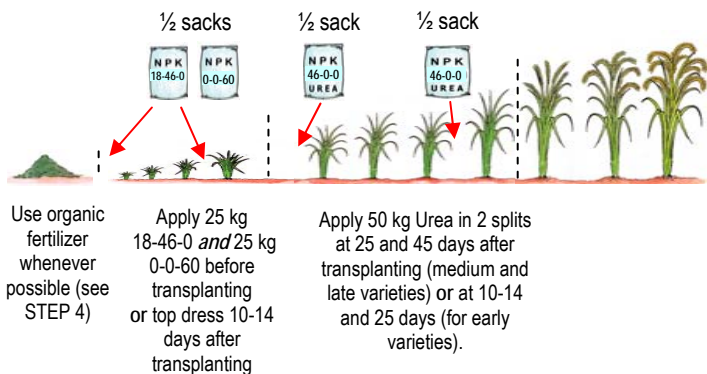
### *How to manage fertilizer properly?*

- Use organic fertilizer (manure, compost, straw, husk, tree leaves) whenever possible (see STEP 4), preferably on upper, sandy soils.
- Use maximum inorganic fertilizer rates according to soil type (see Annex 2). If the soil type is unknown, use for 1 hectare 50 kg Urea (46-0-0) and 25 kg DAP (18-46-0) and 25 kg Muriate of Potash (0-0-60). Twice this rate can be used if the drought/flooding risk is low. Apply no inorganic fertilizer if the drought/flooding risk is high.
- Apply all P and K (and little N) evenly 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 10-14 and 25 days for early varieties. Do not apply Urea near or after booting anymore.
- Topdress chemical fertilizer only in standing water and when rice leaves are dry. Topdress evenly across the whole field.
- Use inorganic fertilizer preferably for improved varieties (STEP 1), do not apply high rates for traditional varieties.
- Do not use inorganic fertilizer if you need more than 2.5 kg paddy to pay for 1 kg fertilizer.

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

## How to use organic and inorganic fertilizers:

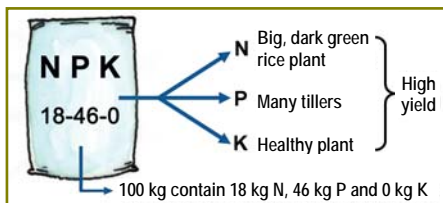
1. Use organic fertilizer (manure, compost, straw, husk, tree leaves) whenever possible (see STEP 4), preferably on upper, sandy soils.
2. Use inorganic fertilizer to further increase yields (rates are in kg per hectare).



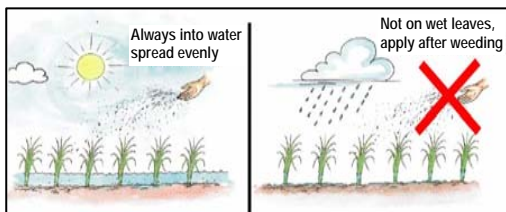
The inorganic fertilizer rate above is a general recommendation for the region. Twice this rate can be used if the drought/flooding risk is low. Apply little/no inorganic fertilizer if the drought/flooding risk is high.

For soil-specific fertilizer rates see Annex 2.

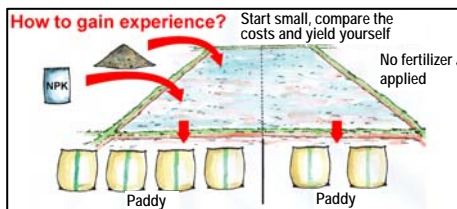
## General knowledge on inorganic fertilizer



1. The most important nutrients for rice are nitrogen (N), phosphorus (P), and potassium (K).
2. The nutrient content of inorganic fertilizer is written on the bags, for example "NPK 18-46-0" means that 100 kg (2 bags) contain 18 kg N, 46 kg P, and 0 kg K.



3. Topdress inorganic fertilizer only in standing water and when rice leaves are dry.
4. Do not apply Urea near or after booting, it is too late and will not increase yields.
5. Do not use inorganic fertilizer on fields with a high risk (drought, flooding), or on tall traditional varieties.
6. Do not use inorganic fertilizer if you need more than 2.5 kg paddy to pay for 1 kg fertilizer.



7. To gain experience with inorganic fertilizers, use inorganic fertilizer on half of your field. Compare the yield in this part with the other half of the field where no inorganic fertilizer was used.



## 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), DAP (18-46-0 NPK) and Muriate of Potash (0-0-60 NPK), and the recommended fertilizer rate for a Prateah Lang soil is 50-23-30 kg NPK/ha.

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

Recommended P rate (23 kg P ha) multiplied by the area (0.5 ha) divided by the P in the mixed fertilizer (46) multiplied by 100 = 25 kg DAP

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

Recommended rate (30 kg K ha) multiplied by the area (0.5 ha) divided by the K in the Muriate of Potash (60) multiplied by 100 = 25 kg Muriate of Potash

3. Finally, calculate the quantity of Urea that you need:

The mixed fertilizer already contains some N: 25 kg DAP multiplied by the N in the mixed fertilizer (18) divided by 100 = 4.5 kg N

Recommended rate (50 kg N ha) multiplied by the area (0.5 ha) minus the N in the mixed fertilizer (4.5) divided by the N in urea (46) multiplied by 100 = 44.6 kg Urea

If the application of K is not recommended for your soil, you can skip step 2 above.

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;

## STEP 7

# 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 the cut panicles remain lying in the field; field drying causes rapid deterioration of 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 per 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 rice by repeated 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 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.



Much too early

Too early

Correct time

Too late

4. Minimize the time the harvest remains 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 the dried rice by winnowing. Store the rice in a cool, dry, and clean area, preferably in a sealed container.

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

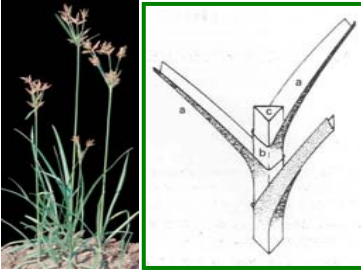


# Annex 1

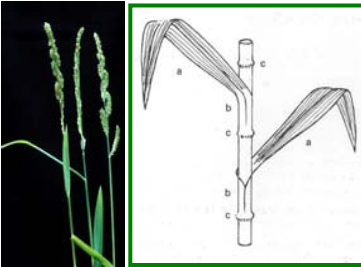
## Characteristics of weed types for optional herbicide use.

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.

Chemical name *	Weed type	Amount of chemical used	Time of application	Remarks and spray volume (amount of water to be mixed with the chemical)
pretilachlor	sedges, grasses, broadleaves	1.0-1.5 Liter per hectare (L/ha)	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	sedges, grasses, broadleaves	1.0 L/ha	2-5 days after transplanting	Apply on saturated soil. Spray volume is 150-200 liter per hectare.
butachlor + propanil	sedges, grasses, broadleaves	1.5 - 2.0 L/ha	6-10 days after transplanting	Apply on saturated soil. Spray volume is 150-200 liter per hectare.
2,4 D	sedges, broadleaves	0.75-1.0 L/ha	15-21 days after transplanting	Weeds need to be above water. Re-flood within 2-3 days after application.
metsulfuron methyl	sedges, broadleaves	20 g/ha	20-25 days after transplanting	Apply on saturated soil. Spray volume is 150-200 liter per hectare

\* The chemical name is the name of the active ingredient usually mentioned on the product label, the product may have a different name. The list above is not complete and covers only 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 perpendicular to the wind, so that the herbicide is not blown in your face;
3. Spray products from a height of around 50 cm above the rice plants;
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.**

## Annex 2

### Soil specific fertilizer recommendations for improved rice varieties (modified from CARDI).

Recommended rates are upper limits. Fertilizer rates are given in 50 kg bags and in N-P-K per hectare. Further advice on inorganic fertilizer in STEP 6.

Soil name	Soil description and occurrence	Recommendation per hectare *
Prey Khmer	Very sandy soil with a bright color. Occurs on old terraces + lowlands.	1 bag urea, 1/2 bag DAP, 1/2 bag MOP (28-12-15 kg NPK/ha)
Prateah Lang	Sandy topsoil with a bright color over loamy subsoil. Occurs on old terraces + lowlands.	1+3/4 bag urea, 1 bag DAP, 1 bag MOP (50-23-30 kg NPK/ha)
Bakan and Orung	Loamy topsoil over a sandy subsoil. Occurs on old terraces + lowlands.	2 bags urea, 1 bag DAP ** (55-23-0) kg NPK/ha)
Toul Samrong	Light gray to brown, clayey topsoil with big cracks when dry. Occurs on old terraces + lowlands.	3 bags urea, 1+1/2 bag DAP (83-35-0 kg NPK/ha)
Kompong Siem	Dark gray to black, clayey topsoil with big cracks when dry. Often big basalt boulders lay around.	2+1/2 bags urea (58-0-0 kg NPK/ha)
Koktrap	Dark brown to black, clayey topsoil over light colored loamy subsoil. Occurs on old terraces.	2+1/2 bags urea, 1+1/2 bag DAP ** (71-35-0 kg NPK/ha)
Kbal Po	Dark brown to black, clayey topsoil with big cracks when dry, over clayey subsoil. Occurs on active floodplains.	3+1/2 bags urea (81-0-0 kg NPK/ha)
Krakor	Light gray to brown, loamy topsoil over loamy subsoil. Occurs on active floodplains.	4+1/2 bags urea, 1 bag DAP (118-23-0 kg NPK/ha)

\* Urea contains 46% N; DAP contains 18% N and 46% P; MOP contains 60% K.

\*\* On Bakan, Orung, and Koktrap soils, K response is variable and often limited. If all rice straw is regularly removed, apply 1/2 to 1 bag MOP per hectare with N and P.

Note: NPK rates are actually given in N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O on these pages but for simplicity we used N, P, and K in the text;

## 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 want to calculate which one is the cheapest (example, real prices might be different):

### Fertilizer 1

Price	60 000 Riel	How much P is in the sack of fertilizer?
Sack weight	50 kg	50 kg multiplied by 46 P divided by 100 = 23 kg P
Fertilizer type	DAP 18-46-0	
		How much costs 1 kg P of this fertilizer?
		60 000 Riel divided by 23 kg P = 2609 Riel for 1 kg P

### Fertilizer 2

Price	20 000 Riel	How much P is in the sack of fertilizer?
Sack weight	20 kg	20 kg multiplied by 20 P divided by 100 = 4 kg P
Fertilizer type	MAP 16-20-0	
		How much costs 1 kg P of this fertilizer?
		20 000 Riel divided by 4 kg P = 5000 Riel 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.

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

# Annex 3

## Frequent nutrient problems in Cambodian lowland rice and the corresponding plant symptoms:

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

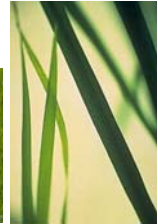
Plant symptoms: stunted, yellowish plants, especially older leaves or the whole plant is yellowish. To test if N deficiency is the cause of poor crop growth, apply urea to a small part of the field.



No N applied



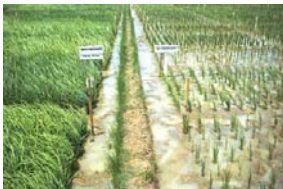
With N applied



No N With N

2. **Phosphorus (P) deficiency:** Second most common deficiency after N, most rice soils contain limited amounts of P.

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 especially on Prey Khmer and Prateah Lang soils (very sandy soils). K deficiency is favored by constant removal of rice straw without return of organic fertilizers.

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 and mainly on lower fields with long flooding periods during crop growth. 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.



## 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 to maintain the soil fertile.

Average nutrient (N, P, K) removal from the 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
The rice grains and straw are removed	17.5	6.9	20.5

Average nutrient (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). And 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 24 hours soaking and another 24 hours incubation (the little roots should not be too long or they break easily). Seedlings should be broadcast onto recently drained, puddled and leveled fields. If too wet, the field is allowed to dry for 12 to 24 hours before seeding. Avoid flooding the emerging seed 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 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. Use of herbicides is necessary to minimize the weed population (see Annex 1). 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 seeding, basal fertilizer application with a seed drill is a good option.

In rainfed lowlands, wet DS should be avoided on very wet/lower fields where the danger of seeds being washed away or submerged after heavy rainfall is high. And on very dry/upper fields, DS rice may suffer from severe weed problems.

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

Chemical name *	Weed type	Amount of chemical used	Time of application	Remarks and spray volume (amount of water to be mixed with the chemical)
Pretilachlor (with safener for DS) e.g. Sofit	sedges, grasses, broadleaves	1.0 Liter per hectare (L/ha)	0-3 days after seeding	Drain and apply to saturated soil. Spray volume is 150-200 liter per hectare.
butachlor	sedges, grasses, broadleaves	1.0 L/ha	6-8 days after seeding	Apply on saturated soil. Spray volume is 150-200 liter per hectare.
2,4 D	sedges, broadleaves	0.75-1.0 L/ha	15-21 days after seeding	Weeds need to be above water. Re-flood within 2-3 days after application.
metsulfuron methyl	sedges, broadleaves	20 g/ha	20-25 days after seeding	Apply on saturated soil. Spray volume is 150-200 liter per hectare.

\* for additional details see Annex 1;

## Why Alternate Wetting and Drying (AWD)?

AWD is a water saving technology that can be used to reduce the water needs for rice cultivation. Therefore 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.

### *The 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 field surface.

In this 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 field surface.

To see how deep the water level is below ground, 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, and should be used as little as possible.
- Insecticides should not be used within the first 4 weeks after transplanting or direct seeding. And they 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 at the same time, which might cause even bigger insect problems afterwards.
- If insecticides are used, they must be used according to the instructions on the label. Otherwise they might not have the expected 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.



