

Step up your knowledge on Rice Cultivation (Ver. 2)



Agricultural Productivity Promotion Project in West Tonle Sap
(APPP)



For the users

This manual was prepared by the Agricultural Productivity Promotion Project in west Tonle Sap (APPP), jointly implemented by the Ministry of Agriculture, forestry and Fishery (MAFF) in Cambodia and Japan International Cooperation Agency (JICA) for exclusively the use of the Cambodian farmers and relevant stakeholders to enrich their technical knowledge and capacity on rice cultivation.

Not like an ordinary technical flow manual, this manual was formed as an” subject specific manual” to inspire the farmers with a correct idea and way of farming practice based on the agronomical theories behind the each technique.

Chapter 1 is inclusive of basic knowledge offered particularly for the rice farmers and Chapter 2 covers a part of agronomical expertise for the personnel in a position to extend agricultural techniques to the farmers

We wish everybody who has received this manual can successfully develop their knowledge and technical capacity to produce more quality rice with higher yield.

Agricultural Productivity Promotion Project in West Tonle Sap(APPP)

Chapter 1

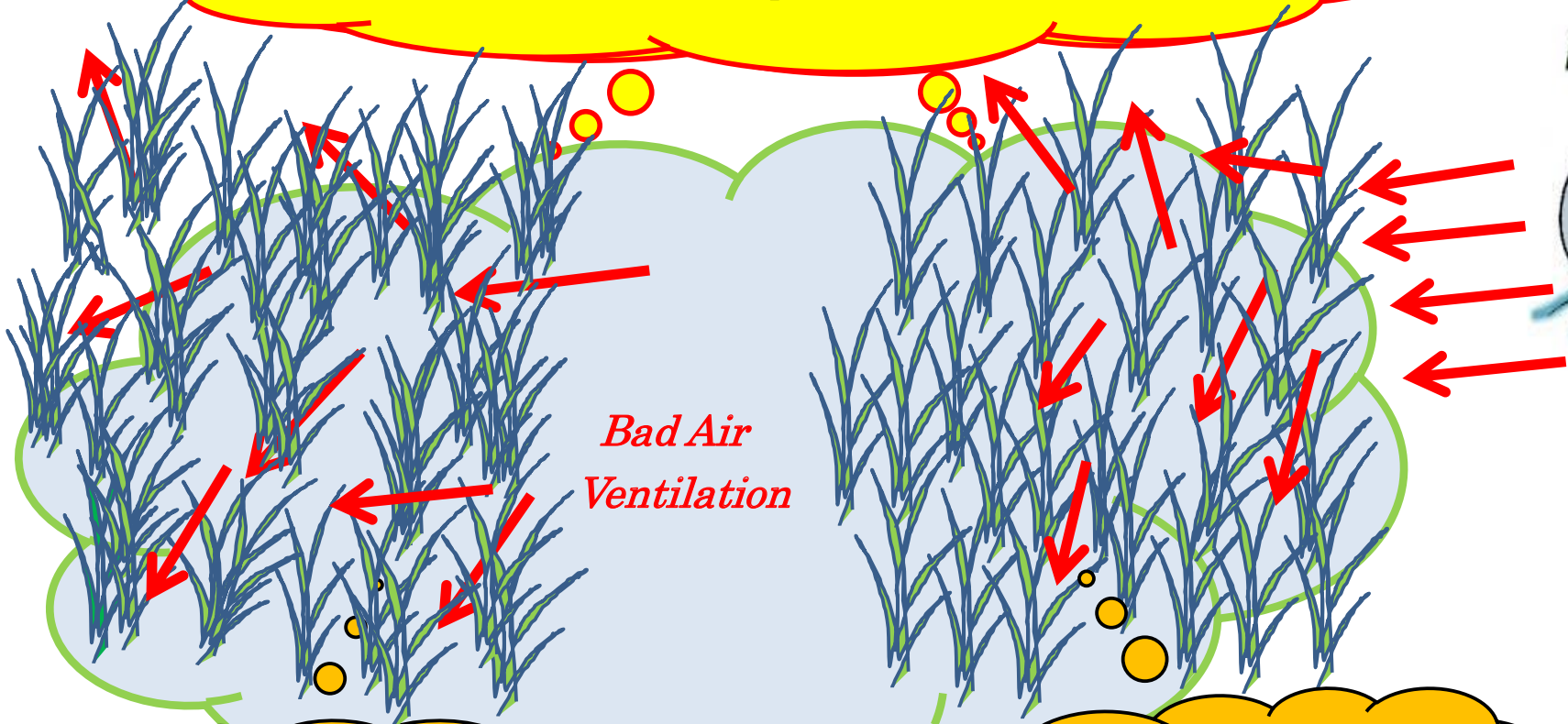
1

Basic knowledge for rice farming



-Bad Air Ventilation-

Bad air ventilation in the paddy gives disease agents (insects, bacteria) a good environment for their living & multiplication.

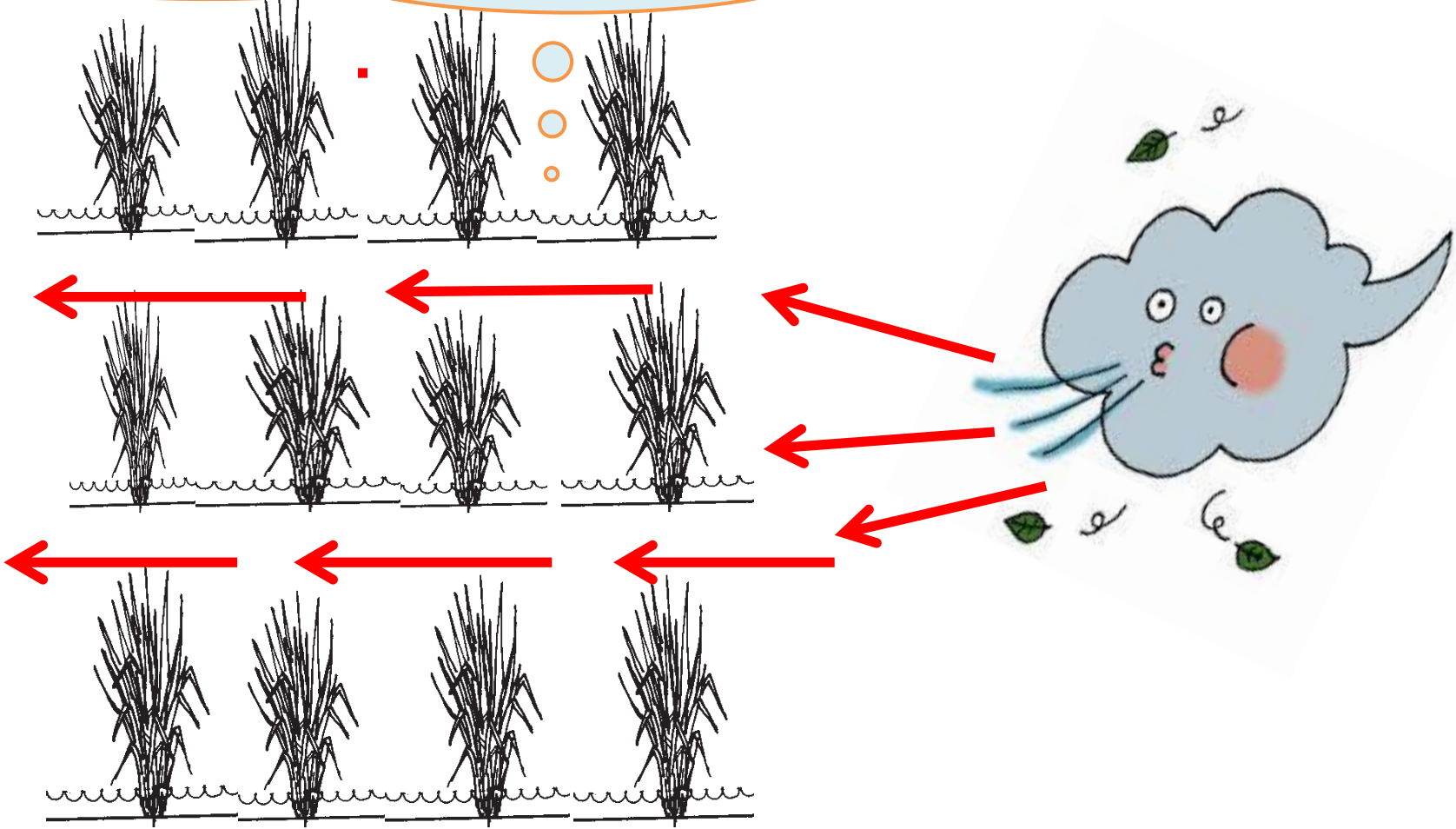


Highly jammed random planting

Highly jammed direct sowing by hand broadcasting

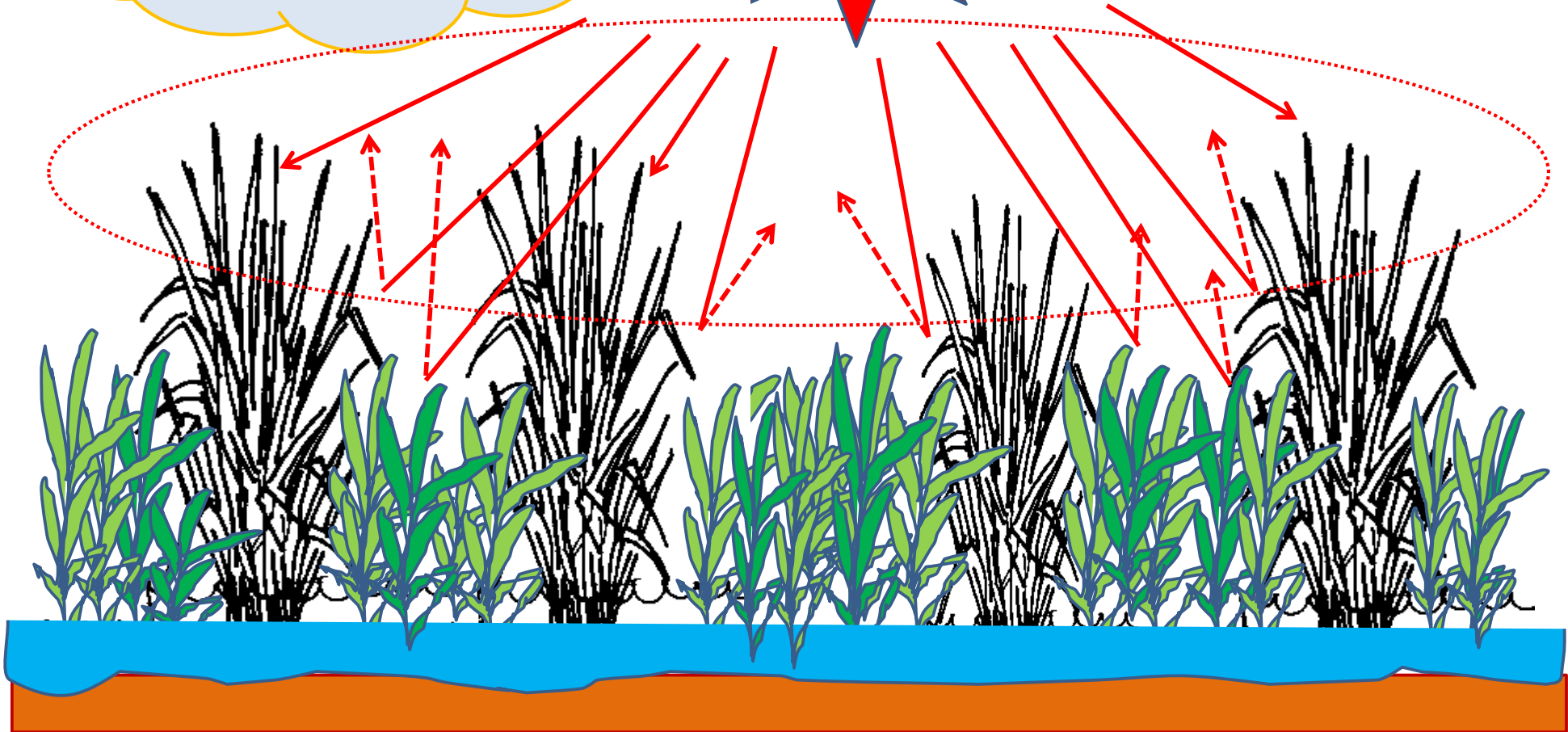
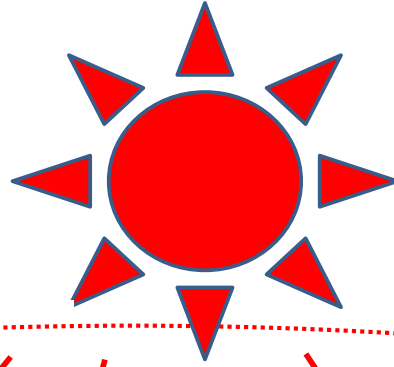
- Good Air Ventilation -

Good air ventilation in the paddy is necessary for not creating a favorable environment for disease agents.



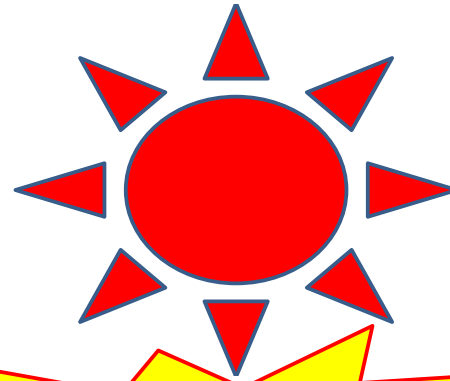
- Sun light blocked by Grasses -

A lot of grasses block sun light energy to reach lower part of paddy leaves.

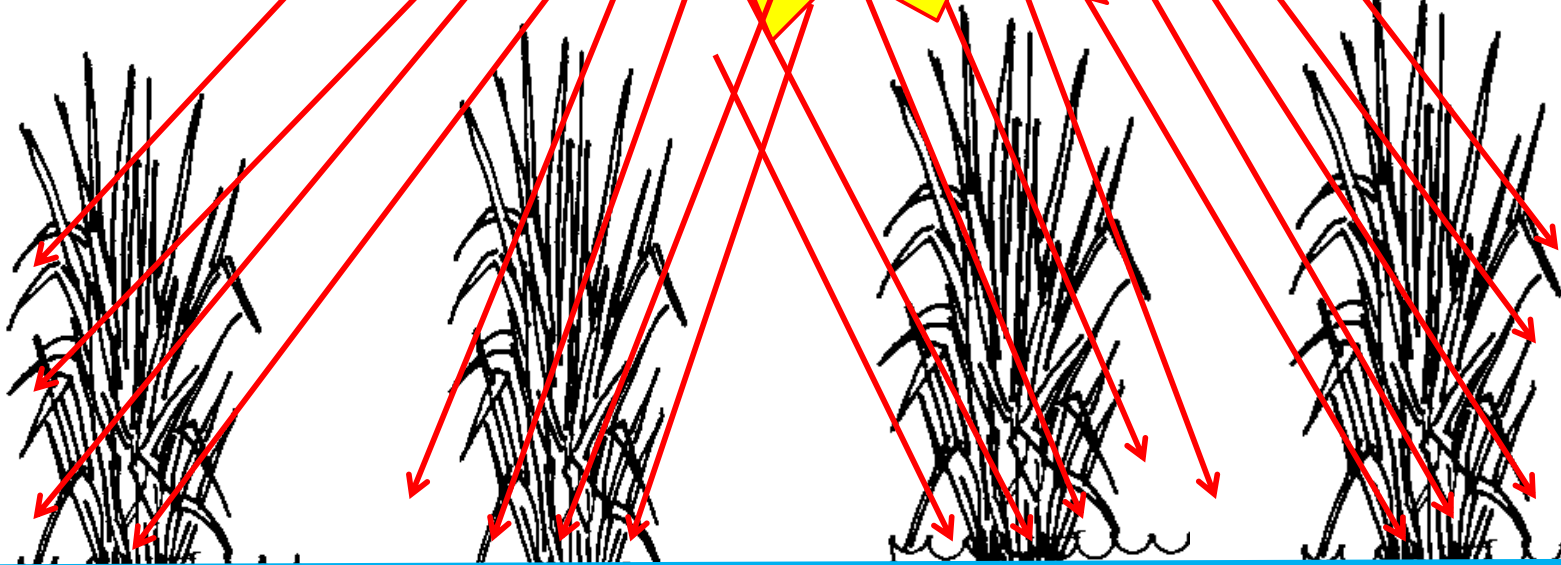


- Sun light under well weeded paddy field -

Sunlight reaching to the lower part of the plants makes paddy healthy and “more productive”.



Solar Energy



Well weeded field (no grasses)

Grasses (weeds), a home of germs, fungus and insects

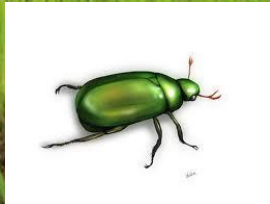
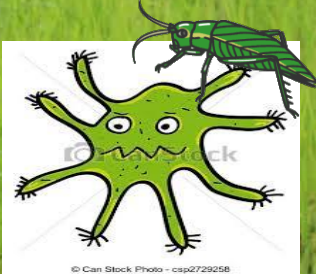
Grasses are comfortable home of germs, fungus and insects for their multiplication



“Weeding” is the primary & basic practice indispensable for the pest control

Little or no weeds can create a good condition to minimize a multiplication of insects and bacteria.

A lot of weeds give a good living environment for insects, germs, bacteria, and finally they transfer to the field and multiply themselves drastically and give more damages to the paddy.



A sample of good practice for weeding

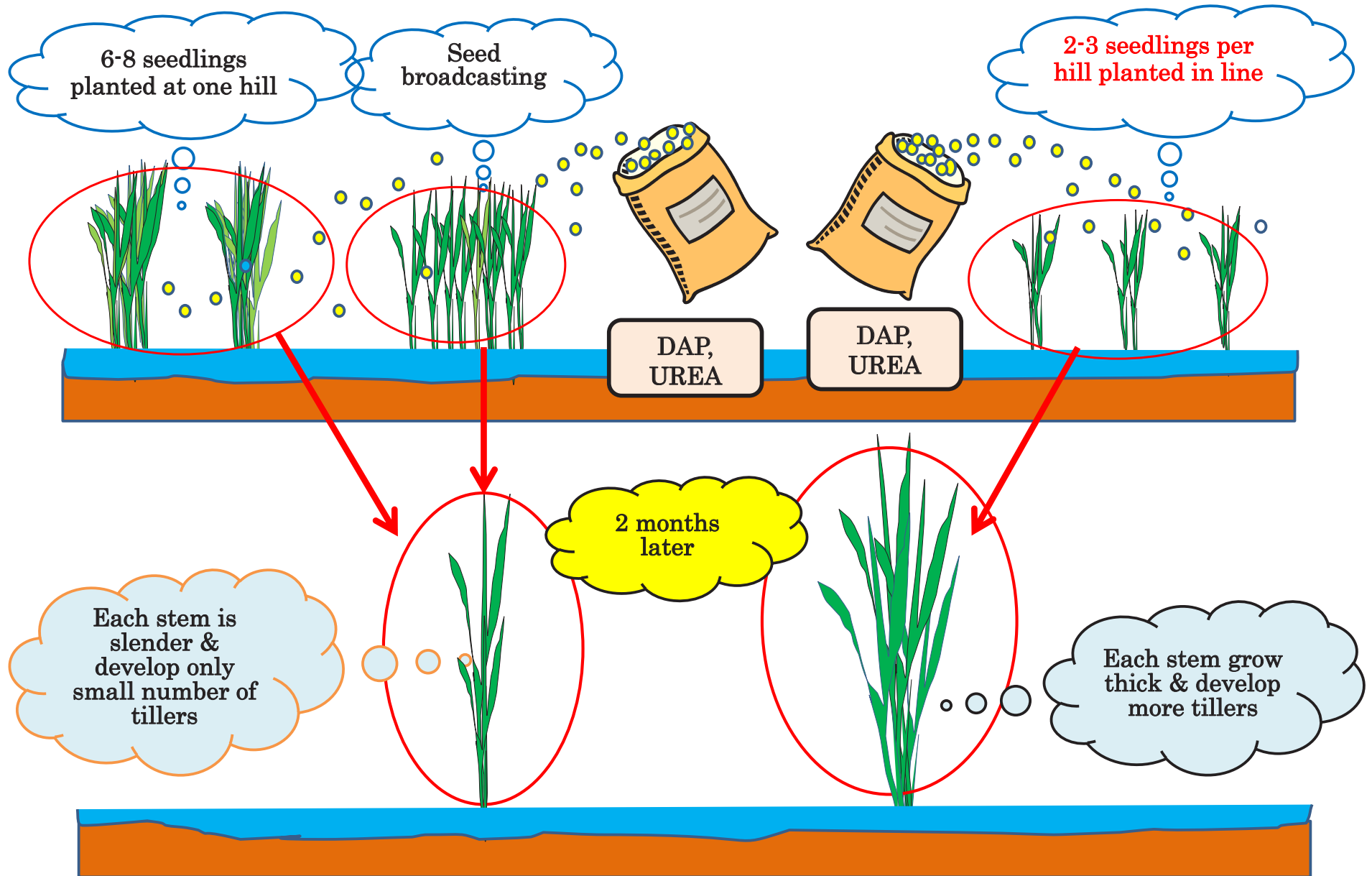
**Well weeded
ridge and paddy
field**



Let' do weeding positively
to help the healthy growth
of rice plants and minimize
a loss of soil nutrients!!



Planting density and effect of fertilizer (1)



Planting density and effect of fertilizer (supplemental explanation) (2)

Family A



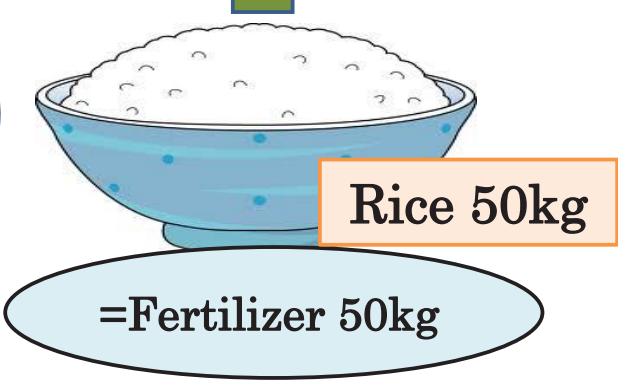
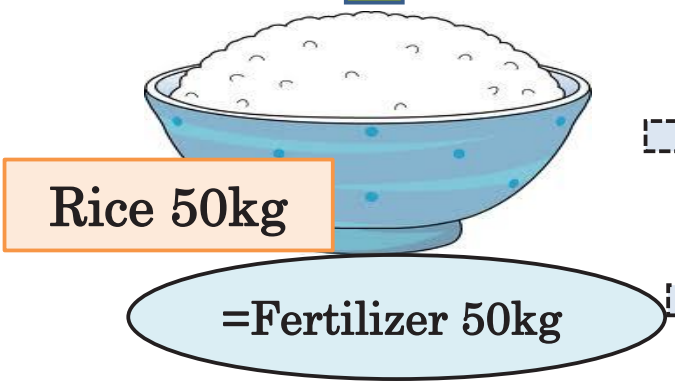
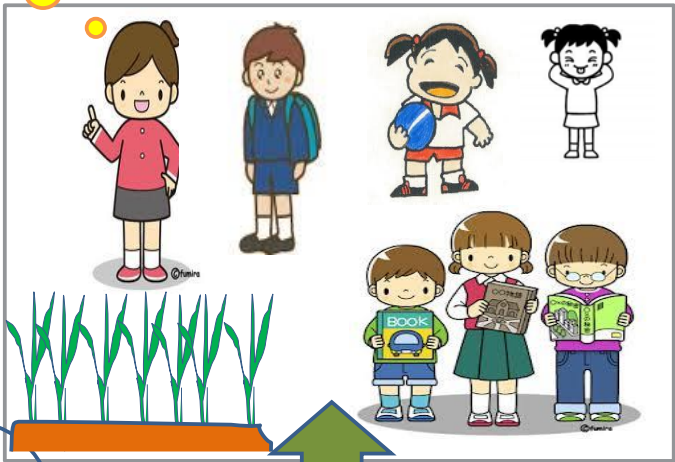
Family B



Which family member can eat more rice ?



Which Rice Seeding can get more nutrient ?



Land must be prepared as leveled as possible for securing growth uniformity

Unleveled Land preparation



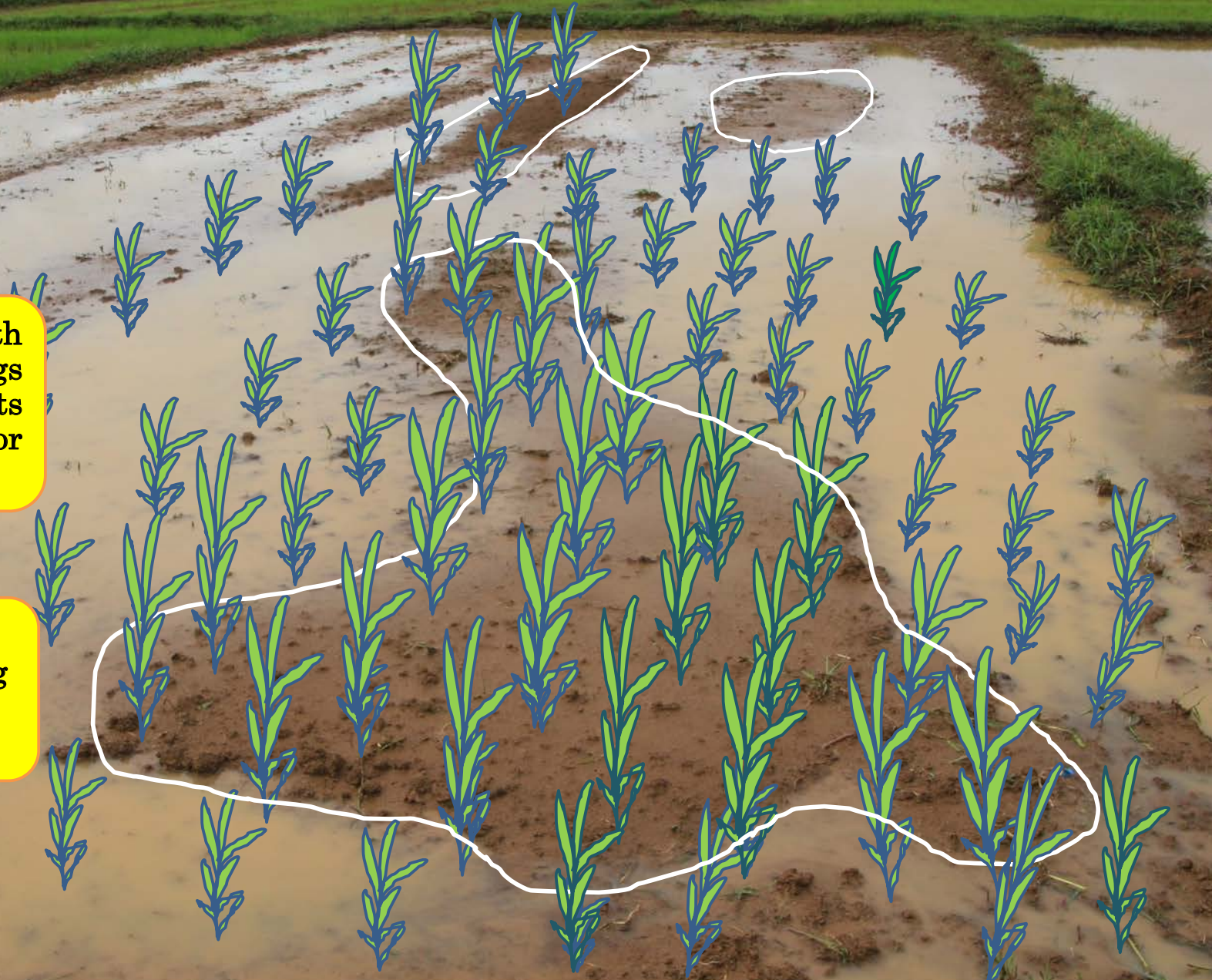
Induce different growth speed of seedlings depending on the spots where water is present or not present.



Come up with a lack of uniformity in the timing of panicle maturity at the later growth stage.



Low quality product



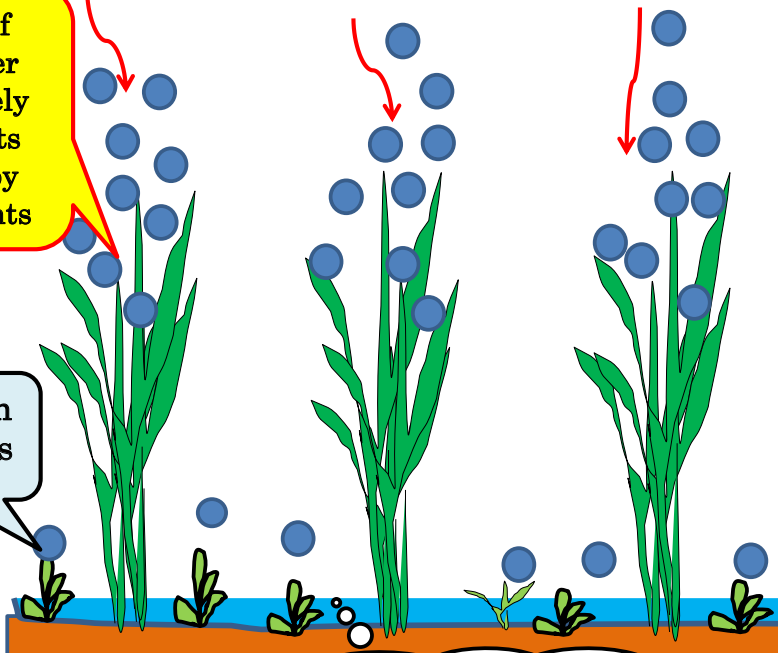
- Saving money by weeding -

Unit price 35 \$ × 3bags = 105\$
105\$ × 10% = 10.5 \$ (lost)



90 % of fertilizer effectively elements taken by rice plants

10% taken by grasses



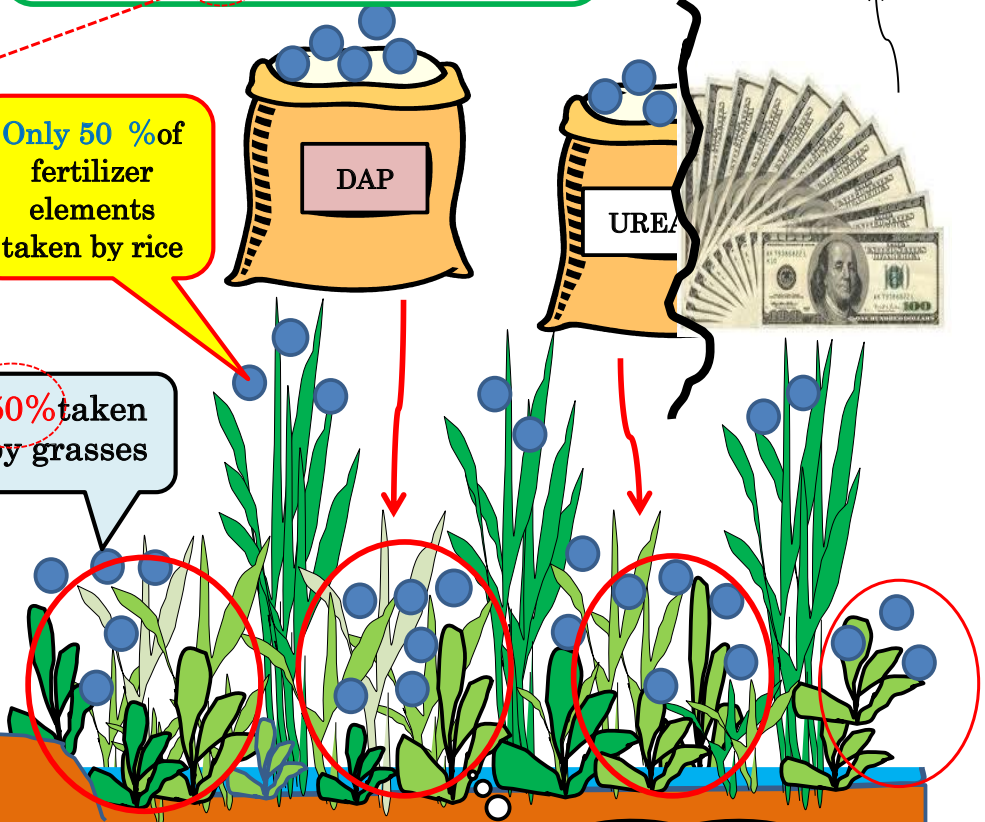
Only little grasses

Have you ever thought how much money are you losing by not weeding?

35 \$ × 3bags = 105\$
105\$ × 50% = 52.5 \$ (lost)

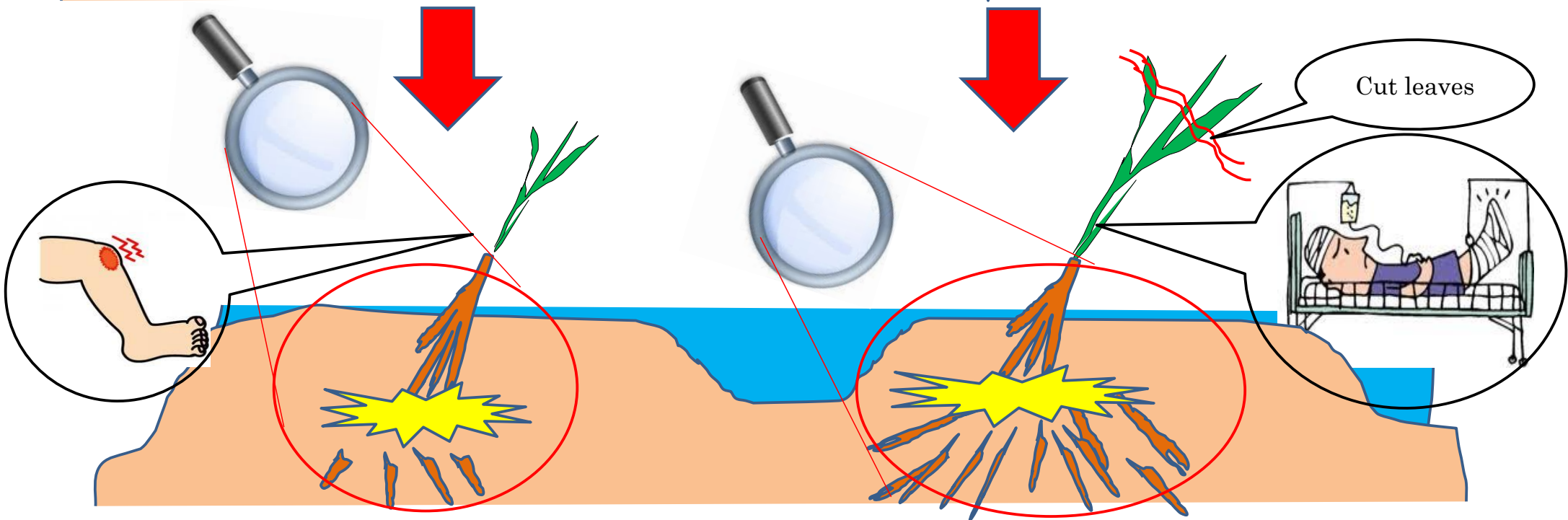
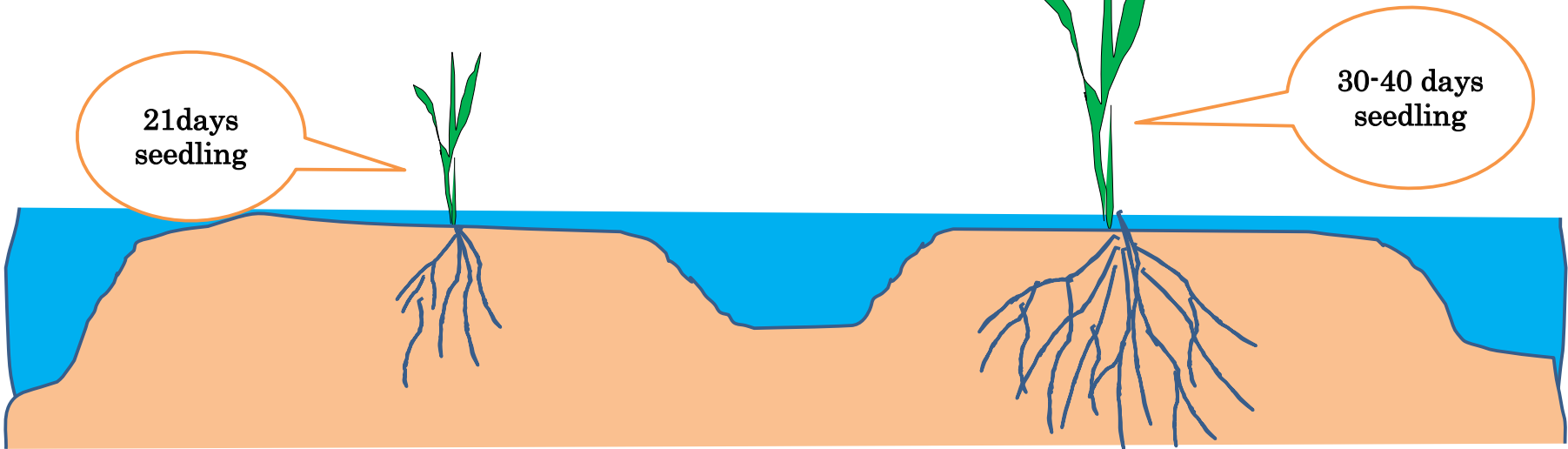
Only 50 % of fertilizer elements taken by rice

50% taken by grasses



Full of grasses

Which seedling is more damaged?



Fertilizer Application

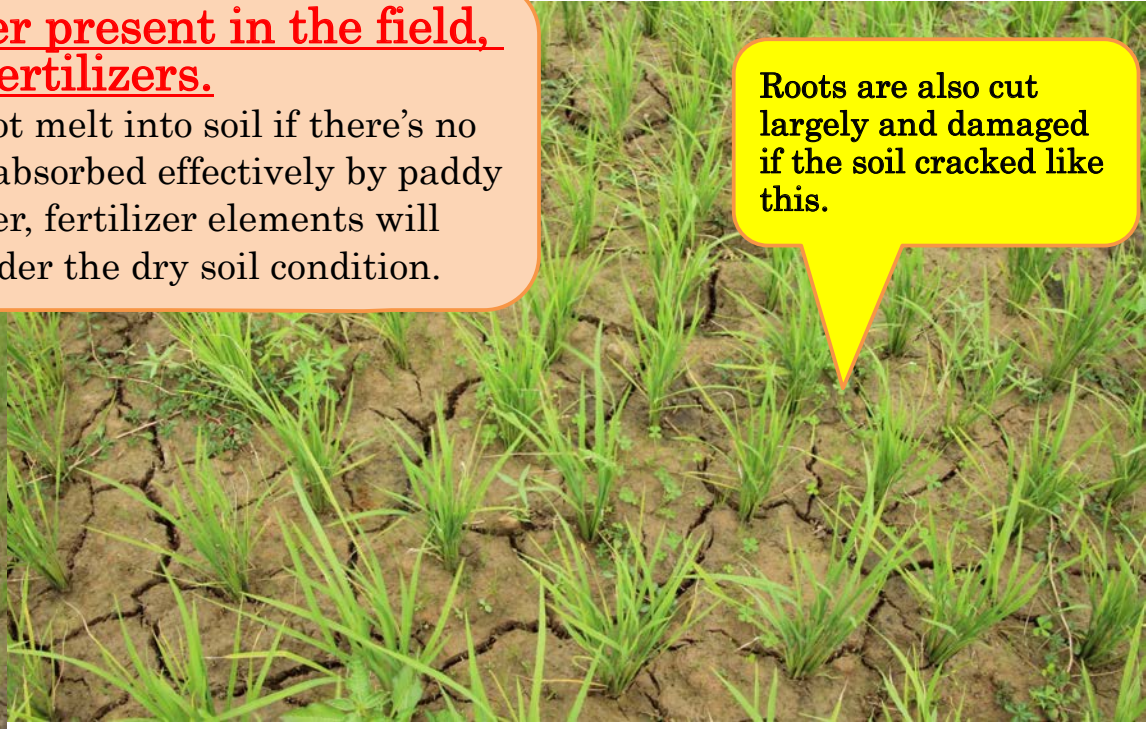


Field condition necessary for applying fertilizer

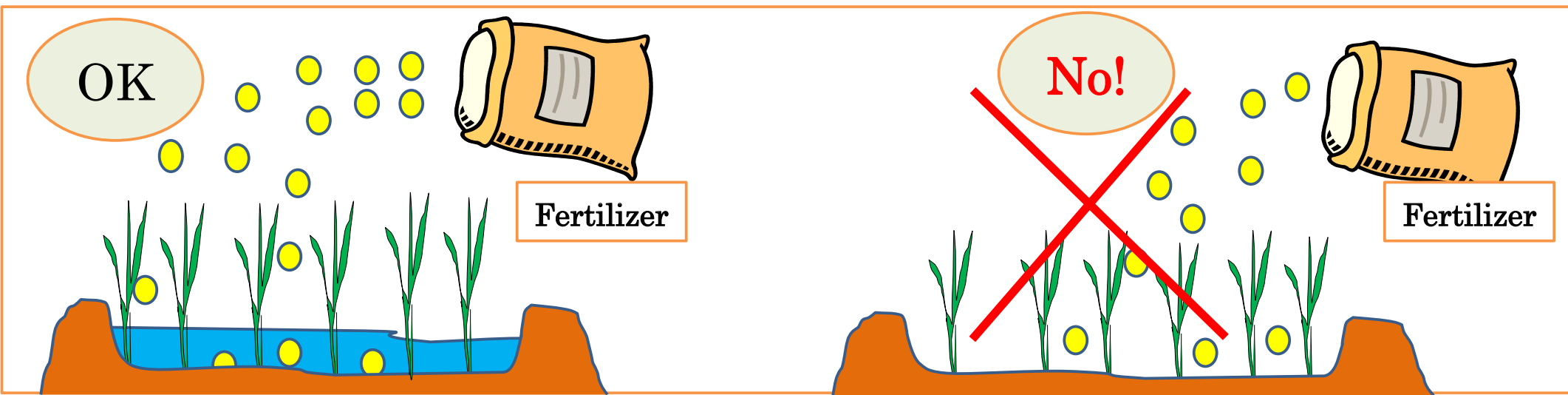


When no water present in the field, do not apply fertilizers.

*Fertilizer does not melt into soil if there's no water and not be absorbed effectively by paddy roots. And farther, fertilizer elements will escape into air under the dry soil condition.

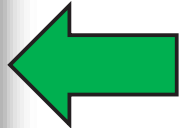
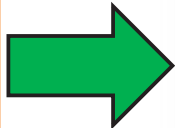


Roots are also cut largely and damaged if the soil cracked like this.



Organic Fertilizer (Compost)

- The organic farming requires an application of lots of matured(well decomposed) compost.
- Picture (right) shows a condition of well processed compost by taking a couple of months for processing.
- The amount of compost in the picture covers only for 0.5ha of paddy.



Manure and Compost must be broadcasted evenly covering entire field in order to make the soil surface layer enriched evenly .

For real organic farming, application of 5.0-10 ton/ha of matured(well decomposed) compost is required every year.

Organic Fertilizer (Cow Manure Compost)



How to process

Mix with rice straw or rice hull and sprinkle a little water up to moist condition



Cover sheet of vinyl or any material to protect from rain.



After 3 -4 weeks, mix it well and stay another 4 -5 weeks with occasional hand mixing until compost become sandy texture



(Not recommended)

Fresh cow manure in less processed

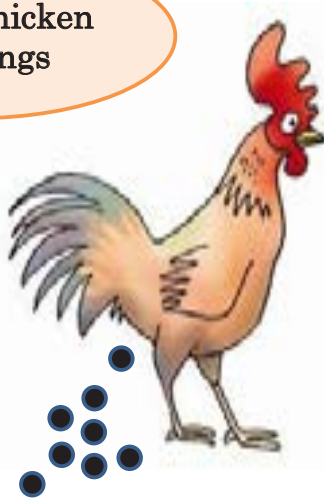
(Recommended)

Well processed into sandy texture.

When & How much of Organic Fertilizer (animal manure) should be applied?



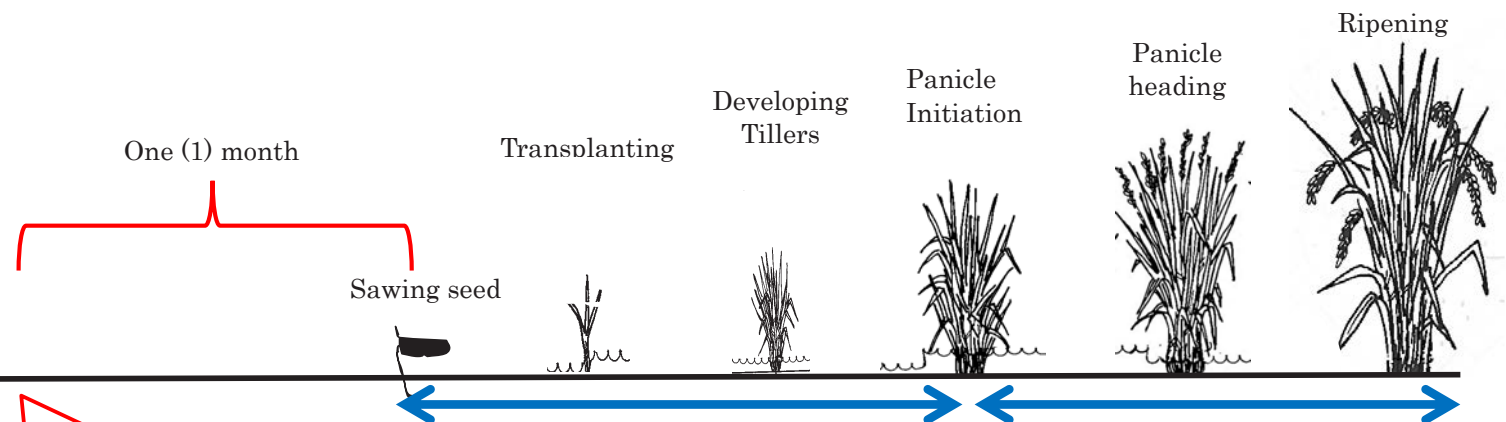
Packed chicken droppings



- Nitrogen(N) Content ranges 1%to 3% . Phosphate (P)&Potassium (K) content range 1% to 6% depending on the type of manure (Cow, Pig, Chicken). → See Page48
- In order to supply(N.) equivalent to 1bag (50kg)of DAP (N=18%), around 250kg of manure must be applied to one hectare. When supplying (N) equivalent to UREA (N=46%), 550kg of manure will be required in application to one hectare of land.



Apply and mixed in to the soil by ploughing at least one month before sowing the seed



Vegetative growing stage

- Soil nutrients are taken up to develop and build up plant body(= Increase the number of tillers)

Reproduction / multiplication stage

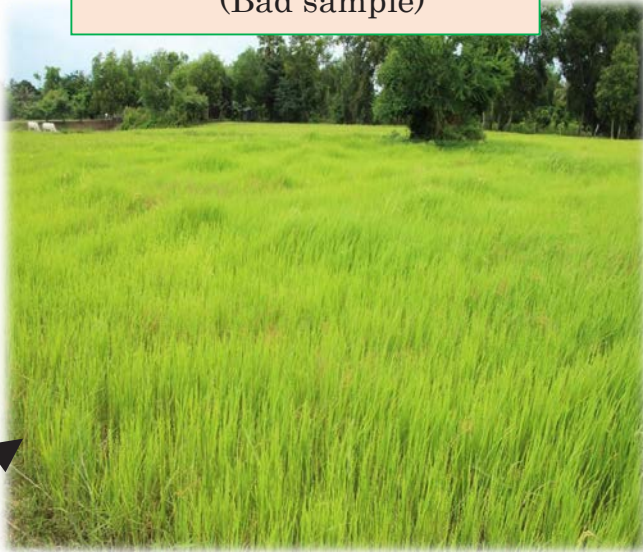
- No tillers increase in this stage
- Soil nutrients is mainly used for growing panicles and fattening grains

How to apply animal manures, rice husk charcoal

Hill of animal manure remained without being scattered



Unevenly growing paddy (Bad sample)



Evenly growing paddy (Good Sample)




Hill of rice husk charcoal roughly put on the soil



★ **Manures and charcoal should be evenly broadcasted on the soil like a picture on the right shows !**

★ Hilling up of manure remained in the rice field without scattering whole area evenly will drive unevenness of rice growth. After all it drives the unevenly matured panicles which makes the paddy quality low as a sale product.



- Pest Control -



Countermeasures for Pest & Insect control

Four (4) major actions effective for reducing rice diseases and unbeneficial insects

			
<p>Burning plant residue</p> <p>*Burning the places in & out of paddy field is one of the best practice to burn out the nest of pathogen and insect eggs.</p>	<p>Seed treatment for disinfection</p> <p>*Seed disinfection by soaking into hot water at 60°C for 10 minutes is effective for the early growth stage.</p>	<p>Weeding inside field & levee</p> <p>*One of purposes of weeding is to remove the nest of pathogen (fungi, bacterium, virus) and insect eggs for control their multiplication.</p>	<p>Splaying chemicals (Pesticide, Insecticide)</p> <p>*Splaying chemicals should be the last measure.</p>

Key word during rice growing period → **“Early Finding and Early Countermeasure”**

Do not miss the initial symptom of infection by daily close observation of paddy field!!



Identify the disease and insects by referring this manual!!



Positive Effects

In case that a paddy field was seriously infected by rice disease & insects in the previous cultivation, burning up of stubbles and dried grasses in the paddy fields and on the levees is strongly recommended in order to avoid widespread occurrence of diseases and insects in the next cultivation.

Positive Effects on burning the field:

- ① **Killing pathogen and insect eggs surviving in the stubble and grasses after harvest.** (←most important effect)
- ② Ash can supply Potassium element.



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Negative Effects

- *Losing lots of organic materials (dried rice straw as stubble).*
- *Killing the beneficial microorganism in the surface soil layer.*

In case that there was no occurrence of serious and widespread diseases and insects in the previous cultivation, the stubble does not need to be burned and should be mixed into soil by plowing soon after harvest under the moist soil condition for accelerating decomposition of straws during off season of cultivation



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Type of Agricultural Chemicals for RICE

INSECTICIDE

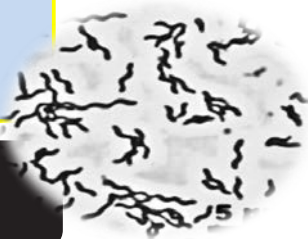
To kill Insects, Bugs and Worms



Major insects and worms	Applicable chemical
● Rice Army Worm	NATO 55EC (Liquid form)
● Brown Planthopper	NATO 55EC / ACTION 5SC (liquid form)
● Green Leafhopper (*Tungro virus transmitter)	ACTION 5SC (liquid form)
● Leaf Folder	NATO 55EC (Liquid form)
● Rice Bug	Available insecticide is not identified
● Yellow Stem Borer	ACTION 5SC (liquid form)
● Rice Thrip	Available insecticide is not identified

FUNGICIDE

To kill "Bacteria, Fungus"



Major diseases	Applicable chemical
● Rice Blast	SAWANT 400EC (liquid form)
● Leaf Blight	Available fungicide is not identified
● False Smut	Available fungicide is not identified

HERBICIDE

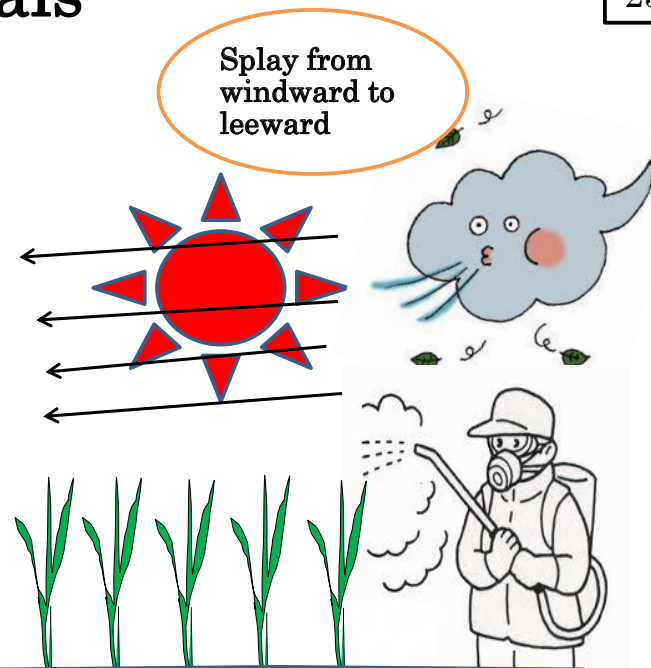
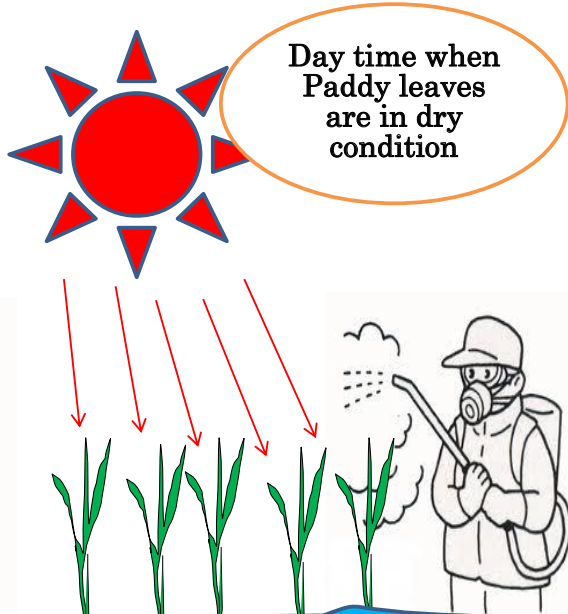
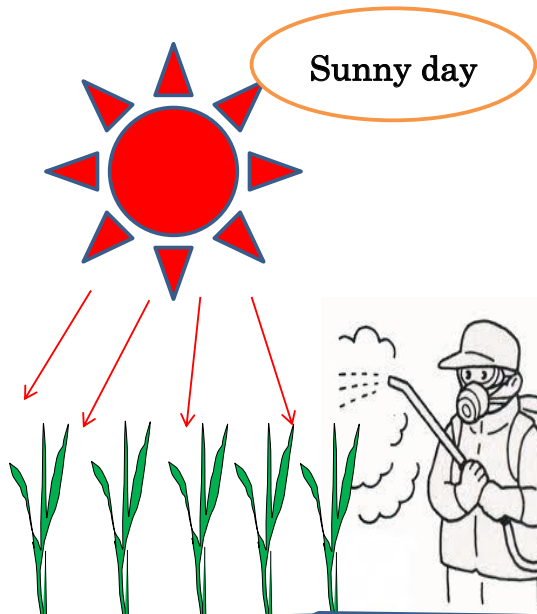
To kill weeds and plants (selective)



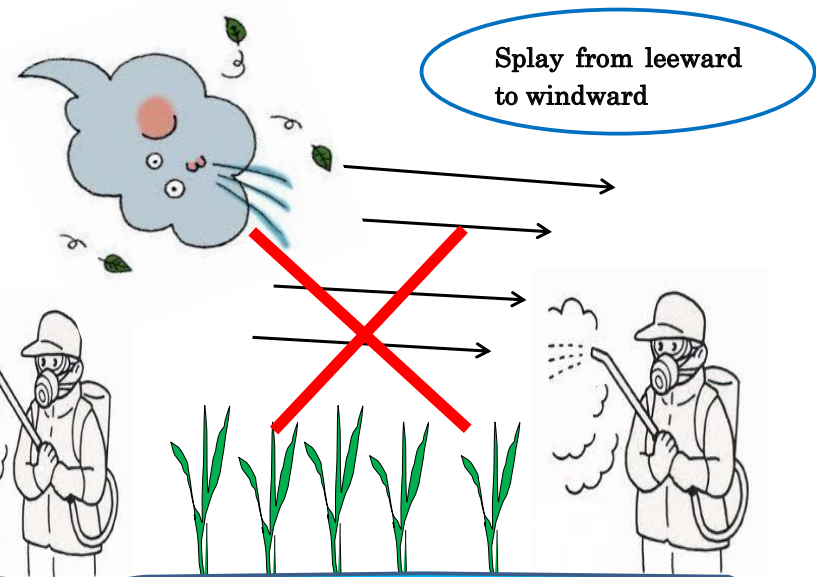
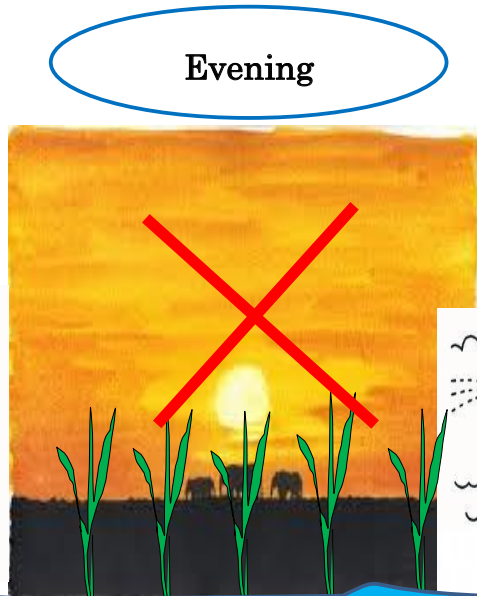
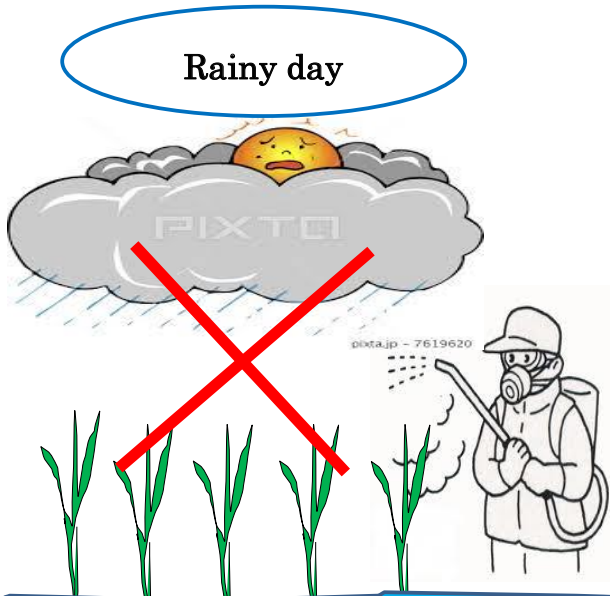
All Chemicals are **POISONOUS** to human, animals and fishes "Dangerous" !!

When & How to spray chemicals

Good

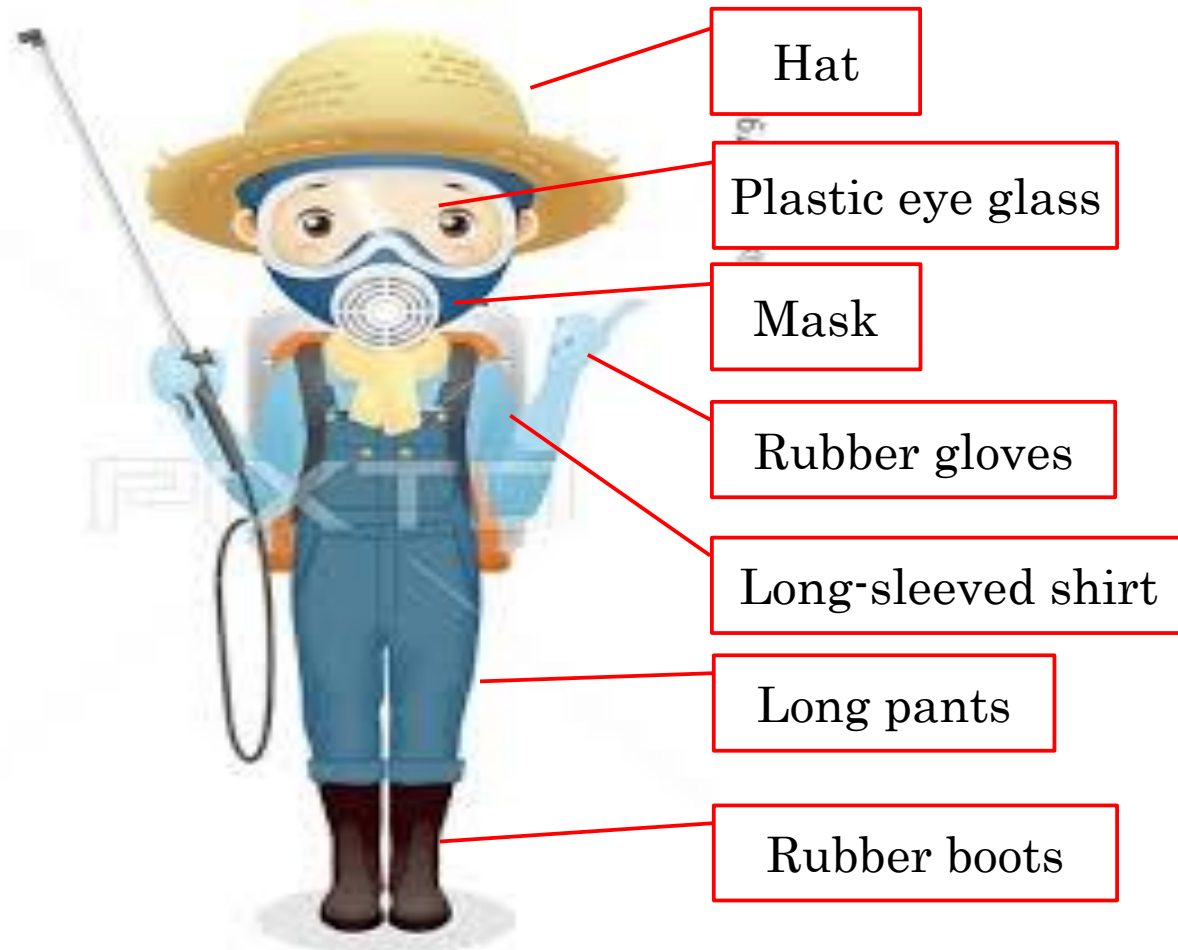


No Good



All kind of Agricultural Chemicals are “POISONOUS” to Human & Animals

You have to protect your Body from
the **POISON !!**



-CAUTIONS-

When splaying chemicals ;

- Entire body must be fully covered like a sample sketch on the left.
- After splay work, do not drink liquor or any of alcohol drink which may add more risk of inducing physical disorder of vour bodv.

How to prepare Chemical Solution (in case of "SAWANT")

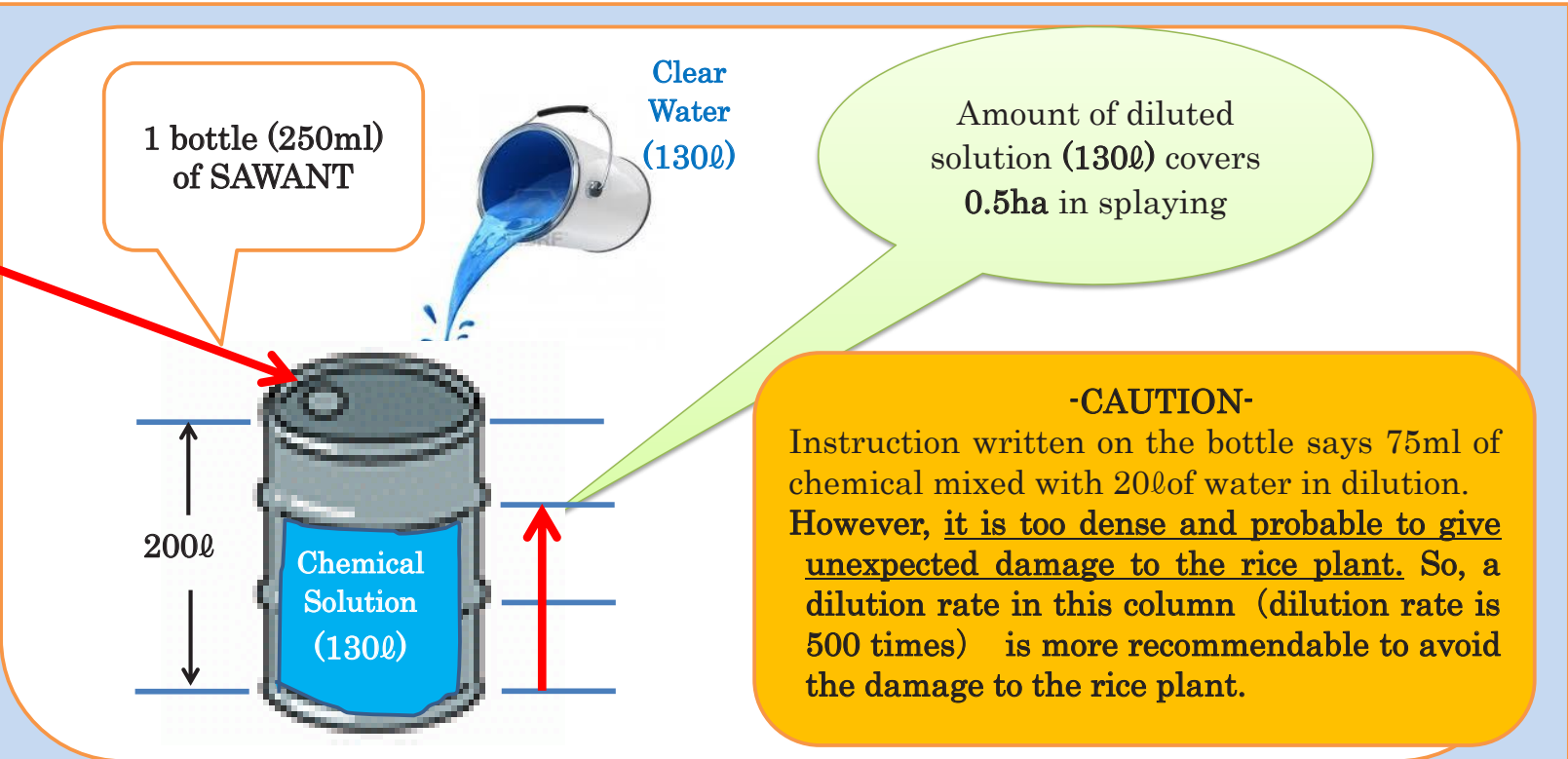


Left (250ml), Right (500ml)

Name of Chemical: **SAWANT**
Type of Chemical: Fungicide:
Targets : *Rice Blast

CAUTIONS

- It is wrong cognition to think of "Higher the density of solution , the more effective "
- Do not splay 2 weeks before harvest.



How to prepare Chemical Solution (in case of "ACTION 5SC")



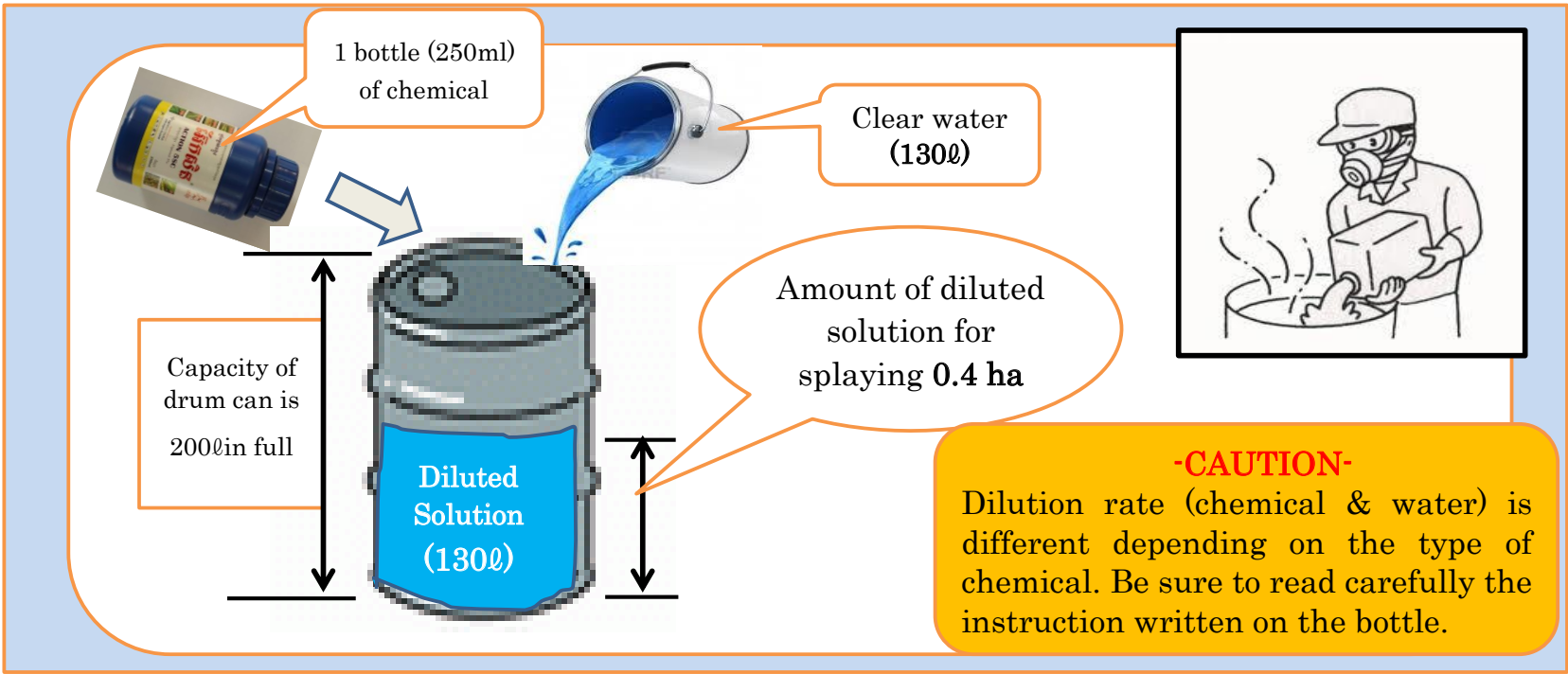
Both are the same product (250ml)



Name of Chemical: ACTION 5SC
Type of Chemical: Insecticide:
Targets : Insects and worms
 (*Yellow Stem Borer, Brawn plant hopper, Green leaf hopper, Leaf holder)

CAUTIONS

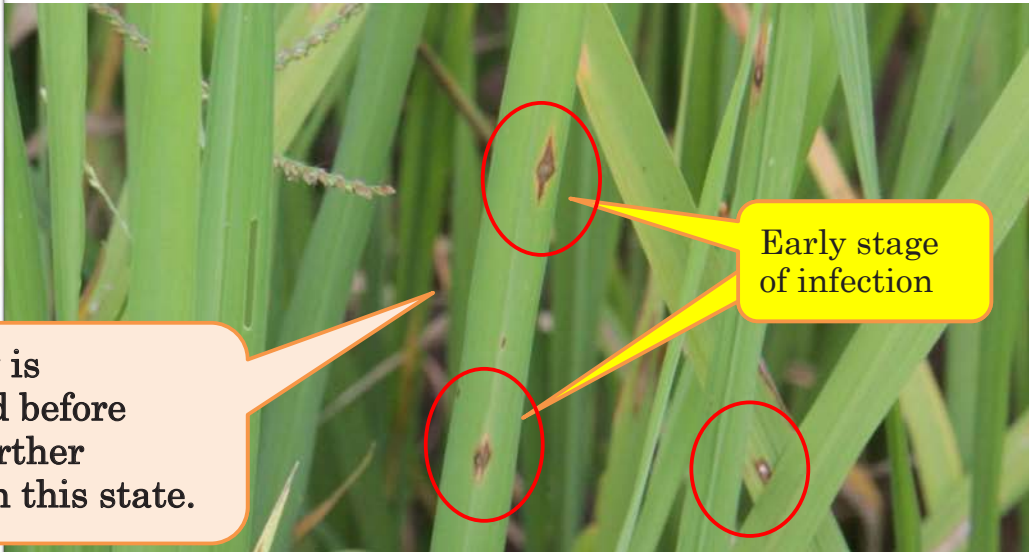
- Precise dilution rate must be kept by following the instruction written on the label of bottle
- It is wrong cognition to think of “Higher the density of solution , the more effective one “
 Be sure to follow the instruction of mixture rate with water (dilution).
- Do not splay 2 weeks before harvest.



Rice Diseases



“Rice Blast” and applicable chemical-(1)



A quick spray is recommended before expanding further infection than this state.



“Rice Blast” and applicable chemical-(2)



Neck of head turned blackish and rotten (Neck Blast)



Infection expands rapidly unless apply appropriate chemical at early stage of infection.



Infectant: Fungous

Infectible stage: Seedling stage, Tiller growth stage, Heading to maturity stage

Applicable chemical:

**SAWANT 400EC, Flash 75WP, SAKATA 500 SC
SANASA 100 SC, TANAXA 700WP, CARBENZIM 500FL,**

Application times and observation:

● At the beginning of infection ⇒ Splay **one time**

● In case seriously infected

⇒ **one time a week × 2 weeks**

**take 6-7 days between 1st splay and 2nd splay and carefully observe the symptom of leaves after splay.*

● Not splay from 2 weeks before harvest.

***Factors in favor of disease development and proliferation**

- Susceptible variety
⇒ **Phka Rumdoul**
- Use of infested or diseased seeds
- Excessive use of Nitrogen fertilizers
- Much weeds and grasses in and surrounding area of the paddy field
- Poor air flow and poor sunlight penetration to lower part of stems
- Rainy days with high air humidity

False Smut

32



Infectant: **Fungus** (=spore)

*appears only on panicle

*spore can survive on the ground and infect new plants in next cultivation

Damage: Increase sterile (empty) panicles

Type of chemical: **Fungicide**

(Available fungicide is not identified)

Countermeasure:

Pick up by hand together with whole infected panicle when find out in the field

Factors in favor of disease Development

- Excessive use of **Nitrogen fertilizer** .
- Application of **Nitrogen** (top dressing) **at a late stage of growth** (after panicle heading)
- High humidity (much rain)

Leaf Blight



Infectant: **Vacteria**

Infectible stage: Tiller growth stage,
Heading stage

Applicable chemical:

Applicable chemical is not identified

Effective preventive method:

⇒ **Weeding, particularly in the irrigation canal**

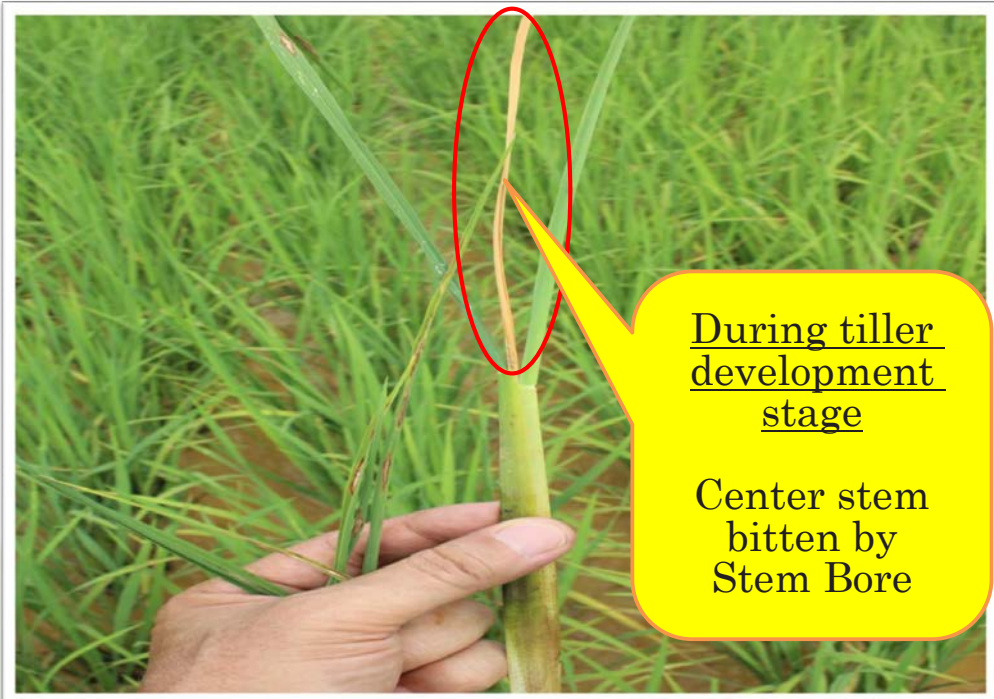
***Factors in favor of disease development and proliferation**

- **Presence of much weeds and grasses in and surrounding area of the paddy field.**
- **Excessive application of fertilizers**
- Presence of rice stubbles of infected plants
- Presence of bacteria in the rice paddy and irrigation canals
- High temperature, high humidity, rain, deep water and **flood**

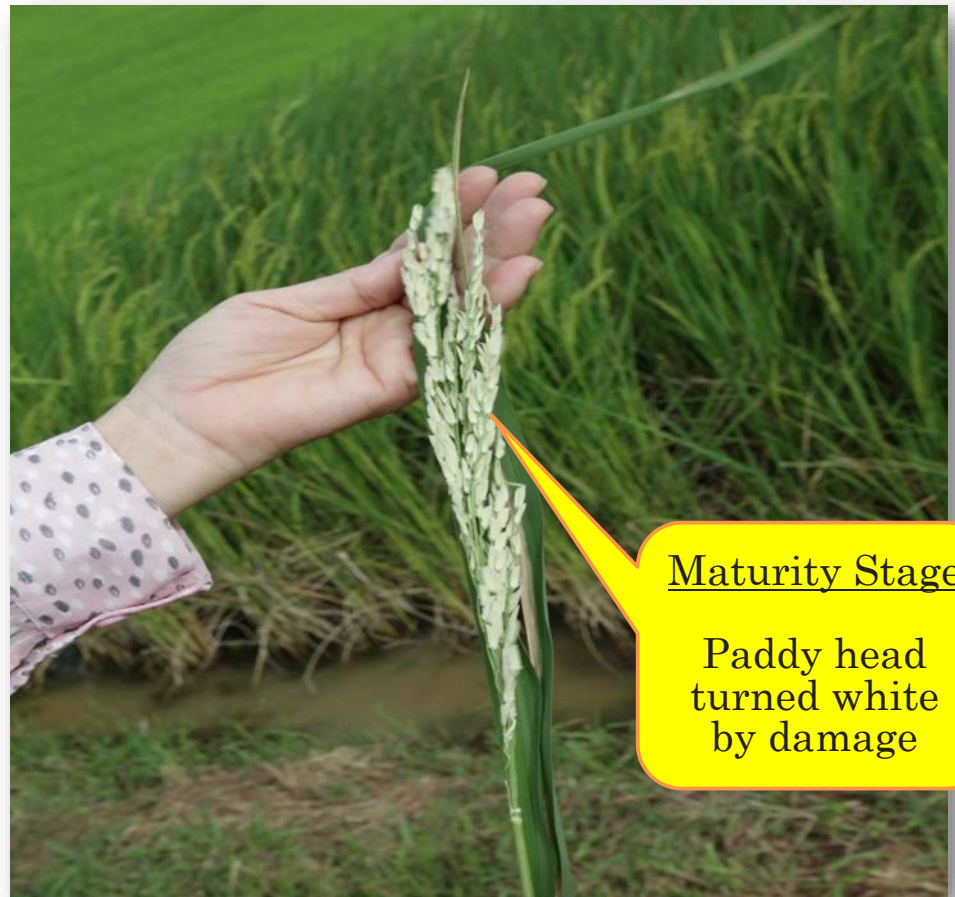
Insects & Worms



Yellow Stem Borer (1)



During tiller development stage
Center stem bitten by Stem Bore



Maturity Stage
Paddy head turned white by damage



Rice attacked by this insect wilts and becomes dead-heart or white head.
In case of severe attack, white head comes out in mass.
Female keeps 300 pieces of eggs in the ovary.

Yellow Stem Borer (2)



Applicable chemical: **ACTION 5SC** (Refer to other kinds on page 43)

Application times and observation:

- At the beginning of infection ⇒ Splay **one time a week**.
- In case infection is serious ⇒ **one time a week × 2 weeks**
**take 6-7 days between 1st splay and 2nd splay and take a close look at the symptom of leaves every day after 1st splay.*

Factors in favor of insect development

- Presence of **weeds and grasses** in and surrounding area of paddy field
- Stubbles remained in the field

Brown Plant hopper



Applicable Chemical: ①ACTION 5SC, ②NATO 55EC
How to use: Follow the instruction on page 25
Splaying: When find few hopper, splay immediately

- *Factors in favor of insect development**
- Presence of much weeds
 - Continuous submerged (**high water level**) conditions in the field
 - High shady and humidity **due to much weeds**
 - Excessive use of Nitrogen
 - Hopper will multiply after Panicle Initiation (PI) stage

Rice Thrip



- Rice thrips feed on germinous grasses, and adults and larvae on levees and fields after harvest.
- This pest attacks mainly young rice at nursery stage but sometimes attacks rice in the field after transplanting.
- After being attacked, the leaves wilt and produce empty grains.



Damage: -Feeding damage to leaves during young paddy plant
-Make black spot grains and degrade grain quality drastically.

Applicable chemical: **ACTION 5SC**, **DIAZAN 50 EC**, **DIAPHOS 10 H**

How to use chemical: Refer page 24

Factors in favor of insect development

- Dry weather
- No standing water
- Presence of gramineous weeds and grasses

Green Leaf hopper



Applicable Chemical
ACTION 5SC

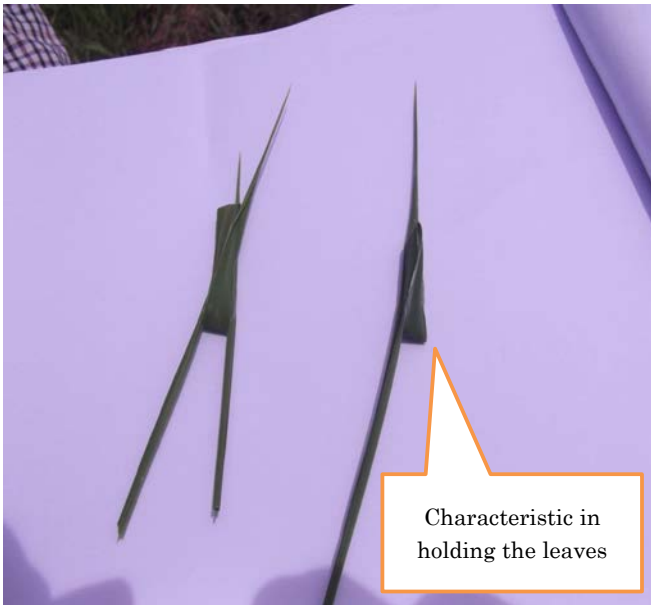
Damages:

- Feed on rice sucking the plant sap at the latter growth stage.
- Green leaf hopper will transmit **virus disease** such as Tungro, Yellow dwarf, etc
- *In case rice plant was infected by virus disease, another type of chemical (contains virus killer chemical agent) must be applied.*
(*Virus killer chemical may not be available in Cambodia)
- Uniform the cultivation time at similar timing is one of ways to avoid inducing plant hoppers.

Factors in favor of insect development

- A lot of weeds and grasses in and surrounding areas of paddy field and irrigation canal.
- Low rainfall, high temperature
- Excessive use of Nitrogen fertilizer

Leaf Folder



Applicable Chemical: NATO 55EC

*If you find folded leaves in the paddy field, recommended to tear off the leaf together with worm staying inside.

*Factors in favor of insect development

- Presence of much weeds inside paddy fields and surrounding border ridges.
- High shady and humidity due to much weeds
- Excessive use of fertilizers
- Direct sowing paddy

Rice Bugs



At early stage of maturity, the bugs suck latex in the panicles and leaves blackish spot on the grains

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Black bug suck from the stem and block the development of tillers and growth of stems.

Applicable chemical: **ACTION 5SC**




Damage:
— Both the nymphs and adults feed on endosperm of the rice grain. And it makes smaller, spotty, deformed and discolored grains. After all they make a paddy low quality.

- Factors in favor of insect development**
- Presence of weeds and grasses in and surrounding areas of paddy field
 - **Practice of random planting**
 - Overcast (cloudy) sky and frequent rainfall
 - Flowering and milky stage of the panicles

List of Pesticide

Name of Disease		Usable Chemical	
Rice Blast	 <p>ឆ្លាស់</p>	<p><u>SAWANT 400EC</u>, <u>CARBENZIM 500FL</u>, <u>SANASA 100SC</u>, <u>TANAXA 700WP</u>, <u>Flash 75WP</u></p>	<p>កាបេនស៊ីម, សាណាសា, សាវន្ត, តាណាហ្សា</p>
(Bacterial) Leaf Blight	 <p>ជំងឺរលាកស្លឹកដែលបង្កឡើងដោយបាក់តេរី</p>	<p>Not identified</p>	
Sheath Blight	 <p>ជំងឺរលាកស្រទមស្លឹក</p>	<p>SAKATA 500SC, VALIDAN 5SL</p>	<p>សាកាតា, វ៉ាលីដាន</p>
Rice Stripe(virus)		<p>There is no chemical to control virus directly. Control of Brawn Planthopper (virus transmitter) is the first step, and usable chemicals are as follows. <u>ACTION5SC</u> <u>NATO 55EC</u>, <u>SECSAIGON 25EC</u>, <u>OSIN 50WP</u></p>	

List of Insecticide

Name of Insect		Available Chemical	
(English)	(Khmer)	(English)	(Khmer)
Rice Army Worm 	ដង្កូវហ្វូង	<u>NATO 55 EC</u> , <u>VITASI 480EC</u> , <u>ACTION5SC</u>	ណាតូ, វីតាស៊ី, អុស៊ីន
Brawn Planthopper 	មមាចត្នោត	<u>VITASI 480EC</u> , <u>CYRIPHOS 585EC</u> , <u>SECSAIGON 10EC</u> , <u>ACTION5SC</u> , <u>NATO 55EC</u> , <u>SECSAIGON 25EC</u> , <u>OSIN 50WP</u> , <u>VINO 200SC</u> , <u>NAFAZA 350SC</u>	វីតាស៊ី, ស៊ីរីផូស, ដ្យាហ្វូស, យេតាន, អុស៊ីន, ហ្វីប្រូនីល, វីហ្គុន, ណាតាហ្សា
Green Leafhopper 	មមាចខៀវ	<u>VITASI 480EC</u> , <u>CYRIPHOS 585EC</u> , <u>OSIN 50WP</u> , <u>VIFONE 200SL</u> , <u>NAFAZA 350SC</u>	វីតាស៊ី, ស៊ីរីផូស, អុស៊ីន, វីហ្គុន, ណាតាហ្សា
Leaf holder 	ដង្កូវមូរស្លឹក	<u>VICARE 36EC</u> , <u>ALPHAN 5 EC</u> , <u>VITASI 480EC</u> , <u>CYRIPHOS 585EC</u> , <u>SECSAIGON 10EC</u> , <u>SECSAIGON 25EC</u> , <u>CYPENRAN 10EC</u> , <u>DIAZAN 50EC</u> , <u>VINO 200SC</u> , <u>VIGO 500EC</u> , <u>PERAN 50EC</u> , <u>KINALUX 25EC</u>	វីយែរ, អាណូហ្គាន, វីតាស៊ី, ស៊ីរីផូស, សិកសែហ្គាន, ស៊ីប៉េរ៉ង់, ឌីអាស្យាន, វីណូ, ប៉េរ៉ង់, គីណាលុច
Rice Bags 	ស្រឹងដញ្ចក់ទឹកដោះ	<u>CYRIPHOS 585EC</u> , <u>SECSAIGON 10EC</u> , <u>SECSAIGON 25EC</u> , <u>OSIN 50WP</u> , <u>VINO 200SC</u> , <u>NAFAZA 350SC</u>	
Rice Case Worm 	ដង្កូវបំពង់កាត់ស្លឹក		វីតាស៊ី, ស៊ីប៉េរ៉ង់, វីហ្គុន, គីណាលុច
Yellow Stem Borer 	ដង្កូវស្លឹកដើម	<u>NATO 55 EC</u> , <u>GOLDEN DRAGON 585EC</u> , <u>CYRIPHOS 585EC</u> , <u>CYPENRAN 10EC</u> , <u>DIAZAN 50EC</u> , <u>DIAPHOS 10H</u> , <u>NETOXIN 18SL</u> , <u>PERAN 50EC</u>	ណាតូ, ហ្គោលដិនដ្រាហ្គាន, ស៊ីរីផូស, ស៊ីប៉េរ៉ង់, ឌីអាស្យាន, ដ្យាហ្វូស, ណេតុស៊ីន, ប៉េរ៉ង់
Rice Thrips 		<u>DIAZAN 50 EC</u> , <u>DIAPHOS 10 H</u>	

Herbicide (weed killer)



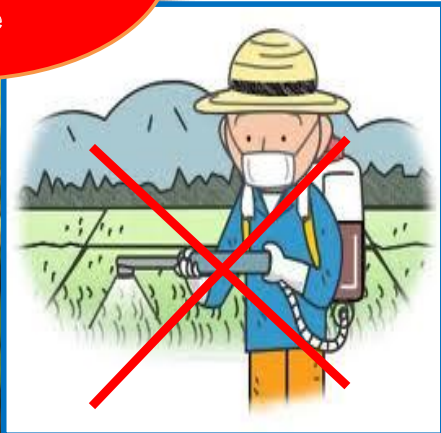
Herbicide damage to the paddy



Herbicide solution scattered on the leaves and panicles








Do not splay herbicide in panicle maturity stage






CAUTIONS !

- Should know HERBICIDE can stunt the growth or even kill the leaves and degrade the quality of rice if herbicide solution is too dense.
- Be careful not to splay over rice plant, particularly during maturity stage after heading.

Herbicides for Rice Culture available in the Cambodian Market

					
Trade Name	Nominee 10SC	BISONA 100SC	NO WORRY 100SC	Sre ors Smav	Bayon Smav
Active Chemical	Bispyribac sodium				
Target Weed	Annual Grasses, Broadleaf Weeds				
Application Information	<ul style="list-style-type: none"> • Post-emergence Type. • Transplanted/Wet Direct Seeded: 2-4 leaf stage of weeds or 7-15 days after transplanting/seeding. • Drain excess water before spraying to expose target weeds, irrigate 1-3 days after application to obtain desired weed control. • Dilute 10 ml product per 16 litters of water. • Spray Rate (water volume): 160 ℓ - 320 ℓ per ha. • Spray on leaves of weeds (Not absorbed from roots). 				

						
Trade Name	Vitoxomone		PYANCHOR 3EC	Smao Srov Prang	Xpert 70WP	
Active Chemical	Propanil	24D	Pyribenzoxim	Quinclorac	Fenoxaprop-P-ethyl	Pyrazosulfuron-ethyl
Target Weed	Annual Grasses,	Broadleaf Weeds	Barnyard Grass Broadleaf Weeds	Grasses	Grasses (Crabgrass)	Grasses, Broadleaf Weeds
Application Information	• Post-emergence Type.	2,4-D is absorbed from leaves, stems, and roots of weeds	• Post-emergence Type.			

Chapter 2

Basic agronomy for Agricultural Instructors

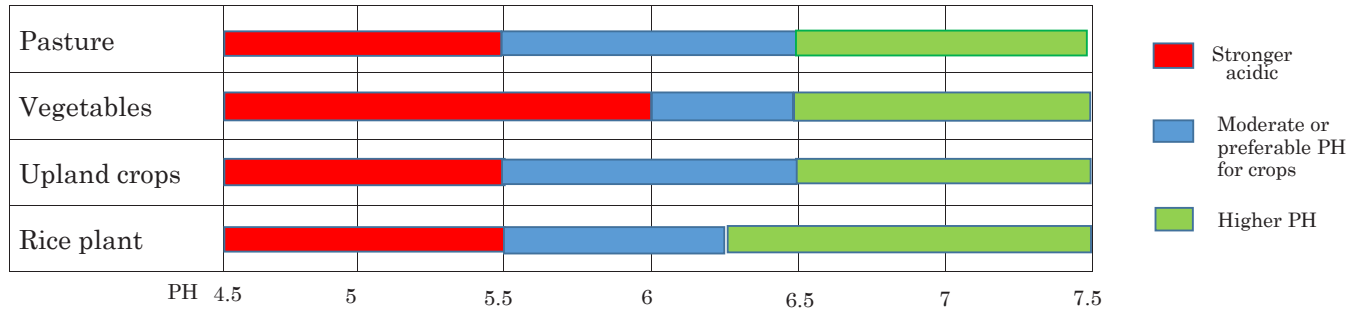


Chemical & Physical environment in the Soil

Soil Acidity (PH)

Adaptability and preference of crops for soil PH

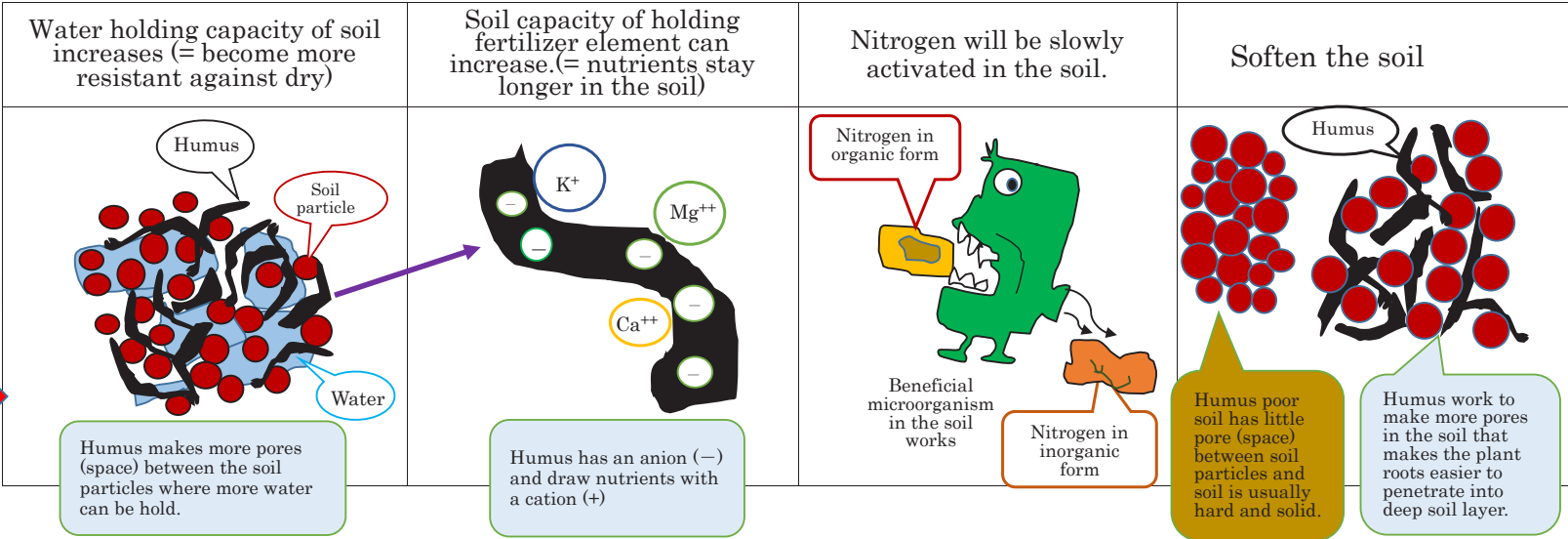
(*PH : Potential of Hydrogen)



How a humus (decay of plants) works in the Soil



Effects of Plant compost



“Compost” as an organic materials

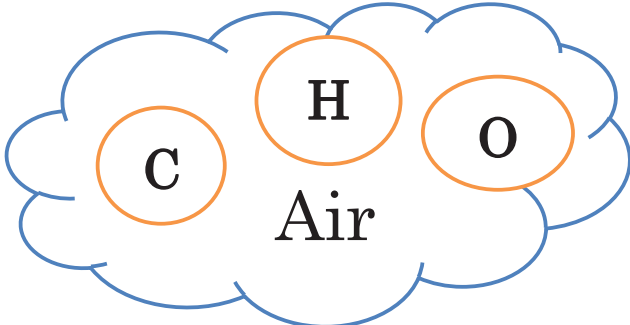
Compost is the best organic material (if it is processed appropriately) for betterment of soil environment in chemical / physical/ biological conditions.

Compost	Characteristics & Effects	Notes in use
Animal manures	<ul style="list-style-type: none"> ● N.P.K Contents are much high compared to plant materials. ● Less effective for betterment of soil physical environment. 	<ul style="list-style-type: none"> ● Application of <u>fresh manure</u> just before and during cultivation should be avoided due to the generation of ammonia gas during decomposition process. ● High Nitrogen contents should be fully considered and calculated when applying Chemical fertilizer such as DAP & UREA. It cause an over application of Nitrogen. ● Manures must be evenly scattered onto the field in order to avoid ununiformed growth of crops.
Plant materials	<ul style="list-style-type: none"> ● N.P.K contents are low. ● Much effect for improvement of soil physical conditions as shown in the illustration above. 	<ul style="list-style-type: none"> ● If not applied together with Nitrogen source like an animal manure, Nitrogen deficiency in the soil may occur due to that much Nitrogen is consumed by microorganism which work to decompose the plant materials..

Approximate content (%) of fertilizer elements

Organic Materials	Nitrogen (N)	Phosphate (P)	Potassium (K)
Chicken manure	2.5%	6.5%	3.5%
Pig manure	3.0%	5.0%	2.5%
Cow manure	1.0%	1.0%	1.5%
Rice straw	0.4%	0.2%	1.7%

16 Essential elements necessary for the growth of crops



3 Major elements

N	P	K
Nitrogen	Phosphoric acid	Potassium

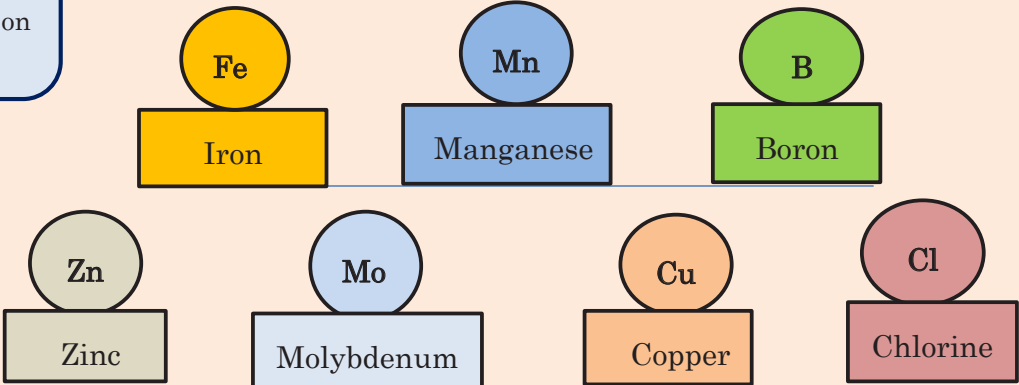
3 Medium elements

S	Ca	Mg
Sulfur	Calcium	Magnesium



Trustable fertilizer has an indication of each Trace Element and their contents (percentage) on the bag

7 Trace Elements (Micro elements)



Category	Element	Major Functions	Symptoms in deficiency	Symptoms in over application
Major Elements	Nitrogen (N)	<p>The crops absorb Nitrogen in the inorganic form of Ammonium (NH₄) and Nitric acid (NO₂, NO₃) from roots and synthesize Amino Acid and Protein. Nitrogen also works for composing Chlorophyll (plant cell indispensable for Photosynthesis), Enzyme and Hormone which are deeply related to sound growth of the crop. Major effects of Nitrogen is as follows:</p> <ul style="list-style-type: none"> • Enlarge stems & leaves, develop roots, and deepen the color of leaves 	<ul style="list-style-type: none"> • Growth stays slow and decrease the number of tillers • Leave's color fades out to yellowish • Reduce the yield and lower the quality 	<ul style="list-style-type: none"> • Leaves & stems turns dark green, more soft • Obstruct flowering and fruition • Induce over growth of stems and leaves, and over developing tillers which weaken the resistance against lodging and diseases infection. • Induce the delay of maturity.
	Phosphoric acid (P)	<ul style="list-style-type: none"> • Promote flowering and fruition • Accelerate plant growth • Accelerate root development and its growth • Increase the number of tillers, roots & leave • Increase the number of fruit (grain) and quality 	<ul style="list-style-type: none"> • Decrease the number of tillers and flowers • Delay flowering and fruiting • Make the roots growth feeble • Color of leave's edge turns blackish or purplish 	<ul style="list-style-type: none"> • It would hardly be serious obstacle, but growth finish early and induce early ripening of fruit (grain) with a lower yield • Over application can induce a deficiency of Zinc (Zn), Iron (Fe) and Magnesium (Mg)
	Potassium (K)	<ul style="list-style-type: none"> • Promote root development and growth • Strength plant against diseases • Strengthen roots & stems against disease • Promote flowering and fruition 	<ul style="list-style-type: none"> • Worsen a taste and looking of fruit • Lower the root growth and cause a root rot 	<ul style="list-style-type: none"> • Obstruct an absorption of Magnesium and Calcium
Medium Elements	Calcium (Ca)	<ul style="list-style-type: none"> • Indispensable element for tightly stick the plant cells each other and for healthy root growth • Neutralize soil acidity(PH) 	<ul style="list-style-type: none"> • Color of new leaves turns yellow from the top or edge of leaves and die out. 	<ul style="list-style-type: none"> • Induce a deficiency of Boron(B), Manganese (Mn) , Zinc (Zn) and Iron (Fe)
	Magnesium (Mg)	<ul style="list-style-type: none"> • Indispensable for promoting Photosynthesis • Assist the work of Phosphoric acid • Magnesium(Mg) is the one of important elements consisting Chlorophyll in the leaves which works for Photosynthesis 	<ul style="list-style-type: none"> • Color of old leaves turns out yellowish from the edge of leave 	<ul style="list-style-type: none"> • Induce a deficiency of Boron(B), Manganese (Mn) and Zinc (Zn)
	Sulfur (S)	<ul style="list-style-type: none"> • Regulate the plant growth, • Deeply related to oxidization and deoxidization inside the plant • A lack of Sulfur causes insufficient growth of plant 	<ul style="list-style-type: none"> • Color of leaves turns yellow, particularly it appears more on old leaves 	<ul style="list-style-type: none"> • Induce the soil oxidization
Trace Element	Iron (Fe)	<ul style="list-style-type: none"> • Indispensable element needed in the process of forming Chlorophyll in the plant (*Chlorophyll is substance present in green leaves and necessary for Photosynthesis) 	<ul style="list-style-type: none"> • Color of leaves color turns out yellow and white 	<ul style="list-style-type: none"> • Obstruct an absorption of Phosphoric acid (P) • Roots go rotting • leaves color turned white
	Manganese (Mn)	<ul style="list-style-type: none"> • Compose an enzyme related to protein formation and breathing of plant • Synthesize Chlorophyll necessary for Photosynthesis • Synthesize Vitamins in the plant 	<ul style="list-style-type: none"> • Spots with yellow or brown appears on the leaves 	—
	Boron (B)	<ul style="list-style-type: none"> • Promote a development of new buds and growth of roots 	<ul style="list-style-type: none"> • Worsen budding • Lower the root growth 	<ul style="list-style-type: none"> • Color of leaves color turns out yellow and brown
	Zinc (Zn)	<ul style="list-style-type: none"> • Works for developing new leaves • Zinc (Zn) relates the action of plant growth hormone 	<ul style="list-style-type: none"> • Leaves grow small or change a shape 	<ul style="list-style-type: none"> • Color of new leaves change yellow and spots appear
	Molybdenum (Mo)	<ul style="list-style-type: none"> • Essential element for Nitrogen fixer (microorganism) working to medium a fixation of aerial Nitrogen • Synthesizing Vitamins in the plant 	<ul style="list-style-type: none"> • Spots with yellow color appears on the leaves and leaves bend 	—
	Copper (Cu)	<ul style="list-style-type: none"> • Copper (Cu) relates an action of oxidization enzyme • Forming Chlorophyll 	<ul style="list-style-type: none"> • Color of leaves turns yellow and white, and leaves bend 	<ul style="list-style-type: none"> • Worsen the root growth
	Chlorine (Cl)	<ul style="list-style-type: none"> • Chlorine (Cl) is an necessary element for the action of photosynthesis 	<ul style="list-style-type: none"> • Leaves die off from the top 	<ul style="list-style-type: none"> • Root's rot

Nitrogen Cycle in nature



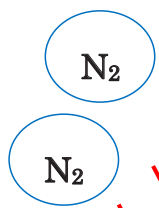
- Carcass
- Excrements ,Dungs, Chicken dropping
- Rice straw, Grasses, Trees
- Humus

Nitrogen in Organic form

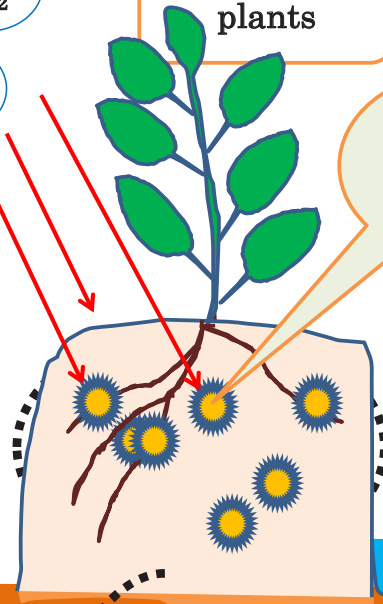
Beneficial microorganism works to convert the organic materials to the inorganic form



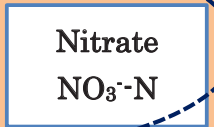
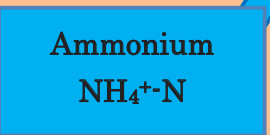
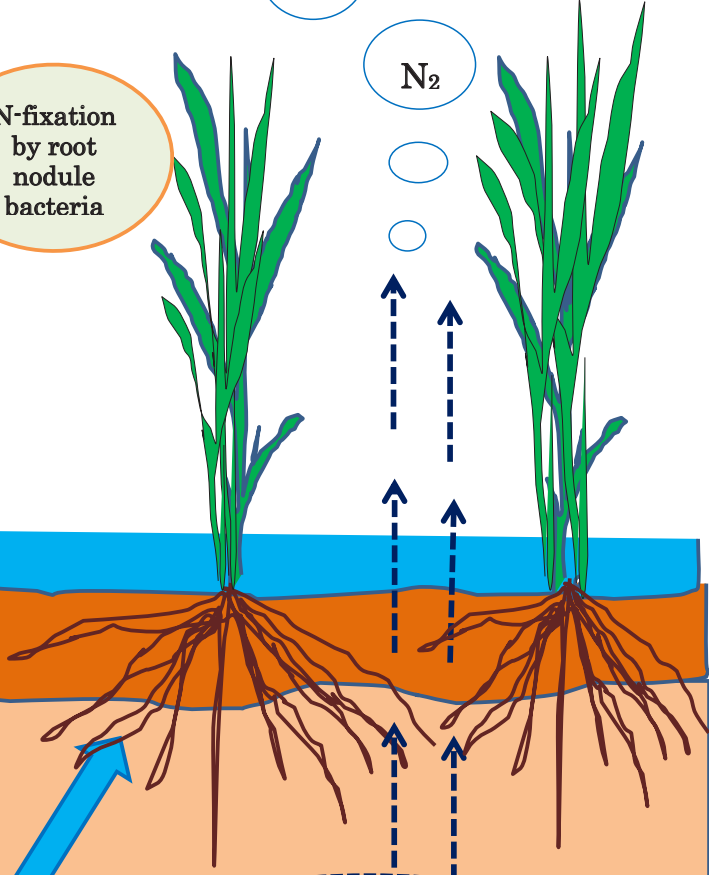
Nitrogen in Inorganic form



Leguminous plants



N-fixation by root nodule bacteria



Beneficial microorganism works to convert Ammonium to Nitrite and to Nitrate

Transformation of Nitrogen and its movement in the soil

Ammonium
 $\text{NH}_4^+\text{-N}$



Nitrate
 $\text{NO}_3^-\text{-N}$

Upland Soil

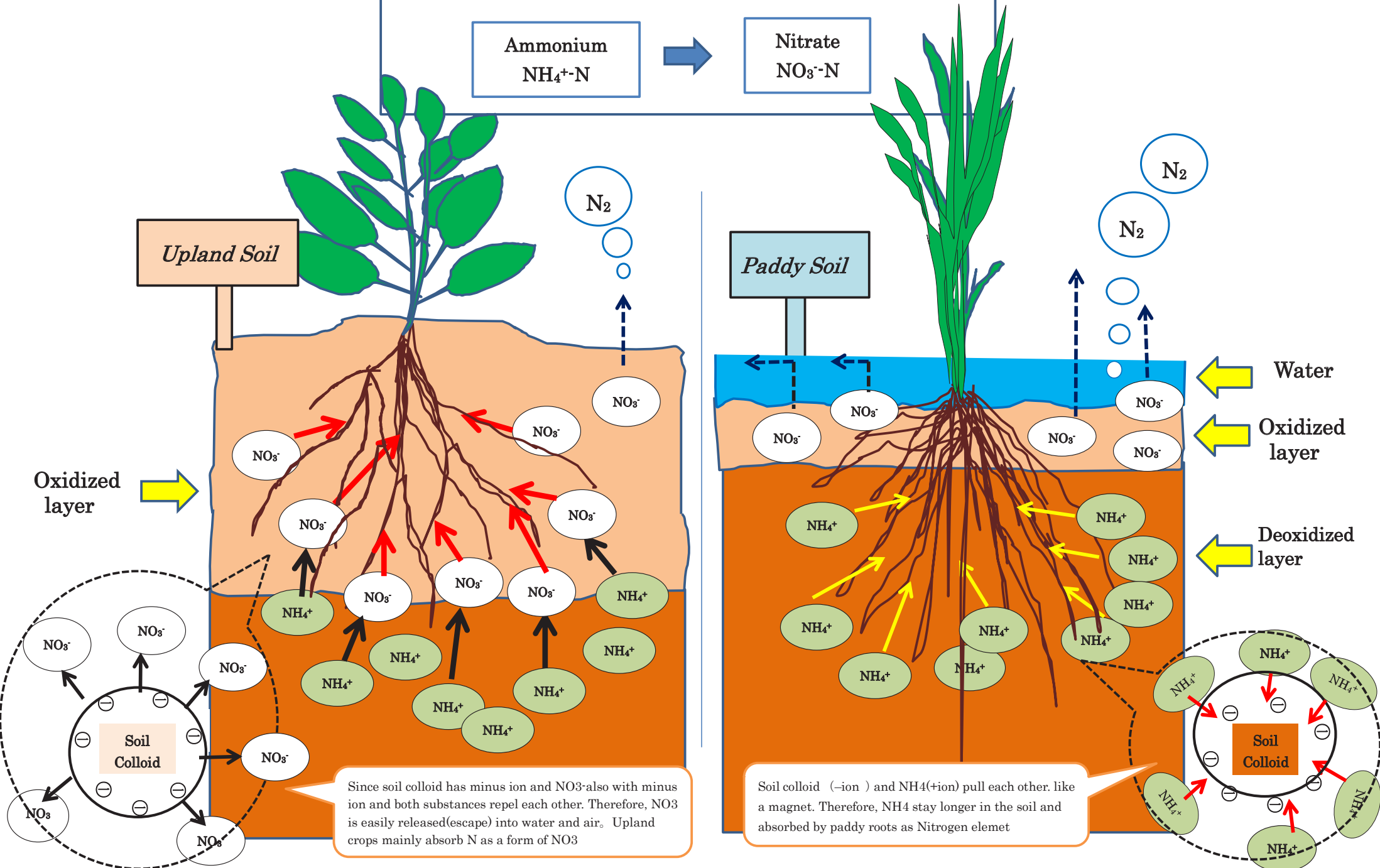
Paddy Soil

Oxidized layer

Water

Oxidized layer

Deoxidized layer



Since soil colloid has minus ion and NO_3^- also with minus ion and both substances repel each other. Therefore, NO_3^- is easily released (escape) into water and air. Upland crops mainly absorb N as a form of NO_3^-

Soil colloid ($-$ ion) and NH_4^+ (+ion) pull each other. Like a magnet. Therefore, NH_4^+ stay longer in the soil and absorbed by paddy roots as Nitrogen element

Seedling Nursery in Dapog Method



How to make “Dapog Seedling”



①

Preparation of necessary bed soil materials

1. Banana Stem and leaves
2. Soil & dried animal manure (no use fresh manure) or well decomposed compost
3. Rice husk charcoal (not ash!)
4. Approximate mixture rate is Soil 40%, Manure (or compost) 30%, Rice husk Charcoal 30%
5. If manure or compost is not available, only soil (50%) and charcoal (50%) will be fine.



②

Molding make

1. Make an outer fence by using a piece of ripped-off banana stems.
2. Stems are vertically skewered by bamboo spits.
3. Lay down banana leaves flat covering entire bottom. (Polyvinyl sheet can be a substitute instead of banana leaves, but it requires extra cost for purchasing)

Size on nursery bed necessary for one hectare is ;

1 plot = 10 m^2 ($1 \text{ m} \times 10 \text{ m}$) = 0.25ha
For planting 1 hectare, 5 plots is required to make.



③

Bed preparation

1. Spread mixed bed material flatly at about 5cm thick and lightly stamp the surface
2. Sprinkle water to the extent that the bed material get slightly wet. (*Do not sprinkle water as much as flowing over the surface layer)

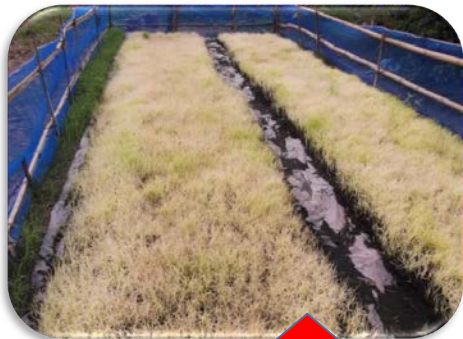


Seeding

1. Seed amount to be broadcasted is $0.8 \text{ kg} / \text{m}^2$ ($1 \text{ m} \times 1 \text{ m}$),
2. Seed amount necessary for one hectare ;
 $8 \text{ kg} / \text{plot} (1 \text{ m} \times 10 \text{ m} = 10 \text{ m}^2) \times 5 \text{ plots} = 40 \text{ kg} / \text{ha}$



④



Sample of failure case

Water shortage immediately drive the leaves color turned yellow to white (Do not mistake with the diseases)

***Never neglect to sprinkle enough water at least 5 times a day.**



⑦

Field condition required

1. In case that water level in the field is high, Dapog seedling could not be transplanted
2. Picture above is the best water level and for transplanting



⑥

Transplanting

1. 12 to 14 day's young seedlings is the best timing for transplanting.



⑤

Checking Seedlings

1. After germination, check the seedlings carefully for leaves color.
2. **Sprinkle enough water at least 5 times a day !!**



Covering

1. After seeding, cover the seed with mixt soil thinly
2. Sprinkle water again

