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System of Rice Intensification **Guideline on SRI Practice in Irrigated Paddy Fields in Laos**

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Guideline on SRI Practice in Irrigated Paddy Field

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Part-1

Introduction to SRI

1. General

The System of Rice Intensification, known as SRI, is an innovation in rice production systems by raising productivity of the land, labor, water and capital. SRI is a set of modified practices for managing rice plants and the soil, water and nutrients. SRI can produce more paddy yield with less external inputs. Furthermore, SRI is environment-friendly. SRI method can be adopted to any type of rice variety (local variety, HYV, hybrid variety). SRI is an innovation that is constituted entirely of knowledge, but not depending on external inputs and materials.

SRI is a concept consisting of the following practices (menu).

- Transplant young seedlings.
- Transplant single seedling at a hill with utmost care for seed roots.
- Transplant at wider spacing.
- Less use of chemicals (fertilizer, pesticide, insecticide, herbicide).
- Less water use by applying wet-dry cycle of soil moisture.



SRI Paddy (left) vs. Non SRI Paddy (right)

The SRI concept is nowadays applying to other crops (wheat, sugarcane, millet). SRI is in progress by evolving and ramifying.

2. Benefits and Impacts of SRI

SRI methods have the following benefits and impacts, in general, compared to conventional methods of paddy cultivation:

- To increase paddy yields usually by 20-50% and sometimes 100% or more;
- To reduce required seeds for transplanting by 60-80%;
- To reduce use of chemical fertilizers and agrichemicals;
- To reduce irrigation water by 25-50%;
- To reduce production costs usually by 10-20%; and

3. History of SRI

SRI was developed in 1980's by Fr. Henri de Laulanié, S.J., who spent half a lifetime in Madagascar, working with poor farmers to improve their rice productivity and output so as to alleviate poverty.

SRI was discovered by Prof. Dr. Norman Thomas Uphoff, CIIFAD Cornell University USA, in 1993 when he visited Madagascar to lead a study mission. He arranged a field test of SRI for 5 years in Madagascar to confirm the SRI effects. After his conviction on SRI, with an utmost dedication, he has disseminated SRI worldwide from 1997 to date.



Fr. Laulanié



Prof. Norman Uphoff,

4. Expansion of SRI in the World

Country and year reported first on SRI test results are shown in the right table (42 countries in total). Countries with good progress of SRI practice (over 10,000 ha) in 2010 are India, China, Vietnam, Cambodia, Indonesia, Myanmar and Madagascar. Total SRI area reached 1 million ha in 2010.

Year	East/South East Asia	West/South Asia	Africa	Latin America
1983			Madagascar	
1999	China, Indonesia			
2000-01	Cambodia, Laos, Myanmar, Thailand, Philippines	India, Bangladesh, Sri Lanka, Nepal	Ghana, Sierra Leone	Cuba
2002-03			Benin, Guinea, Mozambique	Peru
2004-05	Vietnam	Pakistan	Senegal, Mali	
2006		Bhutan, Iran, Iraq	Zambia	
2007		Afghanistan		Brazil
2008	Japan		Rwanda, Egypt, Ghana	Costa Rica, Ecuador
2009	East Timor, Malaysia			
2010	North Korea, Taiwan		Kenya	Panama

5. Green Revolution vs. SRI

SRI method is compared with the green revolution (rice) approach as follows:

Item	Green revolution (rice)	SRI
History	In 1960's, new high yielding variety (HYV) for rice (IR-8) was developed in IRRI and caused remarkable yield increase. This was accepted internationally as a key to solve food shortage.	In 1980's, an innovative paddy cultivation method was developed in Madagascar. Then disseminated worldwide from 1979.
Principle	Increase unit yield of paddy by using HYV with increased use of chemical fertilizers and water.	Increase unit yield of paddy by any type of rice variety by reducing seeds, chemicals fertilizers and water.
Environment	Heavy burden on environment due to high use of chemical fertilizer and agricultural chemicals.	Environment-friendly owing to reduction of greenhouse gas by intermittent irrigation and chemical use.
Water Use	High consumption of irrigation water	25-50% less use of irrigation water
Evaluation	Recently, no rice yield increase occurs. Shortage of water resources and overuse of chemicals have caused problems.	Yield of rice can increase with less input of external resources, and can reduce production cost.

6. Key Elements of SRI

For details, please refer "ETAG Final Report Agricultural Technologies for Developing Countries: Annex 3, Case Study, System of Rice Intensification, by Norman Uphoff & Amir Kassam, April 2009"

(1) Young seedlings

The seedling for transplanting by SRI should be young less than 14 days old after seeding (nursling seedling)*, preferably 8-12 days old. When the seedling is transplanted carefully it grows healthily and generates more number of tillers. It can achieve the potential of giving higher yield.

*Note: * = Nursling seedling has quite different characteristics from aged seedling more than 15 days old, which holds remaining albumen (nutrient) more than 35% in a seed, or preserving the growth potential for tillering and root development.*

(2) Careful transplanting of single seedlings

The transplanting of single seedlings should be done quickly after the seedlings are removed from the nursery bed, and carefully putting the seedling (keeping soil and seed sac attached to the root) in very shallow (1-2 cm). This will set back their resumption of growth. Careful handling of seedlings avoids trauma to the roots, with little or no interruption of plant growth and no 'transplant shock'.

(3) Wider square spacing

Transplanting should be in a square pattern with spacing of at least 25 x 25 cm distances between rows and hills. As SRI practices build up soil fertility, through root exudation and additions of organic matter to the soil, sparser planting will give higher productivity. It is counterintuitive that reducing plant populations by as much as 80-90% can give higher yield, but this is the result, provided that the other SRI practices are also followed. The higher yield with reduce population results from the increase in panicle-bearing primary tillers per unit area, and also more filled grains per panicle, as well as usually higher grain weight

(4) **Aerobic soil conditions**

Using nursing seedling is the single most important contributor to higher SRI yields, but the second most important is keeping the paddy soil moist but not continuously saturated. This avoids the suffocation and degeneration of rice plant roots and also supports more abundant and diverse populations of aerobic soil organisms that provide multiple benefits to the plants. This can be done by alternate wetting and drying (AWD) with cycles ranging from 6 to 14 days. The operative principle is to provide both roots and soil biota with optimizing amounts of both water and oxygen. The result is larger and deeper root growth which gives rice plants more resilience to adverse climatic conditions, such as drought, storms or extreme temperatures.

(5) **Active soil aeration**

Not flooding fields is conducive to passive soil aeration, letting biological processes improve soil structure and functioning. Beyond this, SRI promotes mechanical measures to aerate the soil. When paddy fields are not kept continuously flooded, weed growth becomes a greater problem. SRI results depend substantially on maintaining mostly aerobic soil conditions. Good soil aeration can be obtained through biological means through the activity of the soil biota. Instead of weeding and throwing the weeds outside the plot, there are several advantages of turning the weeds into the soil by using a rotary weeder. This will cause advantages of (a) the soil gets aerated, and (b) the weeds get decomposed in the soil and turn into organic matter. Due to this the roots and the plant grow healthily and higher yields can be achieved.

(6) **Use of organic manures**

SRI practices give better results to the extent that the soil is well-supplied with organic matter. When organic matter is added, the microorganisms in the soil multiply manifold and bring nutrients into available form and are made available to them as and when they are needed. It is possible to increase organic matter production and N fixation through the use of high-biomass legumes as cover crops in rotation, also returning as much of the crop residue as possible to cover the soil surface and/or add organic matter into the soil. This practice has been an integral part of Conservation Agriculture, and it is believed that SRI systems could also benefit from it

7. **Plant Growth by SRI**

Distinctive features of plant growth according to SRI management are:

- More profuse tillering, starting about a month after transplanting,
- More and larger panicles of grain, often but not always with higher grain weight,
- Much larger and healthier root system, that remain functioning throughout the crop cycle,
- Soil is biologically more active.



SRI plant (left) has more tiller & bigger root

8. Type of SRI

SRI will be defined technically by key practices (menu) mentioned in section 1, but not a fixed package to be followed strictly. Even though only a part of key practices is adopted, it can be considered as SRI as far as SRI effects appear.

SRI can be categorized as the following types.

- **Basic SRI:** Same menu as originally proposed by Fr. Henri de Laulanié in 1983, or to transplant single young seedlings at wider spacing and to apply intermittent irrigation. Chemical fertilizer is used, but occasionally some organic matters are used to improve soil structure.
- **Organic SRI:** Similar menu as Basic SRI, but no chemical fertilizers use. Necessary to apply organic materials, compost or manure, to improve soil fertility and to enhance biological activity. This is the most preferable and ideal SRI.
- **Partial SRI:** This is a type of SRI to apply a part of menu of SRI, though SRI effects will be decreased. It will be caused by farmer's preference and/or local conditions. For example, a set of practices to transplant "not young" seedlings at wider spacing is considered as a partial SRI. Rainfed SRI will be categorized as a partial SRI due to difficulty to control soil moisture.

For easy acceptance of SRI by local farmers, it is proposed to employ a gradual approach to start from the basic SRI or the partial SRI and then to grade up to the organic SRI. Each practice of SRI can be adjusted flexibly by farmer as explained in Part 2 so as to meet with site conditions, availability of local resources, and farmers' preference.



Part-2

Guideline on SRI Practice

1. Selection of Suitable Location for SRI (pre condition)

Success of SRI by pioneer farmers at a new area is quite important. Paddy fields of pioneer SRI farmers are a show window functioning as demonstration plot for SRI. At the initial stage to introduce SRI, priority for site selection should be given to suitable area for SRI such as leveled plots, convenient to irrigate and drain, and fertile soil.

The site conditions hamper to generate enough SRI effects are, in general, as follows:

- Saline or alkali soil area.
- Strong acid soils area (pH is below 4.0).
- Inclined plot.
- Newly leveled plot without topsoil.
- Poor drainage area due to high groundwater table.
- Humid climate area without dry season.
- Very cool area during transplanting period.



pH Meter to check soil condition

Some social and political conditions may cause difficulty for sustainable SRI practices. They are:

- Tenant farmer.
- Location where side job opportunities for farmers are ample.
- Location where local government agricultural office is against SRI.
- Location where agricultural extension office is not function.

2. Procedure for Dissemination of SRI

To introduce SRI in areas without experience on SRI, careful selection of pioneer farmers and full support for them are indispensable. Recommended procedures for SRI dissemination in such areas are as follows. SRI training for farmers will be done by SRI experts, experienced NGOs, and trained extension workers. Support by local government is quite effective.

1. To conduct SRI guidance and training to local Extension workers by SRI experts.
2. To conduct general SRI guidance to farmers at villages, and to select candidates of SRI pioneer farmers (SPFs).
3. To conduct intensive SRI training to SPFs just before the start of cropping season.
4. To provide seeds, fertilizers and rotary weeder to SPFs.
5. To continue monitoring and guidance to SPFs for the whole cropping season.
6. To use SPFs' paddy fields as a demonstration farm to show SRI to other farmers.
7. To use active SPFs as SRI extension workers in the area for SRI dissemination.



SRI Guidance to Extension Workers



General Guidance on SRI



Intensive Training on SRI

3. Nursery Bed

There are two methods of nursery bed preparation. Preparation of nursery bed at the corner of main paddy fields is common practice and suitable for larger land holding farmers. Nursery preparation by portable tray developed in Indonesia is suitable for smaller land holding farmers.

(1) Nursery Bed in Paddy Fields

The proposed nursery bed is 1.2 m wide. The length can vary depending on the need and space available. Seed requirement is 5 kg/ha for transplanting single seedling per hill, and 10 kg/ha for double seedling per hill.

Depending upon the convenience, a single bed or several smaller beds can be prepared. As the roots of 6-12 day old seedling would grow up to 15 cm, it is recommended to prepare raised nursery beds of 15 cm high.

Nursery bed is prepared in this manner by using FYM (farm yard manure).

- 1st layer: 3 cm thick well decomposed FYM
- 2nd layer: 4 cm soil
- 3rd layer: 3 cm thick well decomposed FYM
- 4th layer: 5 cm soil

All these layers should be thoroughly mixed.

Make a channel around the nursery bed.

To prevent the wet soil dropping down the bed should be made secure on all sides with wooden planks, bamboos or any other suitable material.

FYM helps in easy presentation of roots. The plants that are grown in well decomposed manure gain resistance to diseases.



(2) Nursery Tray

In case that paddy area by farmer is not large (less than 0.3 ha per farm household), it is recommended to use tray for nursery preparation. Tray is either plastic flat tray available in the local market or bamboo flat basket made by farmers. On a tray, put banana leaf and then put soil-FYM mixture (50% each) at 4 cm depth. If rack for tray is prepared, nursery management becomes easy and finally quality of seedlings will be better. On the rack, cover sheet should be placed to avoid rainfall. This method will help farmers easy for transplanting work at the main paddy field by transport tray directly to the field.



4. Seed Selection, Soaking, and Broadcasting

Young, 6-12 day seedlings should be transplanted in SRI method. Best SRI effects can be obtained when transplant 8 days seedlings. Age of seedling should never be over 15 days. The nursery should be prepared with utmost care.

(1) Selecting good seeds

To select good seeds for seeding, salt water will be used. Salt should be put into water in a bucket until an egg in a bucket is raised to the surface. Submerged seeds only should be used for seeding.

However, if salt is not available or too expensive for farmers, good seed selection by water without salt is applicable.

(2) Germinating the seed

Soak the paddy seed for 12 hours. Then transfer the soaked seed into a gunny bag or make a heap and cover it with gunny clothe.

Leave it for 24 hours. At this time the seed germinates. You can observe the white root or radical emerges from the seed.

This seed is used for sowing on the nursery bed. Never delay after germination for sowing. If delay, the roots grow and get matted together making it difficult to sow the seeds with wider spacing.

(3) Broadcasting the seed

To ensure uniform broadcasting, make the seed into 4 equal parts.

Broadcast each part separately one after the other. Two seeds should be separated by a distance of length of one seed. It is better to broadcast the seeds in the evenings.

(4) Covering the seed

Cover the seed with a thin layer of well decomposed FYM or dry soil. Even paddy straw can be used for this purpose, if the straw is healthy without disease in the previous cropping season.

The seed is protected from direct sunshine and rainfall. It also must protect from being eaten away by birds and ants. When straw is used as a layer it should be removed after the appearance of the shoots.

(5) Watering the beds

Depending upon the need, watered the bed daily in the morning and evening.

The water should be gently sprinkled over the bed. When pots are used for watering, use one hand to break the force of the water. The nursery can be watered by letting in water into the canal surrounding the nursery bed.



5. Preparation of Main Field

(1) Plowing and puddling

Land preparation for SRI is the same as for conventional method. But for SRI, no standing water allowed.

(2) Ditch in a lot

For smooth implementation of intermittent irrigation, digging field ditches inside a lot is recommended. If lot size is big, additional ditch should be dig at 5 or 10 m interval. These ditches will function as small channel to flow down excess water and can keep paddy field dry for SRI.

(3) Small bund in a lot

If the lot surface is uneven, water would be stagnating at lower part and higher part will dried up. It is recommended to make a small bund in a lot to separate the higher part and lower part to improve the elevation gap for better water management.

(4) Marking for transplanting position

Location of hill for SRI transplanting should be at regular position. Use of grid marker is necessary. Rake marker will be made by wood or bamboo. Rolling marker suitable for large lot is made by iron. Interval of marking is 30 cm x 30 cm as a standard. But marking at 25 cm x 25 cm spacing is also common practice. Spacing of marking is flexible depending on site conditions and farmers preference.

If marking is difficult under soft soil?

Take a rope and tie a knot or a stick at every 30 or 25 cm (same as planting interval). Using this rope as guide, transplant one row after the other. For the rows to be straight, it is ideal that a rope is tied along the length of the field and the marker is drawn along the rope. Tie a rope as guide and draw the marker again along the rope.



Rake Marker
(Indonesia)



Rolling Marker
(India)



6. Transplantation

Special Care

Young, 6-12 day seedlings are recommended to transplant in SRI method. Utmost care should be taken from taking seedling from nursery bed to transplant without experiencing any 'shock'. The seedling should not be damaged either during or uprooting or transplanting in the main field.

Transportation of seedlings to the main field

In SRI method, the seedlings would be very small. So a metal sheet is pushed 10 cm below the nursery and lifted on to the plate. This means that the seedlings along with the soil are taken on to the sheet. This can be transported to the main field on the metal sheet itself or transferred into a wicker basket.

When the nursery is raised in plastic trays or banana trunk leaves, they can be transported along with them.



Field condition before transplantation

The main paddy field should be wet condition but no standing water. If necessary, light irrigation can be provided before the transplantation.

Five (5) days after transplantation, light irrigation should be provided. Day of light irrigation will differ by soil condition.



Number of seedling per hill

Single seedling per hill is recommended as a standard. However, if there is any doubt regarding the survival of plant, then two (2) seedlings can be transplanted per hill. Transplantation of three (3) seedlings per hill or more is not recommended from a viewpoint of cost and labor savings. It should be noted that the total paddy yield in a lot is almost the same among the transplantation of single, two, and three seedlings per hill.



Placing of seedlings

For SRI transplanting, seedlings should be placed at intersection point carefully on paddy surface at shallow position (less than 1.5 cm deep) with the roots forming a 'L' shape. After placing of a seedling at right position, soil should be covered on extended root by fingers.



7. Weed Management

Advantage to use weeder

As there is no standing water in SRI method periodically, weeds would be more.

Instead of manual weeding to throw weeds outside a plot, use of weeder has several advantages.

They are: (a) to control weeds, (b) to turn weeds into the soil to be useful as organic manure, (c) to aerate soil and roots are exposed to air, (d) to grow diverse micro organisms in the soil which make nutrients available to the plant.

Timing of weeding

The first weeding should be done by using weeder within 7 days after transplantation even though weeds are still not appeared much. This earlier weeding practice can remarkably reduce the quantity of weeds later on. After the first weeding, another weeding (2 to 3 times) would be necessary at about 10 to 15 days interval during the vegetative growth stage of paddy. Timing of weeding should be decided following the schedule of irrigation so as to practice at few days after irrigation supply when dried soil becomes soft after irrigation.

Type of weeder

There are two types of weeders commonly used.

Manual weeder: Simple and cheap weeder of local made. Weeding work is more harder than rotary weeder.

Rotary weeder: weeding and soil mixing can be done and recommended for SRI.



Manual weeder

Design of rotary weeder

Weeding by weeder requires labor. Weeding for one (1) ha of paddy can be done by a person traveling a distance of more than 30 km. So a weeder should be efficient in its function and easy to use so as to reduce the drudgery on labor.

The recommended weeder should fulfill the following requirements.

- To arrange to clean the mud that gets stuck to the teeth.
- To be low cost and easy to be prepared locally.
- To be light weight and durable.
- To reduce the walking distance.



8. Water Management

Water management for SRI is an intermittent irrigation or AWD (alternate wetting and drying). Intermittent irrigation should be applied during the vegetative growth stage only. After the panicle initiation stage until maturity, shallow water should be maintained in the field. The water in the paddy field should be drained at 20 days before harvest.

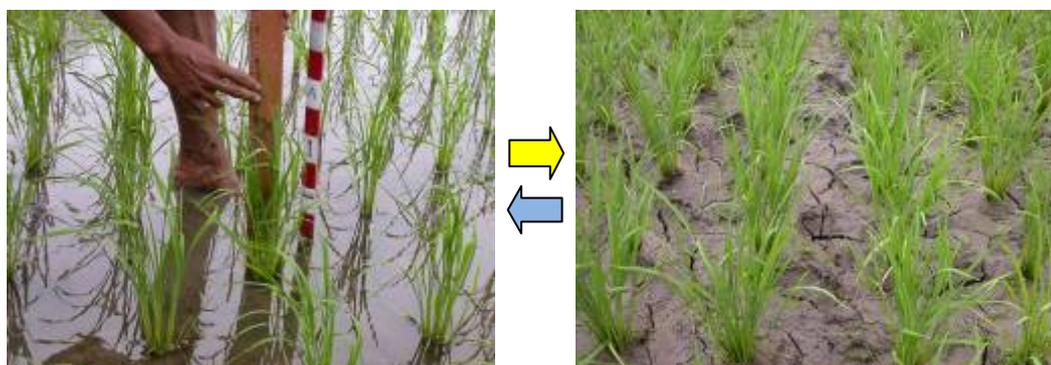
The SRI plots should have secured water resources so as to irrigate the field when required.

The cycle of wetting and drying period during the vegetative growth stage will be decided by on-farm trials. The cycle should flexibly be adjusted based on soil, field and environment conditions.

Procedure to determine the wetting-drying cycle will be as follows (IRRI).

1. Properly plug (or seal) all holes (or cracks) in the paddy bunds.
2. Apply irrigation water to a depth of about 3-5 cm in the paddy field, then stopped.
3. Observe how long (duration) will the ponded take to subside or disappear in the paddy. Record the time as T(1).
4. When ponded water has disappeared, observe how long it will take until the soil develop small shallow cracks. Record the time as T(2).
5. Irrigation interval = $T(1) + T(2)$
This interval may be used as a guide when the next irrigation may be applied.
6. To ensure that the rice plant is not stressed, the level of the perched water table should not be allowed to lower beyond the effective root zone, which is in general about 15 cm below the ground surface.

Until the farmers gain the confidence in intermittent irrigation method for SRI, few alternative methods can be followed. For example, instead of waiting until the field develops hairline cracks before irrigating, start with lesser intervals and slowly increase the gap between the two irrigations.



Observation well (recommended)

To ensure that the rice plant is not stressed, the level of the water table should not go below 15 cm from ground surface. Installation of a simple observation well (10-12 cm dia., 50 cm long PVC pipe) at the corner of paddy lot is recommended to determine when to irrigate again.



Observation well in a paddy lot

9. Pest & Disease Management

Wider spacing and use of organic manures for SRI results in healthy growth of the plants and incidence of the pests and diseases is naturally low. According to research in 2005-06 in Vietnam, occurrence of four major disease/pests (Sheath blight, Leaf blight, Small leaf folder, Brown plant hopper) for SRI paddy compared with conventional cultivation paddy was 45% in the Spring season cropping and 29% in the Summer season cropping.

Though SRI paddy has more resistance against disease/pests compared with conventional, type of disease/pests to be affected has no difference. When disease/pests occur, it is recommended to take immediate action to eliminate them based on advice of local extension officer and, if necessary, information from “Rice Knowledge Bank of IRRI” < <http://www.knowledgebank.irri.org/rice.htm>>.

The uniqueness of organic SRI lies in not using the chemical pesticides. The pests can be managed by using some organic concoctions (MOL: microorganism local) either as a preventive measure or as and when needed. Each country has some ideas to prepare MOL.

“Amrit Jalam” developed in India is one of such MOL.

Preparation of Amrit Jalam

Required materials:

- Cow urine - one (1) liter
- Cow dung - one (1) kilogram
- Jaggery (tree sap from coconut) - 250 gram
- Water (chlorine free) - 10 liter

Preparation and Use:

Mix all the above materials in a plastic container or an earthen pot. Let them ferment for 24 hours. Dilute this with water in the ratio of 1:10. Filter the solution using a fine cloth.

This can be used for spraying. Amrit Jalam can be stored for a period of 30 days.

However it has to be stirred daily. When urea is used, the plants grow succulently and are easily susceptible to pests and diseases. When Amrit Jalam is sprayed, it not only gives nitrogen to the plants but also repels harmful insects and micro organisms.

10. Soil Fertility Management

The organic matter is the food for the soil microorganisms. When the soil is alive with microorganisms then the nutrients needed for the plant would be in readily available form. When soil is rich with microorganisms then the plant grows healthily, develops resistance to pests and diseases and yields higher. Thus methods of improving the soil fertility should be taken up.

Application of farm yard manure/compost (10-20 ton/ha) and/or green manure is recommended.

Quality of compost to be purchased should be checked carefully.



Farmer training for compost making



Compost making practice



Charcoalized rice husk making

11. Harvesting

Harvesting is the process of collecting the mature rice crop from the field. Paddy harvesting activity includes cutting, stacking, handling, threshing, cleaning, and hauling. It is important to apply good harvesting methods to be able to (1) maximize grain yield, and (2) minimize grain damage and quality deterioration.

Harvesting can be done manually using sickles and knives, or mechanically with the use of threshers or combine harvesters. Regardless of the method, good grain quality should be preserved during harvest operations, and harvest losses are kept to minimum.

Key actions for proper harvesting are:

- To harvest at the right time with the right moisture content;
- To avoid delays in threshing after harvesting;
- To use proper machine settings when using a threshing machine;
- To clean the grains properly after threshing; and,
- To dry the grains immediately after threshing

