



Cultivating Rapeseed / Mustard with SRI Principles: A Training Manual

Foreword



In 2009-10, the Agricultural Technology Management Agency (ATMA) and PRADAN initiated a program to use SRI methods in rapeseed cultivation. Initially, there were 7 women farmers from Gaya district who started the experiment. In 2011-12, the Sir Dorabji Tata Trust (SDTT) extended support for this innovation effort, so that about 1,600 farmers were able to use SRI methods for rapeseed that season.

This manual has specific steps for cultivating rapeseed/mustard with SRI methods. It should be equally useful for farmers and village extension workers. It is intended to help small and marginal farmers with limited resources to produce more for themselves and to gain more financially.

How is rapeseed cultivated with SRI methods?

The following core principles of SRI for rice are applied in SMI rapeseed cultivation:

- **Low seed rate:** Only 50 to 250 grams per acre
- **Priming** of seeds with seed selection/treatment
- **Preparing nursery** with treated/sprouted seeds
- **Transplanting seedlings** when they are about 8 to 12 days old and have only 3-4 leaves
- **Wide and uniform spacing of single plants** across the field
- **Aerate the soil** while suppressing the weeds using mechanical rather than chemical means
- **Other practices** in crop husbandry are similar to normal methods

The yield achieved by applying SRI principles is *about double that achieved with conventional methods*. Farmers from Gaya and Nalanda districts of Bihar have reported yields of 2.5 to 3.0 tons per hectare, or more.



Seed varieties and seeding rates

Seed selection

There is no specific preference for any particular variety of seed, but it is always better to use newer seeds, while getting rid of older ones.

Seeding rate

The quantity of seeds to be used depends upon the length of the crop cycle of the variety chosen. If the variety is of **longer duration**, the quantity of seeds required is less; whereas for **short duration** varieties, the seed requirement is greater, as shown below.

| Duration of the variety | Spacing (in cm) | Seed rate (grams) |
|-------------------------|-----------------|-------------------|
| Less than 100 days | 30 x 30 | 250 |
| 100-120 days | 45 x 45 | 200 |
| 120-130 days | 60 x 60 | 125 |
| 130-150 days | 75 x 75 | 75 |

Priming of seeds and seed treatment

- Put the seeds into a ceramic or non-metallic pot with half a liter of warm water having a temperature of about 60⁰ Celsius. Stir the mixture so that any damaged or underdeveloped seeds float on the surface. Remove these, keeping just the heavier seeds for use.
- Pour into the pot a mixture of cow urine, jaggery (coarse sugar), and vermicompost, in roughly equal proportions. Leave the seeds to soak in the mixture for 6-8 hours. The warm water should be about double the quantity of seeds being prepared, while the other materials should each be about half the quantity of the seeds. So, for example, if the amount of seed is 250 grams, the lukewarm water should be about 500 ml, and each of the other items should be about 125 grams.
- After 6 to 8 hours, separate the seeds from the mixture and add a small amount of *Trichoderma*, a beneficial microorganism that supports plant growth and health. Then put the seeds onto a cotton cloth and tie it up around them. The rate for adding *Trichoderma* should be 4 grams per kg of seed, so 1 gram of this microorganism additive would be sufficient for 250 grams of seeds.
- Keep the seeds this way for about 8 to 10 hours to let them germinate. Time will vary depending on local climatic conditions.
- Once the seeds have germinated, plant the sprouted seeds in the raised nursery beds, described next.



Seed



Warm water



Vermicompost



Jaggery



Cow urine

Nursery preparation

Prepare a raised seedbed in a field such as is generally used for vegetable cultivation. The area of the seedbed will depend upon the seed variety used; a smaller area is enough for a longer-duration variety; a larger area is needed for a shorter-duration variety.

| Duration (in days) | Area of the nursery (in square meters) |
|--------------------|--|
| Less than 100 | 60 |
| 100-120 | 50 |
| 120-130 | 30 |
| 130-150 | 20 |

- Mix the soil of the seedbed with **vermicompost** (2 to 2.5 kg per square meter) and **carbofuran** (2 to 2.5 grams per square meter).
- The bed should be **4 to 6 inches above the ground level**, and the width of the bed should be **one meter**.
- If there is more than one nursery bed, a **channel** of one-foot width should be dug between the two beds.
- The soil should be **moist** when putting in the sprouted seeds, and the sprouted seeds should be at a **depth of one-half inch**, keeping a spacing of about 2 X 2 inches between the sprouted seeds.
- Cover the seeds with **vermicompost** and spread a mulching of paddy **straw** over the bed.
- Each morning and in the evening, spray or sprinkle **water** on the nursery for gentle irrigation.
- **Transplant the young plants between 8 to 12 days.**



Field preparation

Plough the field beforehand 2-3 times, so that the soil is well pulverized. If the soil moisture is insufficient, provide some supplementary irrigation before tilling the land. In addition, remove the weeds from the field.

- Mark the places in the field where the mustard seedlings should be planted, using a spade or a rake or a hoe to designate the proper spacing in a square grid pattern; follow the spacing instructions above according to the variety.
- At each marked place, dig a small pit, **6 inches** in diameter and **8-10 inches** in depth. Leave the pits open, exposed to natural sunlight for 2-3 days.
- After 2-3 days, apply 300-400 grams of the mixture described below in the pits, one by one.
- Usually for an acre of mustard crop planting, start by mixing 8 tons of **compost** with 1.5 kg of *Trichoderma*, then mixing this with soil collected from and near the pits, and putting this mixture into the pits. For an acre, use about 27 kg of **di-ammonium phosphate** (DAP) and 13.5 kg of **potash** (MOP). Mix these into the soil and compost and put the mixture into the dug pits, nearly filling them with these materials. Soil should generally be about 50% of what goes into the pit. Before transplanting, each of the pits should be kept or made moist.



Transplanting with SRI methods

- Before transplanting, irrigate the nursery approximately 2 hours in advance to moisten the soil for removing the plants.
- Carefully uproot the seedlings, keeping the soil intact; if possible use a trowel or spade that gives support to the soil, so that it remains intact with the roots.
- Transfer the uprooted seedlings to the main plot in the next 30 minutes, before the roots and soil can dry out.
- Transplant the seedlings at a shallow depth in the pits.
- Irrigate the pits manually with a sprinkler/sprayer for the first 3-5 days. This helps in establishing the plants in the main plot.
- This system requires more work and care, but the results more than compensate for the added effort.



Care of the field up to 30 days after transplantation

- Irrigate the field with first irrigation on the 15th day after transplantation. Apply a dose of urea (27 kg per acre) on the 16th day when there is still moisture in the field. It is better to apply urea close to the roots of the plants.
- On the 20th day, remove any weeds by hoeing in between the rows. Mix about 0.4 ton of vermicompost (VC) and 3 kg of phosphate-solubilizing bacteria (PSB) per acre into the soil using a dry weeder or spade. The timing of this 1st weeding and application can vary depending on local agro-climatic conditions.
- Irrigate the field for a second time on the 30th day, and do a second round of weeding and hoeing. During hoeing, mix 13.5 kg per acre of Biozyme (a biofertilizer) into the soil for further enrichment of the soil biota.



Care of the field 35-50 days after transplantation

- The plants begin growing faster from 30 days after transplantation. Therefore, the plants need more moisture and nutrition. Hence, on or about the morning of the 35th day, apply a dose of urea (13.5 kg per acre) near the roots of the plants and irrigate the field for the third time.
- About 3-5 days after the third irrigation, or about 40 days after transplanting, along with a third weeding/hoeing, apply 13.5 kg of potash (MOP) to the soil. Use a weeder or spade to break up the soil and then to **earth up some soil around the base of the plants**, as is usefully done with potatoes, i.e., up to one foot. This promotes more root growth.



Care of the field from 50 days after transplantation

- The plants grow very fast beyond 50 days after transplanting. The stems, branches and leaves are growing and thickening at this time.
- Aphids should be managed effectively at this time. At the start of the reproductive stage, the plants begin flowering, and subsequently, the siliqua (pod) formation and grain filling take place. In this period, the crop is most susceptible to pest attacks. Therefore, care and attention are required all the time, keeping an eye out for such problems.
- For proper growth and grain filling, irrigate the plot on 60th, 80th, 100th and 120th days after transplanting. Irrigation timing depends on the agro-climatic conditions. If irrigation is not provided on or about these days, there will be drastic reduction in the yield of the crop.



Differences between SRI and conventional methods for mustard/rapeseed cultivation

| <i>Description</i> | <i>Traditional methods</i> | <i>SRI methods</i> |
|-------------------------------------|--|---|
| Seed rate | 5.5 kilograms | 125-300 grams (>95% reduction) |
| Priming of seeds and seed treatment | Not done | With jaggery, cow urine, warm water, and vermicompost |
| Planting method | Broadcasting | Transplanting |
| Plant spacing | Irregular | From 30 x 30 cm up to 75 x 75 cm |
| Sprouting of seeds | One week after broadcasting in the field | Nursery bed is sown sparsely with sprouted seeds |
| Weeding and soil work | Not done | On 15th , 25th and 40th days after planting |
| Irrigation | 2 to 4 times | 5 to 6 times |
| Branches per plant | 1 to 3 | 8 to 20 |
| Leaves | Narrow, with less total area | Wider, with more total leaf area |
| Stems | Thin | Thick |
| Roots | Fairly shallow | Deeper, more than 1 ft in ground |
| Yield per acre | 0.4 ton | 1.2 to 2 tons |
| Seed weight per plant | 10 to 25 grams | 150 to 300 grams |

Mustard yields achieved with SRI methods

During 2009-10, the 7 women farmers from Gaya district who applied SRI principles to rapeseed produced, on an average, **1.2 tons per acre** compared to **0.4 ton** achieved with traditional methods (3 tons per hectare vs. 1 ton).

During 2010-11, 273 farmers from Gaya and Nalanda districts had **1.3 tons per acre** on average. This increased to **1.4 tons per acre** when SMI was done by 1,636 women farmers in 2011-12.

Those farmers who applied all the principles of SRI and who gave six irrigations achieved an average yield of **more than 1.6 tons per acre** (4 tons per hectare).

The maximum yield achieved so far by adopting SRI principles was **1.97 tons per acre**. This was triple the 0.67 ton achieved with the traditional methods.



उप-परियोजना आत्मा, गया एवं प्रदान कमी श्री विधि से राई फसल का एक पौधा लिये किसान के साथ



आयुक्त, मगध प्रमण्डल, गया एवं प्रबन्ध निर्देशक, राज्य जीविकोपार्जन प्रसमिति, पटना श्री विधि से राई की फसल का अवलोकन करते हुये



भारत सरकार के कृषि वैज्ञानिक डी० अरविन्द कुमार सिंह श्री विधि से लगी फसल को देखते हुये।



भारतीय कृषि अनुसंधान परिषद, पटना के प्रधान वैज्ञानिक डी० संत कुमार सिंह श्री विधि के खेत में



Cost estimates for cultivation of rapeseed (per acre in Indian rupees)

| | <u>Unit</u> | <u>Price/unit</u> | <u>Trad'l. methods</u> | | <u>SRI methods</u> | |
|--|-------------|-------------------|------------------------|--------------|--------------------|--------------|
| | | | <u>No. units</u> | <u>Cost</u> | <u>No. units</u> | <u>Cost</u> |
| Seed | Kilogram | 80 | 5.5 | 440 | 0.25 | 20 |
| Priming of seeds and seed treatment | | | | | | |
| Materials (jaggery, cow urine, warm water, vermicompost) | lump sum | 30 | 0 | 0 | 1 | 30 |
| Labor | man hour | 15 | 0 | 0 | 1 | 15 |
| Nursery preparation | man days | 100 | 0 | 0 | 0.5 | 50 |
| Seeds and nursery preparation | | | | 440 | | 115 |
| Field preparation | | | | | | |
| Ploughing (rent for plough and buffalo) | unit | 400 | 2 | 800 | 2 | 800 |
| Labor | man days | 100 | 2 | 200 | 2 | 200 |
| Pit digging | man days | 100 | 0 | 0 | 4 | 400 |
| Field preparation | | | | 1,000 | | 1,400 |
| DAP | kilogram | 15 | 27 | 405 | 27 | 405 |
| MOP | kilogram | 7 | 27 | 189 | 27 | 189 |
| Urea | kilogram | 7 | 55 | 385 | 55 | 385 |
| Biozyme | kilogram | 30 | 0 | 0 | 13.5 | 405 |
| PSB | kilogram | 65 | 0 | 0 | 6 | 390 |
| Vermicompost | kilogram | 5 | 0 | 0 | 400 | 2,000 |
| Nutrient inputs | | | | 979 | | 1,974 |
| Irrigation applications | number | 200 | 3 | 600 | 6 | 1,200 |
| Labor | man days | 100 | 3 | 300 | 6 | 600 |
| Manual irrigation | man days | 100 | 0 | 0 | 4 | 400 |
| Irrigation costs | | | | 900 | | 2,200 |

continued..

| | | | Trad'l. methods | | SRI methods | |
|--|-------------|-------------------|------------------|---------------|------------------|---------------|
| | <u>Unit</u> | <u>Price/unit</u> | <u>No. units</u> | <u>Cost</u> | <u>No. units</u> | <u>Cost</u> |
| Weeding and soil work | man days | 100 | 2 | 200 | 26 | 2,600 |
| Weed control | Total | | | 200 | | 2,600 |
| Plant protection | | | | | | |
| Chemical and pesticides | lump sum | 200 | 1 | 200 | 1 | 200 |
| Labor | man days | 100 | 1 | 100 | 1 | 100 |
| Rent of sprayer | lump sum | 100 | 1 | 100 | 1 | 100 |
| Crop protection costs | Total | | | 400 | | 400 |
| Harvesting | man days | 100 | 13.5 | 1,350 | 6 | 600 |
| Threshing and packaging | man days | 100 | 13.5 | 1,350 | 27 | 2,700 |
| Harvesting costs | Total | | | 2,700 | | 3,300 |
| Rent of the land | lump sum | 4790 | 1 | 4,790 | 1 | 4,790 |
| Interest on fixed assets | lump sum | 45 | 0 | 0 | 1 | 45 |
| Interest on current assets | lump sum | | | 377 | | 558 |
| Depreciation on equipment | | | | 0 | | 355 |
| Capital costs | Total | | | 5,167 | | 5,395 |
| Total operational costs | | | | 18,405 | | 36,921 |
| Management costs (10% of total) | | | | 1,841 | | 3,692 |
| Costs of production | | | | 20,246 | | 40,613 |
| Revenue from production | | | | | | |
| Grain yield | Rp/Kg | 35 | 400 | 14,000 | 1,600 | 56,000 |
| Dry matter (straw, fodder, etc.) | Rp/Kg | 2 | 950 | 1,900 | 4,050 | 8,100 |
| Gross revenue | | | | 15,900 | | 64,100 |
| Net profit | | | | -4,346 | | 23,487 |
| Production cost per kg of grain | | | | 50.6 | | 25.4 |

Disease management

Club Root: *Plasmodiophora brassicae*

Symptoms : Affected plants look stunted. Pale green or yellow leaves develop, and later the plants die untimely.

Non-chemical management:

1. Apply long-term crop rotation (four years) with non-host crops
2. Destroy all cruciferous weeds
3. Avoid growing in fields with previous history of disease occurrence
4. Avoid growing mustard in acidic soils
5. Treat the soil with *Trichoderma*



Infected roots

Downy Mildew: *Peronospora parasitica*

Symptoms : Grayish white irregular necrotic patches develop on the lower surface of leaves. The affected inflorescence does not produce any siliqua or seed. The extent of damage is 17-32 % in mixed infection.

Non-chemical management:

1. Destroy the diseased crop residue
2. Follow crop rotation at least in three years
3. Varieties of *Brassica napus* groups are resistant to this disease
4. Timely sowing and use of healthy certified seeds
5. Application of potash in recommended doses reduces the disease index



Infected leaf

Chemical management: Spray the crop with Mancozeb 75 % W.P. @ 2 gm per liter of water at the onset of the disease for 2 to 3 times with an interval of 10 days. Treat the seeds with 6 gm of Metalaxyl (Apron) per kg seed, followed by single spray with Metalaxyl (Ridomil MZ) at 2.5 gm/liters at 60 days after sowing.

Disease management



Infected stem and siliquae

Powdery Mildew: *Erysiphe cruciferarum*

Symptoms : Dirty white, circular, floury patches on either side of the leaves. Under cold and cloudy environmental conditions, entire leaves, stems and siliquae are affected.

Non-chemical management:

1. Clean the field
2. Destroy crop residues
3. Application of potash in recommended doses reduces disease index.

Chemical management: Spray the crop with soluble sulphur @ 3 gm/liter of water at the onset of the disease and repeat it after 15 days if necessary or apply sulphur dust @ 30kg/ha. If required, use 12 kg per acre of land. Apply Dinocap or Tridemorph @ 1ml per liter of water.

White Rust: *Albugo candida*

Symptoms : White creamy-yellow raised pustules appear on the leaves, which later coalesce to form patches. Swelling and distortion of the stem and floral parts results in 'stag head.' In humid weather, mixed infection of white rust and downy mildew can develop on stag head structures.

Non-chemical management:

1. Use healthy certified seeds and follow crop rotation
2. Destroy crop residues of the last year, particularly stag heads of previous crop.
3. Avoid over-irrigation.

Chemical management: Spray the crop with Mancozeb 75 % W.P. @ 2 gm per liter of water at the onset of the disease. Repeat the spray after 15 days interval or spray with Metalaxyl @ 2.5 gm/liter of water. Treat the seeds with Apron SD-35 @ 6g/kg seed or Thiram @2.5 gm/kg seed.



Infected leaf

Insect pest management



Mustard aphid: *Lipaphis erysimi*

Damage : Both nymph and adults suck the sap from tender leaves, buds and pods. Curling may occur for infested leaves; and at advanced stage, plants may wither and die. Plants remain stunted, and sooty molds grow on the honeydew excreted by the insects. The infected field looks sick and blighted in appearance.

Non-chemical management:

1. Early sowing before 20th October reduces the damage
2. Grow aphid-tolerant varieties like Pusa Kalyani, Laha 101, C. 294, R.L.M. 84, and R.P. 09
3. Regular surveillance of pests and defenders, especially for aphids
4. Conserve native natural enemies like *Poxy nerids*, *Syrphids* and *C.carnea*
5. Ladybird beetles (*Cocciniella septem*, *Punctata*, *Menochilussex maculata*, *Hippodamia variegata* and *cheilomones vicina*) are the most efficient predators of the mustard aphid. Adult beetle may consume an average of 10 to 15 adults/day
6. Predatory bird *Motacilla cospica* is actively feeding on aphids in February-March. Therefore, provide bird perches @ 8-10/acre
7. Spraying of NSKE 5% or other neem formulations at recommended doses



Chemical management: Spraying should be done only when insect population is more than economic threshold level (ETL). Spraying should be done in the evening to avoid damage to pollinators. Spray the crop on as-needed base with either Oxydemetons methyl (Metasystox) or Dimethoate (Rogor) @ 400 ml/acre, or Imidacloprid (Confidor) 17.8 SL @ 50-60 ml/acre, or Thiamethoxam @ 50-60 g/acre.

Insect pest management



Larger Moth (Leaf webber): *Crocidolomia binotalis*

Damage : Newly hatched larvae feed gregariously initially on the chlorophyll of young leaves and later on older leaves, buds and pods; they make webbings and live within. Severely attacked plants are defoliated. Seeds in the pods are also eaten away.

Non-chemical management: Collection and careful destruction of the larvae at gregarious stage while on surveillance. Spraying of NSKE 5% or other neem formulations containing 300 ppm Azadirachtin @ 1 liter / acre. Spraying of BT formulation (Dipel, Delfin, Biodart, Halt, Bioasp, Biolep etc.) @ 400 gram/acre during evening hours at 7-10 days intervals from appearance of the pest.

Chemical management: Spray Endosulfan, Triazophos, or Monocrotophos @ 400 ml/acre or Carbaryl @ 800 gram/acre is effective.

Diamondback Moth: *Plutella xylostella*



Damage : Caterpillars feed on the foliage and make it white and papery. The leaves look withered but in later stages it may be eaten up completely. Caterpillars also bore into pods and feed on developing seeds.

Non-chemical management: Install eight to ten pheromone traps to control the adult males. Conserve its natural enemies like *Cotesia plutellae* and *Diadegma insulare* as they are an important parasitoid for diamond back moth. Spraying of NSKE 5% or other neem formulations containing 300 ppm Azadirachtin @ 1 liter /acre. Spraying of BT formulation (Dipel, Delfin, Biodart, Halt, Bioasp, Biolep etc.)@ 400 gram /acre during evening hours at 7-10 days intervals from appearance of the pest.

Chemical management : Spray Fipronil 5 SC (Regent) or Chlorfenapyr (Rampage) 10 SC or Triazophos 40 EC (Hostathoin) @ 400 ml/acre or Flufenoxuron (Cascade 10 WDC) @ 120 ml/acre.

Insect pest management



Cabbage Head Borer: *Hellula undalis*

Damage : Caterpillars initially mine the leaves and make it white and papery. Later they feed on leaves and bore into stems; entrance hole is covered with silk and excreta.

Non-chemical management: Collection and careful destruction of the larvae at gregarious stage on leaves twice a week. Spray NSKE 5% or other neem formulations containing 300 ppm Azadirachtin @ 1 liter /acre. Spray BT formulation (Dipel, Delfin, Biodart, Halt, Bioasp, Biolep etc.) @ 400 gram/acre during evening hours at 7-10 days intervals from appearance of the pest.

Chemical management: Spray Ethofenprox @ 200 ml/acre, Endosulfan, or Triazophos @ 400 ml/ acre two to three times at an interval of ten days.

Mustard Sawfly: *Athalia lugens proxima*

Damage: Initially the larva nibbles on leaves, later it feeds from the margins towards the midrib. Feeding results in drying up of seedlings and failure to bear seeds in older plants. The yield loss is up to 5 -18 %.

Non-chemical management: Maintain clean cultivation. Apply irrigation in seedling stage because most of the larvae drown to death. Collect and destroy grubs of the sawfly in morning and evening. Conserve *Perilissus cingulator* (a parasite of the grub). Use of bitter gourd seed oil emulsion as an anti-feedant. Spray NSKE 5% or other neem formulations containing 300 ppm Azadirachtin @ 1 liter /acre.

Chemical management: Spray the crop with Endosulphan 35 EC, or Quinolphos 25 EC or Triazophos 40 EC @400 ml/acre.





Children in front of SMI field in Gaya District, Bihar



**Dr. O.P. Rupela,
ICRISAT scientist
standing with
village boy in
front of SMI field
in Gaya district,
Bihar**

This training manual has been prepared by PRADAN (Gaya) with financial assistance from ATMA (Gaya). It contains experience gained through working with farmers from Gaya and Nalanda districts. There have been regular consultations with the Indian Council for Agriculture Research (ICAR), Patna, on cost estimates and financial calculations. Disease and insect management information has been drawn from pamphlet on "Growing Crops with SRI Principles" published by Livolink Foundation of Bhubaneswar, Odisha. The authors thank all the mentioned organizations for their support. Special thanks go to SDTT, Mumbai, for replicating the method elsewhere.

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INSPECTION OF A VIGOROUS FIELD OF SRI-INSPIRED MUSTARD CROP

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