

# System of wheat intensification

## An innovative approach

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*System of wheat intensification (SWI) is an innovative wheat establishment technique involving components of wheat cultivation practices such as sowing, weeding, irrigation, and nutrient management. These management practices provide better condition for growth of wheat crop in the root zone than those plants grown under conventional wheat cultivation practices. SWI is a new opportunity for raising wheat production that can directly increase farmers' income and reduce food insecurity for small and marginal farmers. It may enable the crop to withstand biotic and abiotic stresses which are becoming more severe with climate change in present context. The adoption of SWI can increase productivity and profit of the resource poor farmers by saving agro inputs.*

**Key words:** Conventional, Food security, System of wheat intensification

**W**HEAT (*Triticum aestivum* L.) is a widely cultivated food crop in diverse ecosystems around the world, which contributes more calories and protein to human diet. In India, wheat occupies 29.72 million hectare area with a production of 98.61 million tonnes (ICAR-IIWBR, 2017). During 1960s and 1970s, green revolution revolutionized the production systems, primarily due to its greater responsiveness to fertilizer, water, improvement in yield attributes, shattering resistance and resistance to diseases and lodging, which accelerated adoption of the Mexican varieties worldwide. As the performance galore of input-intensive technology wane away, the perpetuated low and declining productivity of wheat is a major challenge. This mode of cultivation may not meet the food demand of the ever-growing population on a sustainable manner. In this context, the principles of system of crop intensification (SCI)-an innovation in rice production is suitable for wheat cultivation, which demonstrates

better potentiality of production enhancement.

The Principles of System of Crop Intensification (SCI), an innovation that provides opportunity for higher production per unit of agricultural inputs like fertilizer, seed, etc. Encouraging results obtained by adopting system of wheat intensification (SWI) or adopting SCI principles in wheat cultivation. The principles of early and healthy plant establishment, reducing competition between plants, increased soil organic matter, active soil aeration, and the careful application of water are contributing to raise the productivity and profitability of differently-managed crops. In India and Ethiopia such changes in crop management, improvement have demonstrated positive to food security and thus being scaled up with hundreds of thousands of farmers. This production strategy under SCI may be considered as 'labour intensive' but households seeking to get maximum yield from the small areas

of land available to them find that the additional effort and care enhance net returns as well as livelihood security. The resulting crops are more robust, resistant both to pest and disease damage and to adverse climatic conditions. Using SCI methods, smallholding farmers in many countries also started to get higher yields and greater productivity from their land, labour, seeds, water and capital, with crops showing more resilience to the hazards of climate change. Keeping the above in view a carefully-designed experiment was conducted to compare and confirm the performance of conventional improved methods and SWI practices to validate the principles of SWI and to provide supportive empirical evidences.

### What is system of wheat intensification

SWI is an innovative wheat establishment technique involving components of wheat cultivation practices such as sowing, weeding, irrigation, and nutrient management. These management practices provide

better condition of growth for wheat crop in the root zone than those plants grown under conventional wheat cultivation practices.

### Principles of SWI

SWI is primarily based on following two principles of crop production:

1. Principle of root development
2. Principle of intensive care

#### Principle of root development

For the proper development of crop plant, it must be well established from rooting system. Root development is the first step of healthy growth and development of any plant. It requires proper nourishment and sufficient space around the plant. Distance between plants is crucial for proper growth and development of crop plants.

#### Principle of intensive care

Intensification does not mean high number of plant density per unit space; rather it is proper space maintenance and taking care of plants very closely. To enhance productivity it requires intensive care in every stage of plant growth specially management of weed, insect, disease, organic manure and irrigation.

### Package of practices for SWI

In SWI, the fundamental practices of wheat cultivation more or less remain same; however it creates conducive environment for crop through changes in sowing geometry weed management and a stressing on organic manuring. It aims to increase the crop production while enhancing the intrinsic productivity of land, with minimum use of external inputs. SWI requires a number of steps for successful increase in grain and straw yield; land preparation, seed selection, seed treatment, field preparation, sowing, weeding, manure application and proper use of irrigation which are presented in brief below.

**Land selection and preparation:** Well drained, loamy fertile soil with pH ranging from 6.0 to 8.5 is considered ideal for cultivation of wheat. Avoid water logged soils and select land with which is having

adequate drainage facility for removing of excess water.

The three ploughings are required for obtaining good tilth for wheat sowing in SWI. The first ploughing is done to remove roots of preceding crops cultivated on the land. After 1 to 1½ month compost is applied and land is ploughed for the second time. Last ploughing is carried out before sowing of wheat seeds.

**Manure application:** A good wheat crop requires adequate amount of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O proper proportion *i.e.* 80-125:40-60:30-40kg/ha. Soil test based nutrient has been recommended followed by the application of organic manures such as farm yard manure, vermicompost, NADEP compost, liquid manure like *panchagavya*, *amritghol* and *matkakhad* (PAM) and other manures (including crop residue and animal dung are commonly used for this purpose) to maintain the balance of essential nutrients.

**Seed selection and treatment:** 20–25 kg/ha bold and healthy wheat

seeds are taken by putting seeds in solution of 20% salt in water and removal of floating seeds. Thus, for seed treatment a mixture of 10 L warm water (60°C), 2 kg well-decomposed compost or vermicompost, 3 litres of cow urine and 2 kg of jaggery prepared in an earthen pot. After mixing it properly, 5 kg seeds dipped in the mixture and left for 6-8 hours. With the same ratio of the above ingredient, the mixture for may be prepared for more amount of seed for treatment. The next step is to separate seeds from mixture by filter and washing with clean water. Treated seeds is kept in shade for 10–12 hours and by this time seeds fully sprout.

**Sowing:** The sprouted seeds will be used for sowing in the field by dibbling using two seeds per hill. Different row to row and plant to plant spacing (15 cm × 15 cm or 20 cm × 20 cm) can be used depending on the moisture content. A manually driven or motorized seed drill can be used for sowing. If seed drill is not

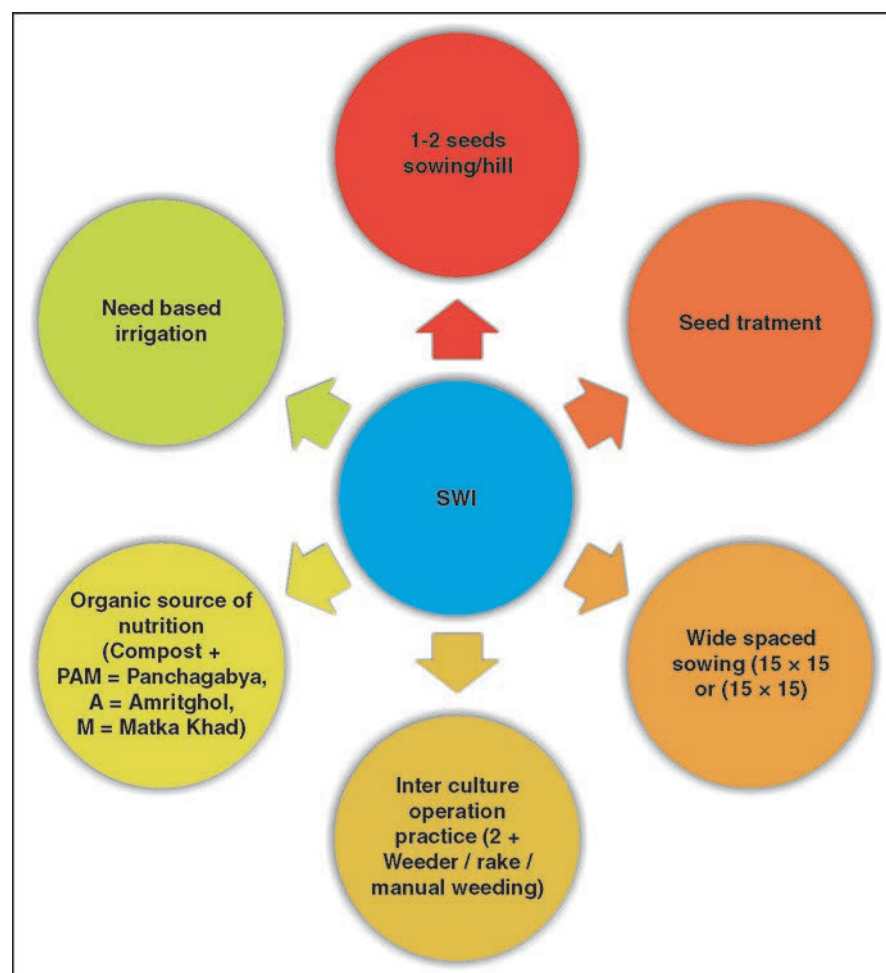


Fig. 1: Package of practices for SWI

**Table 1.** Comparison between conventional and SWI

| Particulars       | Conventional | SWI                                                                    |
|-------------------|--------------|------------------------------------------------------------------------|
| Seed treatment    | Not done     | Done with warm water, cow urine, jaggery, vermicompost and Trichoderma |
| Seed rate (kg/ha) | 100-125      | 20-25                                                                  |
| Sowing            | Broadcasting | Line sowing                                                            |
| Spacing           | 22.5 cm      | 20 cm × 20 cm                                                          |
| Weeding or hoeing | No weeding   | 3 times                                                                |

Source: Uphoff *et al.* (2011)

**Table 2.** System of wheat intensification (SWI), result of Uttar Pradesh (UP), India

| Parameters          | Normal wheat | SWI                                  |
|---------------------|--------------|--------------------------------------|
| Method of sowing    | Broad casted | Single seed sowing (8 inches square) |
| Seed rate           | 35 kg/acre   | 5 kg/acre                            |
| No. of tillers/hill | 4-5          | 25-30                                |
| Panicle length      | 4-6 cm       | 12-15 cm                             |
| Grains per panicle  | 25-30        | 60-70                                |
| Yield (t/ha)        | 1.97         | 2.22                                 |

Source: Ramanjaneyulu (2010)

available then the fields are marked by using rope or a string tagged at 15/20cm intervals. Seeds will be sown at a depth of 2.5–3.0 cm using a dibbler or pegs. Sufficient moisture should be provided in the soil while sowing germinated seed. Wherever the seed failed to germinate or destroyed, the gaps were filled with germinated seeds within 10 days of sowing. Extra seeds germinated in a hill have removed to reduce competition.

**Weed management:** Hoeing is essential component of SWI since it ruins the weeds that compete with crop for space, light, water and nutrients. Weeding through hoeing loosens the soils and effectively aerates the roots, allowing exploration of soil that leads to better water and nutrients absorption from deeper soil depth. The weeds are incorporated into the soils which helps in increasing water holding capacity and nutrients status of the soil. In SWI normally weeding is done 2-3 times, first weeding at 20-25 days after sowing (DAS). Subsequent weedings are carried out at an interval of 10 days.

**Water management:** In SWI, the soil is kept alternately wet and dry, and 3-5 irrigations may be given as per soil moisture status. First irrigation is given at 15 DAS, before the crown root initiation (CRI). A second irrigation will be given after 40 DAS as the soil develop hairline

cracks. Irrigations are given before weeding in the early stages of crop growth. A third irrigation was given at 75 DAS. Fourth irrigation was given at flowering and fifth irrigation at grain-filling stage.

**Pest and disease management:** Varieties, which are resistant to pest and disease are selected, and seed treatment can be done before sowing of the seed to prevent crop damage caused by various biotic stresses. The use of biological pest control tactics like biological agents and organic insecticides is advocated in SWI.

**Harvesting:** Adequate availability of sun light, water and proper aeration leads to effective tillers/hill. The proper adoption of the SWI

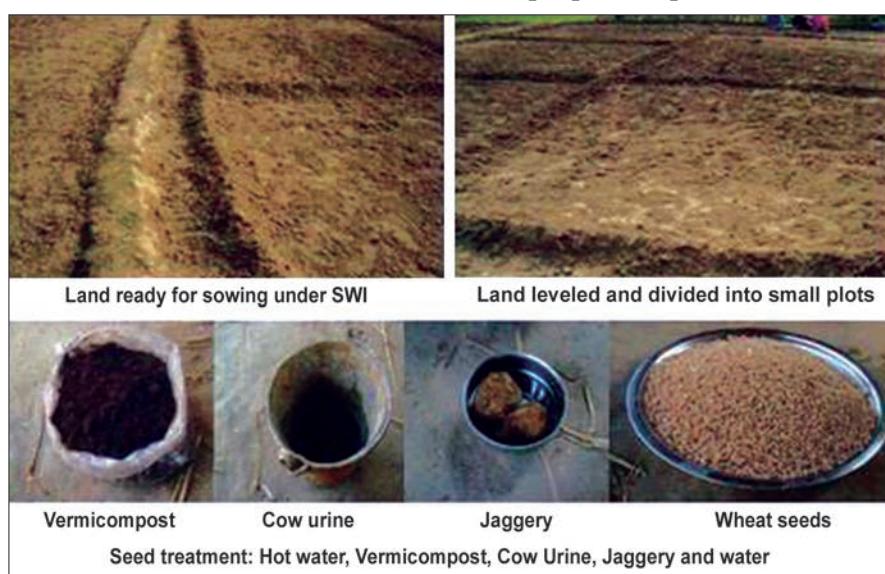


Fig. 2. Land preparation and seed treatment practices under SWI



Fig. 3. Sowing crop at different stage under SWI

**Table 3.** Comparative cost of cultivation under conventional method of wheat cultivation and SWI

| Particulars                               | Conventional (₹/acre) | SWI (₹/acre) |
|-------------------------------------------|-----------------------|--------------|
| A) Operations                             |                       |              |
| Ploughing                                 | 3,000                 | 3,000        |
| Seed                                      | 650                   | 300          |
| Weeding                                   | 0                     | 1,800        |
| Irrigation                                | 300                   | 500          |
| Fertilizer and plant protection chemicals | 200                   | 400          |
| Harvesting and threshing                  | 2,000                 | 2,000        |
| Total                                     | 6,150                 | 8,000        |
| B) Yield and Income                       |                       |              |
| Grain yield (q/acre)                      | 6                     | 10           |
| Gross income @ 1100 per q                 | 6,600                 | 11,000       |
| Straw yield (q/acre)                      | 10                    | 16           |
| Straw Income@ 200 per q                   | 2,000                 | 3,200        |
| Total gross income                        | 8,600                 | 14,200       |
| Net income (Rs)                           | 2,450                 | 6,200        |

Source: Relkar (2011)



Fig. 4. Comparison of wheat panicles from the same variety: On left, plants are grown with usual farmer methods of cultivation (39 grains per panicle on average); and on right, SWI crop management (56 grains per panicle on average).

package and practices, the crop matures in time and subsequently harvested when the moisture content of wheat grain is around 20-25%.

#### Adoption of SWI in India

- In India, SWI first tested in 2006 by PSI (People Science Institute) in northern India with 40 farmers in 25 villages, obtaining a 66% yield increase over their traditional practices.
- Within three years the number of farmers using the new methods was over 12,000 in Himachal Pradesh and Uttarakhand.

- The most rapid growth is in Bihar, where 415 farmers, mostly women, tried SWI methods in 2008-09, with yields averaging 3.6 t/ha, compared with 1.6 t/ha using usual practices.
- In 2009-10, 15,808 farmers used SWI with average yields of 4.6 t/ha. In the past year, 2011/12, the SWI area in Bihar was reported to be 183,063 ha, with average yields of 4.5 t/ha.

#### Benefits of SWI

- More number of effective tillers.
- No lodging of crop and increased

production.

- Early anthesis and crop maturity (4-5 days).
- Long and shining grain is obtained- good grain quality.
- More fodder available for cattle.
- No/ lesser disease incidence and insect infestation.
- Less seed requirement 75-80% seed saving (Only 20-25 kg/ha).
- Weeding facilitated good aeration to roots.
- Less water requirement (20-30%).
- High seed germination rate and better plant stand.
- Suitable for organic farming, fertility of soil is also improved.

#### Constraints in SWI

- Need to design and develop suitable sowing implement.
- Availability of suitable weeder to the farmers.
- Capacity building of farmers in adoption of SWI.
- To ensure irrigation at critical stages of crop growth.
- Intensive scientific study need to be done at research station.

#### SUMMARY

SWI is a new opportunity for raising wheat production that can directly increase farmers' income and reduce food insecurity for small and marginal farmers. It may enable the crop to withstand biotic and abiotic stresses which are becoming more severe with climate change in present context. The adoption of SWI can increase productivity and profit of the resource poor farmers by saving agro inputs.

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#### Know Krishi Unnati Yojana

The *Krishi Unnati Yojana*, a central sector scheme, is envisaged as umbrella programme for focusing on food security, by merging schemes on Soil-health Card, Integrated Scheme on Agricultural Co-operation and Agricultural Marketing, National Mission on Agriculture Extension, Horticulture Development, Price Stabilization Fund, National Mission on Sustainable Agriculture and other programmes.