

# Optimizing lowland agriculture: Raised and sunken bed technology in the north eastern Himalayas

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*The north eastern region of India is blessed with diverse crops, high rainfall, and a suitable agro-climate. However, the region faces unique challenges such as waterlogging and poor drainage during summer, as well as water stress in the winter season. In this context, adoption of raised and sunken bed (RSB) technology in valley lands ensures the proper utilization of available land resources, increases cropping intensity by up to 300%, and enhances farm profitability for long-term benefits. Raised beds can be used for growing vegetables such as okra, tomato, potato, French beans, carrot, brinjal, and broccoli, while sunken beds can be utilized for cultivating rice, followed by vegetable peas, lentils, and other crops using proper resource conservation technologies. Field experiments conducted at ICAR Research Complex for North Eastern Hill Region, Meghalaya, have demonstrated the system's effectiveness in enhancing productivity, soil health, the sustainable yield index, and economic viability. However, its success depends on strategic crop selection and effective nutrient management practices. In summary, the adoption of RSB technology in valley lands could be a practical approach towards achieving food security, improving soil fertility, and enhancing economic resilience in the north eastern Himalayan region.*

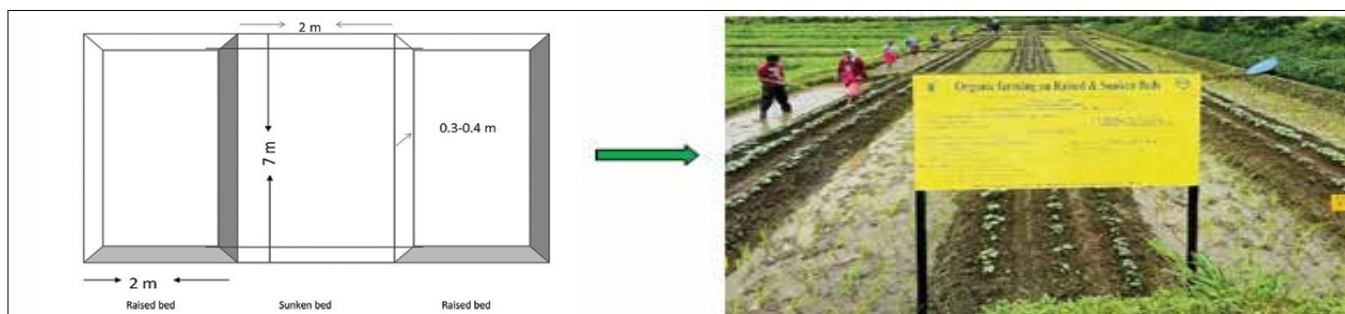
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**R**AISED and Sunken Bed (RSB) technology is an innovative land configuration system designed to optimize crop production in waterlogged and poorly drained agricultural lands. This configuration effectively manages land and water by promoting inter-plot water harvesting, improving soil drainage, enhancing aeration, and facilitating year-round cultivation. It involves excavating surface soil from designated areas to form sunken beds, while depositing the removed soil onto adjacent sections to create raised beds. RSB technology is commonly known as 'high bed-low ditch (HBLD) system' or 'dike-ditch interactive system' in southern China, while in southeast Asia, it is referred to as 'dike-ditch system', or 'raised-bed-dike system (rong chin in Thai)'. In Java and Indonesian tidal wetland, this method is extensively practiced as 'Sorjan or Surjan system', where high value upland crops are grown on raised beds and rice in sunken beds. In India, this system has been successfully adopted in the Indo-Gangetic plains

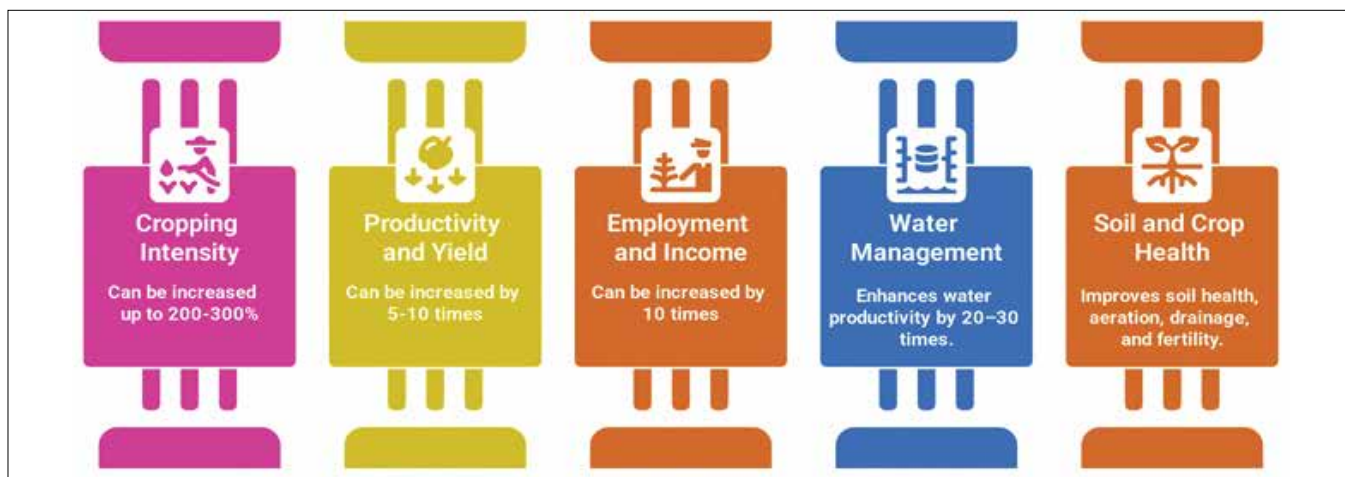
and North Eastern Region (NER), where excessive monsoon rainfall leads to prolonged soil saturation, restricting farmers to rice monocropping. Additionally, in coastal regions like the Sundarbans, RSB system aids in rainwater harvesting, soil salinity management, and dry-season crop production.

## **Raised and sunken beds in ICAR, Meghalaya**

The low-lying areas can benefit from the configuration of lands generally known as RSB technology. In north eastern India, especially Meghalaya, the mono-cropping of rice is predominant in the valley ecosystem, and around 15,500 hectares of land remain under marshy conditions in the rainy season. Contrastingly, in the winter season, the farmers make temporary bun (broad beds) for growing vegetables such as tomato, potato, French bean etc. nevertheless, before the sowing of succeeding rice crops, the bun get dismantled, and levelled which not only escalates the production costs



Schematic illustration of alternate raised, and sunken beds system (RSB)



Advantages of raised, and sunken beds (RSB) technology

but also consumes greater energy. In this context, ICAR Research Complex for the NEH region has developed a permanent RSB by the cut-and-fill method by removing soil from individually sunken beds and depositing it in the adjacent area for creating raised beds. The dimensions of an individual plot were 7 m in length, 2 m in width, and 0.3 m in height, wherein 40% of the areas were allocated to raised beds and 60% to sunken beds.

#### Case studies from ICAR Research Complex for NEH Region, Meghalaya

**Case study 1 [Impact of RSB on productivity and soil health]:** A long-term field experiment was conducted at ICAR-RC for NEH Region, Meghalaya, India to assess the impact of RSB system under different organic nutrient management. In the sunken beds, 03 rice varieties viz. Megha SA-1, Shahsarang 1, and IR-64 were cultivated, followed by pea under no-till conditions. Meanwhile, the raised beds were utilized for three vegetable-based cropping systems: okra-potato, okra-French bean, and okra-carrot along with organic nutrient sources: (i) 100% of the recommended dose of farmyard manure (FYM), (ii) 100% of the recommended dose of vermicompost (VC), and (iii) a combination of 50% FYM and 50% VC. The results of the study demonstrated that the system productivity increases in the Shahsarang 1-pea system by 5.55 14.0% compared to others. Among nutrient sources, application of FYM + VC resulted in 23.0% and 23.7% higher system productivity than VC and FYM alone, respectively. In raised beds, okra-carrot system exhibited the highest system productivity (24.7 t/ha),

system production efficiency (67.7 kg/ha/day), and SYI (0.93). Similarly, the combined application of FYM + VC resulted in greater system productivity (21.9 t/ha), and SYI of 0.82. Further, highest soil organic carbon (SOC) content in the sunken bed system was recorded in the Shahsarang 1-pea system (26.6 g/kg) and FYM application (26.73 g/kg). Similar trend was observed in terms of nitrogen (N), phosphorus (P), and potassium (K). Further, the okra-french bean system (22.6 g/kg) and FYM-treated plots (22.7 g/kg) recorded the highest SOC, statistically similar to okra-potato (22.5 g/kg) and FYM + VC application. Among nutrient management practices, FYM application resulted in the highest available nitrogen (256.3 kg/ha), whereas the combined use of FYM + VC led to the highest available phosphorus (11.3 kg/ha) and potassium (264.8 kg/ha), followed by FYM and VC alone.

**Case study 2 [Impact of RSB on economic profitability]:** The long-term experiment on RSB technology was established in 2005 at ICAR-Research Complex for NEH Region, Meghalaya, India. The experiment consists of four rice cultivars-Megha Aromatic, Shahsarang 1, Ngoba, and Lampnah in sunken beds, while in raised beds, okra-tomato, okra-potato, okra-French bean, and okra-carrot were imposed along with four nutrient management strategies: (i) 75% recommended dose (RDF) through farmyard manure (FYM), (ii) ~100% RDF through FYM, (iii) integrated nutrient management (50% RDF from FYM and fertilizers), and (iv) ~100% RDF through fertilizers. The results revealed that, the highest gross, and net returns



Raised and sunken beds system in the farmers' field, and experimental site at ICAR-Research Complex for North Eastern Hill Region, Umiam, Meghalaya

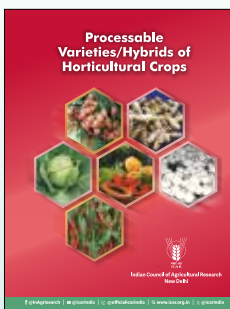
were recorded in Lampnah (1,15,852) and 75,964 ₹/ha, respectively), while Shahsarang 1 yielded the lowest (1,04,063 and 64,087 ₹/ha). Among nutrient management practices, highest production cost was associated with 100% organic management (42,459 ₹/ha), whereas 75% organic incurred the least (36,342 ₹/ha). The highest gross return was achieved under 100% organic management (1,15,764 ₹/ha), with net returns following a similar trend, showing 5.56%, 6.16%, and 6.52% higher returns compared to 75% organic, integrated, and 100% inorganic management, respectively. In raised beds, among cropping systems, highest cost of cultivation was recorded under okra-potato (1,23,564 ₹/ha). The highest net returns were recorded in the okra-carrot system (4,33,006 ₹/ha), which was 1.67%–47.0% higher than other cropping systems. Among nutrient management strategies, the highest net return was observed under integrated nutrient management (1,23,564 ₹/ha), followed by 100% organic (3,83,368 ₹/ha), while 75% organic resulted in the lowest net return (2,86,041 ₹/ha).

### SUMMARY

The adoption of Raised and Sunken Bed (RSB) system presents a promising approach to enhancing agricultural productivity, cropping intensity, and farm income. Since rice is a staple food, completely replacing it is not feasible. However, the "rice plus" system, which integrates rice with legumes in sunken beds and diverse vegetables in raised beds offers a sustainable intensification strategy. RSB technology is an economically viable solution for improving farm productivity and soil health through continuous organic farming. Recommended cropping sequences are particularly effective for enhancing system productivity along with higher economic returns. However, successful adoption depends on precise land configuration, as improper construction may reduce productivity. By implementing RSB systems correctly, farmers can achieve sustainable agricultural growth and significantly improve their livelihoods.

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