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ICAR

TECHNOLOGY BROCHURE

जल प्रबंधन निदेशालय
D. W. M

Directorate of Water Management

(Indian Council of Agricultural Research)

Chandrasekharpur, P.O. Rail Vihar
Bhubaneswar, Odisha 751023, India
Website: www.dwm.res.in

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PREFACE

Water the critical resource is being affected by deforestation, industrialization, urbanization, increasing population and all developmental activities. The Directorate of Water Management (formerly known as Water Technology Centre for Eastern Region) has been addressing the issues of on-farm water management through basic, applied and strategic research activities under rainwater, canal water, groundwater, and waterlogged area management programmes. The Institute developed various technological packages suiting to the need of different agro-ecological regions across the country. These are compiled and described the nitty gritty of the technologies in simple language in this booklet, which help the farming community to go through, understand it and reap the benefits of various technologies wherever possible at their own context.

Directorate of Water Management (ICAR) has developed many promising technologies for **(i)** management and conservation of on-farm water resources for sustainable agricultural production, **(ii)** significant reduction in the use of irrigation water per unit irrigated area, **(iii)** excess water management in agricultural lands, **(iv)** development of sustainable cropping systems in relation to the availability of water, **(v)** strategies for multiple uses of water to enhance water productivity, **(vi)** reuse of poor quality groundwater and industrial and municipal wastewaters, and **(vii)** avoiding the contaminations and further degradation of soil and water resources.

These technologies are tested in the farmers' field and being demonstrated / exhibited through the programmes such as Farmers' Participatory Action Research Programme (FPARP) and Scaling-up of Water Productivity in Agriculture for Livelihoods (SWPA) in different locations. Some of the most promising and bankable technologies to enhance the water productivity in the eastern region are given here.

1. In-situ Rainwater Conservation

Technology description: In 8% of the total rice field, small dugout ponds of 2.5 m depth and 1:1 side slope beneficial is at downstream. This pond can be used for short-duration aquaculture during monsoon and its embankment for growing horticultural crops. The conserved rainwater in the pond is used for giving supplemental irrigations to *kharif* paddy and irrigating *rabi* crops.

Input needed: Size of the pond [800 m^2 (8% of 1 ha area)], total cost of the work (₹ 66,670/-), total man days input (900).

Output capacity: The *kharif* paddy yield could increase from 1.8 t/ha to 4.9 t/ha with fish yield of 1.4 t/ha.

Specific benefit and impact: The cropping intensity increases up to 200%.

Unit cost: The construction cost of the system is about ₹ 67,000/- per hectare.

Optimum dike height in rice fields for in-situ conservation of rainwater

2. Micro Level Water Resource Development through Tank cum Well System

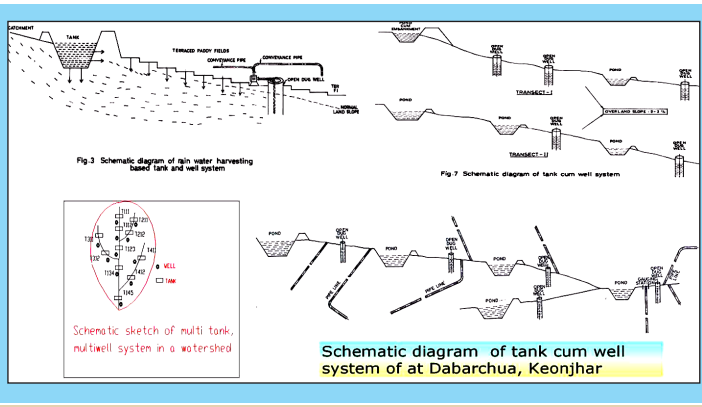
Technology description: The tank cum well system technology along the drainage line in a watershed is recommended for plateau areas having slope of 2 to 5%. The site for the technology should be selected in such a way that the area should have a well defined valley where the runoff flows either as overland flow or channel flow. The well is constructed about 100 to 300 m downstream of the tank to tap the water that is lost by seepage from the tank illustrated as follows.

Input needed: A set of 15 tanks and wells in a village area of 500 ha to irrigate net 60 ha and gross 120 ha area.

Output capacity: ₹ 50,000/- extra gross income per year with additional employment generation of 115 man days per ha.

Specific benefits and impact: Increase in cropping intensity to 166%.

Unit cost: ₹ 80,000/ ha of net command area



An overview of the micro-water resources

3. Farm Pond Based Agricultural Diversification Model for Rainfed Areas

Technology description: Rainwater harvesting system is designed and agricultural diversification model (on-dyke horticulture, fisheries, cultivation of diversified field crops, short term fruits like papaya, bananna, floriculture like marigold, tube rose etc.) with harvested rainwater has developed for small and marginal farmers through multiple use of water. It is suitable for rainfed medium and lowland.

Input needed: Land, seeds of field crops, vegetables and short duration fruits (papaya, banana, drumstick), fertilizers, necessary agro-inputs, fish seed.

Output capacity : Additional income: ₹ 25,000-30,000/- per ha

Specific benefits and impact: The cropping intensity can be increased up to 200% due to harvesting of spring and rainwater to a substantial extent, which in turn generate man days and increases gross income of farm families per year.

Unit cost: ₹ 40/- per m^3

4. Low Cost Management of Acid Soils for Higher Productivity and Water Use Efficiency

Technology description: Soil acidity is one of the limiting factors that affects crop production adversely in many parts of India (nearly 40% soils in India are acidic). It is necessary to ameliorate the acid soils with liming materials along with suitable cropping system and water management practices to enhance the productivity and water use efficiency of crops in acid soil. Liming materials are expensive and not available sometimes. In that respect the low cost liming material like paper mill sludge can be very well used to ameliorate acid soils. This byproduct of paper mill will not only raise agricultural production with low cost but also reduce environmental pollution in the surrounding areas of the factory and it is within the reach of farmers.

Input needed : Low cost liming materials like paper mill sludge, seeds of crops like maize, groundnut, black gram, cowpea and green gram, fertilizers and necessary agro-inputs

Output capacity: Additional income : ₹ 20,000/- per ha, Water use efficiency increased by 36-60%.

Specific benefits and impact: Paper mill sludge could ameliorate acidic soils and increased the yield of different crops by 34-68%. The Odisha Government adopted the technology and planned to ameliorate 2.4 lakh hectares acidic land in 2008 by supplying Paper Mill Sludge. From the year 2008-09, the Odisha Government started supply of paper mill sludge at subsidized rate (Rs 10/- per 50 kg capacity bag). During *rabi* 2008-09, the IFFCO, Bhubaneswar adopted the technology of paper mill sludge application in 120 acres areas in Balasore, Odisha for growing groundnut crops by involving 223 farmers.

Unit cost: Rs 12,000 to 15,000/- per ha depending on the soil pH.

5. Crop Diversification in Drought Prone Areas

Technology description: Crop diversification by adopting maize, groundnut-pigeonpea, sole groundnut and sole pigeon pea under rice based cropping at rainfed upland conditions.

Input needed: Seeds of rice substituted crops (maize, groundnut, black gram, cowpea, green gram), fertilizers and necessary agro-inputs

Output capacity: Higher rice equivalent yield per annum was obtained through maize cob (8125 kg ha^{-1}), groundnut + pigeon pea (5550 kg ha^{-1}), sole groundnut (5640 kg ha^{-1}), sole pigeon pea (5550 kg ha^{-1}).

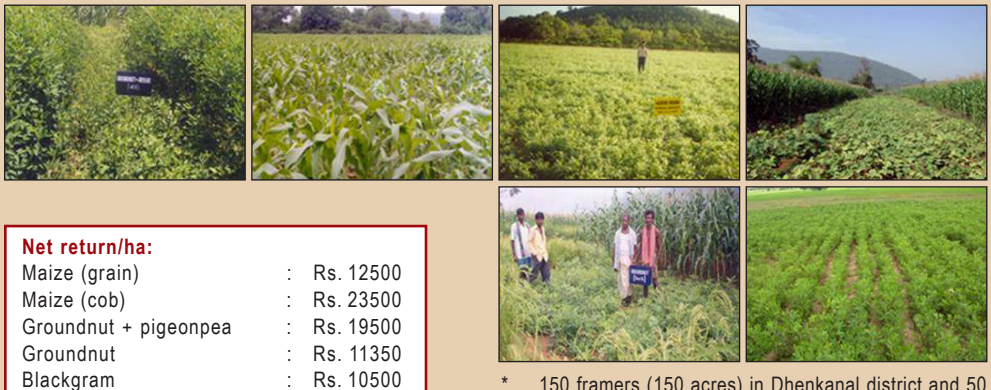
Specific benefits and impact: Rice equivalent yield of 7.5 t ha^{-1} with average net return of ₹ 25,000/- per ha per annum.

Unit cost: Cost of cultivation per unit area is Rs 10,000-14,000/- per ha

6. Residual Soil Moisture Utilization in Rainfed Rice Ecology of Coastal Orissa

Technology description: Growing greengram, blackgram, horsegram and sesamum as paira crop after *kharif* paddy which remains fallow in subsequent seasons.

Input needed: Seeds of greengram, blackgram, horsegram and sesamum and necessary agro-inputs



Net return/ha:

Maize (grain)	:	Rs. 12500
Maize (cob)	:	Rs. 23500
Groundnut + pigeonpea	:	Rs. 19500
Groundnut	:	Rs. 11350
Blackgram	:	Rs. 10500
Cowpea	:	Rs. 9500
Maize (cob) - horsegram (Double cropping)	:	Rs. 28300

* 150 framers (150 acres) in Dhenkanal district and 50 farmers (50 acres) in Mayurbhanj & Balasore districts of Orissa adopted the technology during kharif 2007.
* Technology is suitable in 4.3 mha rainfed upland rice areas of eastern India.

In-situ soil moisutre conservation andcrop diversification in drought prone areas

Output capacity: Sowing of greengram, blackgram, horsegram and sesamum under rice fallow could produce 950, 800, 750 and 450 kg/ha, respectively by utilizing residual soil moisture

Specific benefits and impact: Around 11 million ha land remains fallow after *Kharif* season, by doing paira cropping an additional amount of ₹ 10000 – 15000/- per ha can be earned

7. Design and Development of Rubber Dam for Watershed

Technology description: A rubber dam or flexible check dam is an inflatable structure build across a stream used for water conservation, flood control and regulating flow of water in the stream. When it is inflated, it serves as a check dam/weir, and when it is deflated, it functions as a flood mitigation device and sediment flushing. The head or height of rubber dam is variable. This variable head also regulates the depth of flow in the irrigation diversion channel present in the upstream side of the check dam or in irrigation canals and distributaries.

Rubber Dam

Specific benefits: The main advantages of the rubber dam are its ability for better water conservation, soil erosion control, and flood control. Additional water storage in the range of 4500 to 10000 m^3 is available for irrigation. It also acts as a dam/ reservoir for storing water during scanty rainfall period (dry spells) so that supplemental irrigation can be provided to the crops for enhancing production and productivity. This technology has a potential to benefit farmers in rainfed agro-ecosystems as well as in coastal areas susceptible for sea water ingress, natural calamities like cyclone, flood, high tide, tsunami etc.

Impact: Adoption of technology can increase the crop production, crop diversification and cropping intensity and in turn enhance the rural income. The productivity of rice can be increased up to 62% due to assured irrigation during *Kharif* season, and the productivity of green gram and vegetable crops up to 25% and 40% during rabi and summer seasons respectively.

Unit cost: ₹ 800000/- per one unit of 5 m width and 1.5 m height for 40 ha land

8. Raised and Sunken Bed

Technology description: It is suitable for medium and low land situation. The land is converted into alternate sunken and raised beds (1:1) each of 30 m length and 5 m width. Different

vegetable crops of local importance may be grown on the raised beds. Sunken beds are used for growing low land rice or other aquatic crops like Colocasia. Fish spawn can also be raised up to fingerling stage in the sunken beds together with rice.

Input needed: Land area (1 ha), crop input parameters and fish input parameters and 700 man days.

View of Sunken and raised bed

Output capacity: The adoption of the technology increased *kharif* paddy and pointed guard yield from 4.2 t/ha to 5.2 t/ha and 4.24 t/ha to 4.74 t/ha respectively. In addition, fish yield of 1 t/ha.

Specific benefits and impact: Additional income per ha per year: ₹ 70000/-.

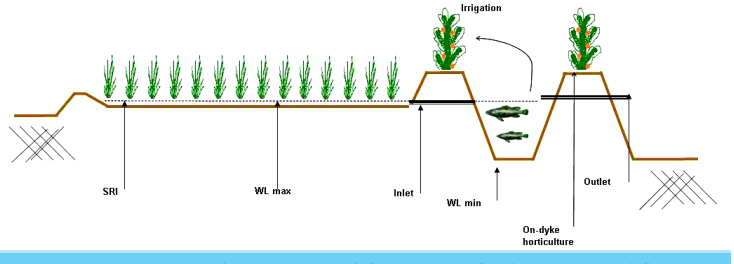
Unit cost: ₹ 50000/- per ha.

9. Integration of Aquaculture with System of Rice Intensification (SRI)

Technology description: To enhance land and water productivity of rainfed medium land, 10% area of System of Rice Intensification (SRI) fields can be converted into small dugout pond (refuge) at downstream to harvest rainwater for utilizing in supplementary irrigation and short-term fish culture, and use its embankment for horticultural crops.

Input needed: Rice field and related agro inputs

Output capacity: Rice yield increased from 2.89 t/ha to 6.16 t/ha with fish yield of 2.6 t/ha. The cost of cultivation ratio indicates that in the integrated SRI system for an investment of ₹ 1.0/-, one can get a return of ₹ 2.97/-, but in conventional rice system for an investment of ₹1.0/-, one can get only ₹ 1.13/-.



View of Integrated SRI field *Lay-out Design of Integrated System of Rice Intensification*

Specific benefits and impact: It has potential to generate net profit of ₹ 268,600/- per hectare of land in two years

Unit cost: ₹ 1,36,000/- per ha

10. Improved Planting Technique for Saving of Irrigation Water in Post-rainy season Crops

Technology description: During post-rainy season, paired-row planting for groundnut at 45 x 15 cm spacing (paired row at 15 cm on raised beds with 45 cm furrow spacing); and paired-row planting of potato at 75 x 20 cm spacing (paired row at 25 cm on raised beds with 75 cm furrow spacing) save irrigation water over flat-bed and normal planting for groundnut and potato, respectively.

Inputs needed: Seeds, fertilizers and necessary agro inputs

Output capacity: For expense of ₹ 1.0/- the maximum net return is ₹ 2.10/- for groundnut (45 x 15 cm) and ₹ 2.15/- for potato (75 x 20 cm) despite substantial saving of irrigation water

Specific benefits and advantages: Paired row planting on raised beds gives pod yield advantage by 13-20% over flat bed planting of groundnut, irrigation water saving to the extent of 27-41% and enhancement of crop WUE by 40-45%. Similarly, the paired row planting technique in potato saves irrigation water by 18-20%, increased irrigation WUE by 15-21% over normal planting. Irrigation water applied through furrows facilitate wetting as well as air entry to the crop root zone. The improved planting technique has the potential advantage of saving irrigation water. This technique would bring more areas under irrigation for post-rainy season crops.

Groundnut crop with paired-row planting

Potato crop with paired-row planting

11. Sub Surface Water Harvesting Structure (SSWHS)

Application/ use: Coastal waterlogged areas

Description/ features: Fresh water floats above the saline water below ground in coastal water logged areas and could be tapped through subsurface water harvesting structure to meet the *rabi* crop irrigation demand as well as pisciculture. To extract water from these structures, pump up to 2 hp is suitable to avoid saline water ingression in to fresh water layer. The depth of structure should be restricted with in sandy zone below ground up to 5 meter.

Input needed: For 0.1 ha area with 4 m depth of 4000m^3 capacity involving 550 man days.

Output capacity: The average water productivity of SSWHS involving pisciulture and *rabi* vegetables is ₹ 36/-m^3

Specific benefits and impact: It results in higher area of irrigation and higher cropping intensity and crop productivity. The average benefit: cost ratio of SSWHS was 1.55 in the first year of construction itself. The participatory approach of implementing SSWHS improves the financial status of the several poor farmers living below poverty line in coastal waterlogged areas and also gives better employment opportunity.

Unit cost: The average unit cost for SSWHS construction is ₹ 14/- per m^3.

12. Pond Based Farming System for Deep Waterlogged Areas

Technology description: Due to poor drainage, saucer shaped topography and high monsoon rainfall, some parts of east coast of India remain waterlogged (> 1m surface water logging) and unproductive. To stabilize and enhance net income from such waterlogged ecosystem, pond based farming technology (deep water rice in *kharif* + salt tolerant vegetables like watermelon, ladies finger, spinach, chili in winter + on-dyke vegetables-fruits + fish inside pond) was conceptualized and implemented in representative deep waterlogged areas (1-2.5 m water depth) of coastal Odisha, India.

Input needed : Land (1 ha), required amount of crop and fish inputs

Output capacity: Additional income ₹ 25,000/- per ha/annum, Water Productivity: ₹ 7.2/- per m^3

Specific benefits and impact: Increased cropping intensity – 200%.

Unit cost: ₹ 60,000/- per ha **.**










- Micro-water resources through farm pondand shallow tube well were designed and implemented in representative deep waterlogged areas of Puri district.
- Through pond based farming system water productivity was enhanced from Rs. 1.2/m^3 (sole rice) to Rs. 6.3/m^3 (rabi crops + fish + on-dyke horticulture).

13. Water Chestnut Production Technology for Waterlogged Areas

Technology description: Targeted area is waterlogged and marshy areas.

Input needed : Planting materials, fertilizers and necessary agro-inputs

Output capacity : Net income : ₹ 25,344/- per ha.

Specific benefits and impact: Water chestnut cultivation already been adopted in 900 ha area in Odisha covering six districts. Has a further potential for adoption in 1.10 million ha of non-arable waterlogged areas in the country.

Unit cost: Cost of cultivation: ₹ 18,000/- per ha

14. Integration of Water Chestnut Cultivation and Aquaculture Technology

Technology description: In shallow waterlogged area of 1.5 m depth cultivations of water chestnut together with fish culture can produce up to 10 t/ha water chestnut and 1.60 t cat fish per ha.

Input needed: 4400 bundles of water chestnut seedlings per ha (2 to 3 seedlings per bundle), and fish seed 7000 – 10000 of 15 – 25 gm mean body weight of fish per ha, and necessary agro-inputs.

Specific benefits and impact: The system with a B:C ratio of 3.3 can produce a net profit up to ₹ 103000/- per ha. The left over water after harvest of fish can be additionally utilized for irrigation of pulses.

Output capacity: ₹ 103000/- per ha

Unit cost: ₹ 33000/- per ha

15. Cat tail (Typha) Production Technology for Waterlogged areas

Technology description: Cat tail locally known as Hogla, plant is an emergent water loving plant grows well in marshy soils and make these areas productive.

Input needed: Planting materials

Specific benefits and impact: The production of cat tail enhances the income of the farmers both from fresh leaves and mats.

Unit cost: Total cost of cultivation including harvest and transport to mat knitter is ₹ 11,900/- per ha and the income obtained from fresh leaves is around ₹ 30,000/- per ha

Typha Plants

Typha mats in wholesale market

16. Wastewater use in farming

Technology description: Soil application and thoroughly mixing of post methanated sugar factory spent wash / distillery effluent is useful for growing crops in acidic red and laterite soil. It improves soil pH, enriched the soil with N, P, K, Ca, Mg, micronutrients and organic matter content.

Input needed: Seeds, fertilizers and related agro inputs

Output capacity: Proper application of post methanated sugar factory spent wash in acidic red and laterite soil could save ₹ 67.92/- per m^3 in sugarcane and ₹ 12.68/- per m^3 in rice per ha despite improving soil pH and soil fertility parameters.

Specific benefits and impacts: Application of post methanated spent wash @ 40 to 50 m^3/ha and @ 80 to 120 m^3/ha before 10 to 15 days of planting / transplanting of sugarcane and rice, improves the cane yield by 0.50 to 2.47 t cane and 6 to 15 kg grain per m^3 addition of the spent wash in sugarcane and rice respectively, growing in acidic red and laterite soil types.

Sugarcane growth under 80m^3 spent wash application

Rice growth under 120m^3 spent wash application

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