RICE BASED FARMING SYSTEMS IN KERALA

N.K.Sasidharan and K.G.Padmakumar
Kerala Agricultural University
Regional Agricultural Research Station
Kumarakom
<table>
<thead>
<tr>
<th>Year</th>
<th>Area (lakh ha)</th>
<th>Production (lakh tons)</th>
<th>Productivity (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971-72</td>
<td>8.75</td>
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<td>1981-82</td>
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<td>2010-11</td>
<td>2.13</td>
<td>5.28</td>
<td>2452</td>
</tr>
</tbody>
</table>
RICE IN KERALA

- Small farm size – less than 0.1 ha
- Mostly single season
- Income inadequate for livelihood
- Only seasonal engagement
- Part time and absentee farmers
- Fallow period 8 months

- Enhance productivity by 50%
- Increase income 3-4 fold
- Increase cropping intensity to 200%
- Render rice farming more organic and environment friendly
- Ensure year round engagement of land
FARMING SYSTEM APPROACH

- Round the year utilization of rice fields
- Integrating compatible components
- Other crops
- Livestock
- Fishery
- Duck/Poultry
# Rice production systems of Kerala

<table>
<thead>
<tr>
<th>Rice ecosystems</th>
<th>Area in ha (91-92)</th>
<th>Percentage to total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kuttanad</td>
<td>38119</td>
<td>6.70</td>
</tr>
<tr>
<td>Onattukara</td>
<td>31031</td>
<td>5.45</td>
</tr>
<tr>
<td>Pokkali</td>
<td>4994</td>
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<tr>
<td>Laterite Midland</td>
<td>266838</td>
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<tr>
<td>Malayoram</td>
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<tr>
<td>Palakkad plains</td>
<td>60342</td>
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<tr>
<td>Black soil (Chittoor)</td>
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<td>6.51</td>
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<tr>
<td>High ranges</td>
<td>27500</td>
<td>4.83</td>
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</tbody>
</table>
HIGH RANGE RICE SYSTEM

- **Extent:** 27000 ha
- **Location:** 800 – 1500 m above MSL
- **Seasons:**
  - Nancha (main) (May/June – Oct./Nov.)
  - Puncha (Dec./Jan. – April/May)
HIGH RANGE RICE SYSTEM

- Situated at Elevations more than 800 m in the Wynadu plateau and Vattavada
- Extent 27500 ha
- Season extents the SW and NE monsoons (July – December)
- Varieties: Scented Jeerakasala and Gandhaka sala, and Uma, Athira.
High range - Rice based systems
LATERITE MIDLAND AND MALAYORAM

- Extent: 3.7 lakh ha (1992)
- Seasons: Virippu, Mundakan Puncha
- Varieties: Short, medium and Photosensitive
Mid land and Malayoram – Rice seasons

- Cropping pattern: Rice - Rice
- First crop (Virippu): April/May – Sept./Oct.
- Second crop (Mundakan): Aug./Sep. – Dec./Jan
- Yield range: 2860 – 8200 kg/ha
- Iron and aluminium toxicity limits crop production
IRRIGATED RICE ECOSYSTEM

- Palakkad plains
- Periyar valley commands
- Chittoor black soils
- Irrigation ensured during the fag end of Mundakan and whole of Puncha
IRRIGATED RICE SYSTEM

- Palakkad plains and chittur black soils
- Irrigated by water from Bharathapuzha
- Extent: 97500 ha
- Season: Virippu, Mundakan
- Varieties: HYV
- Known as second rice bowl of Kerala.
Irrigated rice ecosystem – Palakkad plains

- Malampuzha the largest irrigation scheme
- One fifth of irrigation potential of Kerala
- Valayar, Mangalam, Pothundi, Gayathry and
- Chittoorpuzha are others
- Extent : 60000 ha
Double crop wetlands

First crop (Virippu) : June/July – Sep./Oct.

Second crop (Mundakan) : Oct./Nov. – Jan./Feb.

HYV coverage more than 60%

Short & Medium duration varieties for I crop

Medium & Long duration varieties for II crop
IRRIGATED RICE ECOSYSTEM – CHITTOOR BLACK SOILS

- **Extent**: 37000 ha
- **Soils**: Extension of black cotton soils
- **Soil reaction**: Neutral to alkaline (7 - 8.3)
- **Texture**: Sandy loam – Sandy clay loam
- **Fertility**: Medium – High in available N&P, low in K
- **Yield**: 4500 – 9000 kg/ha
ONATTUKARA RICE ECOSYSTEM

- Extent: 28000 ha
- Crop sequence: Rice-Rice-Sesamum
- Soil texture: Sandy
- Soil reaction: Acidic
- Fertility status: Low in N, medium in available P, & low in Potassium
Virippu Season: April /May - September

Variety: Short duration - Onam, Bhagya, Mattathriveni, Jyothi

Seeding: By dibbling

Weeding: Hoeing

Yield: 1000-1200 kg/ha
Onattukara - First crop at the time of harvest
ONATTUKARA RICE ECOSYSTEM
– II CROP

- **Season**: Aug./Sept. – Dec./Jan.
- **Seedling establishment**: Transplanting
- **Variety**: Ptb –20, Ptb-4, UR-19, Sagara
- **Fertilizer dose**: 40:20:20
  - Application of P and K essential
  - Organic manure addition essential
- **Weeding**: Hand weeding
- **Yield**: 1500-2000 kg/ha
Onattukara
Second crop Nursery
Onattukara

Land preparation for the second crop
Onattukara – A poor second crop
Azolla in Onattukara

Natural way of soil fertility replenishment
RICE – SESAMUM ROTATIONAL FARMING
Rice cowpea integration
Rice-cucumber rotation
Rice- Banana- Cassava System
KOLE LAND RICE ECOSYSTEM

- **Location**: Trichur and Malappuram
- **Extent**: 13000 ha
- **Cropping pattern**: Rice – Rice (35%) Rice – Fallow (65%)
- **Season**: Jan.–May (Puncha) Aug.–Dec. (Mundakan)
Kole lands – Pump house
Kole lands with Irrigation Canal
Kole lands with Irrigation channel
Soil texture: Sandy loam to sandy clay
Organic matter: 2.07 – 4.16
Soil reaction: Acidic (pH 2.6 – 6.3)
EC: 0.16 – 15 ds/m
Yield: 4500-7500 kg/ha.
POKKALI RICE ECOSYSTEM

- Tidal wetlands of Kerala
- 24000 ha in the coastal area of Ernakulam, Alappuzha, Trichur and Kannur districts
- Tidal inundation & consequent salinity
- Rice & Prawn are rotationally grown
- Considered as sustainable system
POKKALI LANDS
Pokkali fields

a view during the high saline phase
POKKALI SOILS

- Basically acidic
- pH : 2.8 to 4.5
- Saline water inundation from October
- Salinity: 12 - 24 ds/m during summer
- Reclamation required for rice cultivation
Two phases of Pokkali Agro-Ecosystem

Low saline phase
June to November

High saline phase
December to May
Pokkali soils – mounds are necessary for reclamation of soil
Seeds are packed in country baskets for soaking
Seed baskets ready for soaking
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Pokkali soils – mounds are necessary for reclamation of soil
Seeds are packed in country baskets for soaking
Seed baskets ready for soaking
Damage due to floods – a regular occurrence in Pokkali fields
Pokkali rice on mound tops ready for dismantling
Spreading operation in progress
Luxuriant growth of the Pokkali rice
Harvesting in knee deep water
PRAWN CULTURE

- Prawn during saline phase
- Traditional practice - prawn filtration
- Prawn seeds are attracted & reared
- Prawn yield 300-1000kg/ha
Income from prawn yields compensates the losses from rice cultivation
Fish species found suitable

- *Cyprinus carpio*
- *Oreochromis mossambicus*
- *Tricogaster pectoralis*
- *Chana striata*
- *Clarius batrachus*
## Effect of rice fish integration on fish survival and yield

<table>
<thead>
<tr>
<th>Fish treatments</th>
<th>Survival %</th>
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<th></th>
<th>Fish Yield kg/ha</th>
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<tbody>
<tr>
<td></td>
<td>1999</td>
<td>2000</td>
<td>Pooled</td>
<td>1999</td>
<td>2000</td>
<td>Pooled</td>
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<tr>
<td>Without fish</td>
<td>----</td>
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<tr>
<td>Male tilapia</td>
<td>36.2</td>
<td>38.1</td>
<td>37.6</td>
<td>209.1</td>
<td>224.2</td>
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<td>16.0</td>
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<td>Rohu-2000</td>
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<td>CD (0.05)</td>
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<td>3.2</td>
<td>3.8</td>
<td>18.2</td>
<td>19.3</td>
<td>21.8</td>
</tr>
</tbody>
</table>
Male tilapia

Oreochromis mossambicus
# Economic analysis of rice-fish-prawn integration in *Pokkali* fields

<table>
<thead>
<tr>
<th>Farming system</th>
<th>Expenditure (Rs/ha)</th>
<th>Yield (kg/ha)</th>
<th>Gross returns (Rs)</th>
<th>Net returns (Rs)</th>
<th>B:C ratio</th>
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</thead>
<tbody>
<tr>
<td>Rice alone</td>
<td>11450</td>
<td>3488</td>
<td>22672</td>
<td>11222</td>
<td>1.98</td>
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<td>Rice-fish</td>
<td>17700</td>
<td>3488 (R) 216 (F)</td>
<td>31346</td>
<td>13646</td>
<td>1.77</td>
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<tr>
<td>Rice–fish–prawn</td>
<td>46700</td>
<td>3488 (R) 216(F) 425(P)</td>
<td>95090</td>
<td>48390</td>
<td>2.03</td>
</tr>
</tbody>
</table>

Rice @ Rs. 6500/ ton

Fish @ Rs. 40/kg Prawn @ Rs. 150/ kg
Pokkali model

Rice during low saline phase
Rice-fish simultaneously
Prawn culture/prawn filtration rotationally

No way interfere with seasonal rhythm
Components well mingle
Accretion rather than depletion in soil fertility
Ecologically sound
Environment friendly
Socially acceptable
RICE-FISH / PRAWN INTEGRATED FARMING

Sustainable, Economic, Eco-friendly
KUTTANAD RICE ECOSYSTEM

- Deltaic formation of four river systems
- Location: 1 – 2.5 m below MSL
- Extent: 56000 ha
- Seasons: Main crop - Puncha (Oct./Nov. - Jan./Feb.)
  Additional Crop (June/July - Sept./Oct.)
KUTTANAD SOILS

- KARAPADAMS - 33,000 ha
- KAYAL LANDS - 13,000 ha
- KARI SOILS - 9,000 ha
KARAPPADOM SOILS

- River borne alluvial soils
- Extent: 33000 ha
- Texture: Silty clay
- Soil reaction: Moderately acidic high salt content, and a fair amount of decomposing organic matter
- Salinity hazard
- Fertility: Available P and K low
KAYAL LANDS

- Reclaimed beds of Vembanad
- Extent: 13000 ha
- Texture: Silty clay
- Soil reaction: Slightly acidic to neutral
- Salinity: Salinity affected
- Fertility: Low in available nitrogen and phosphorous but comparatively rich in potassium
KARI LANDS

- Extent: 9000ha
- Colour: Deep black charcoal
- Heavy in texture, poorly aerated and ill-drained
- Pieces of wood seen embedded in the subsoil
- Soil cracks during summer
- Soils are affected by severe acidity (pH 3-4.5)
- Periodic saline water inundation
- Toxic accumulation of Fe & Al
An overview of Kuttanad rice fields
Pump house – an integral part of puncha lands
Low head axial flow pump (Petti & para)
Aquatic biomass – a source of organic manure
Wet broadcasting ensures uniform plant population
Uneven land leveling results in a patchy stand of seedlings.
A uniform crop stand at seedling stage
RICE FIELDS IN KUTTANAD

- Under utilised
- Mostly single cropped
- Fallow period > 6 months
- Returns <25000/ acre
- Considerable scope of improvement by Farming system approach.
Farming system models developed at RARS, Kumarakom

In two decades

Development of models at station level

- Evaluation of the models
- Validation at farm level
- Transformation from simultaneous to rotational
- Lateral diffusion to farmers fields

ORU NELLUM ORU MEENUM
*Cyprinus* – versatile species

Ploughing and harrowing
Grass carp - weed control
## Cost of production of paddy - before and after fish integration

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<td>1995 (Puncha)</td>
<td>1996 (Virippu)</td>
<td>1996 (Puncha)</td>
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<td>Cost (Rs)</td>
<td>Cost (Rs)</td>
<td>Cost (Rs)</td>
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<td>1</td>
<td>Material</td>
<td>Labour</td>
<td>Material</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<td>5.50</td>
<td>5.50</td>
<td>5.50</td>
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<td>2</td>
<td>b. Bunding</td>
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<td>3</td>
<td>Seed and sowing</td>
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<td>76</td>
<td>3198</td>
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<td>381</td>
<td>270</td>
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<td>894</td>
</tr>
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<td>8</td>
<td>Other Inputs</td>
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<td>9</td>
<td>Harvesting</td>
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<td>Qtls (Rs)</td>
<td>Qtls (Rs)</td>
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<td>13</td>
<td>2 Straw</td>
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<td>14</td>
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<td>15</td>
<td>PROFIT</td>
<td>(-)1405</td>
<td>2289</td>
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</tbody>
</table>
GIANT FRESH WATER PRAWN

Prawn Yield using local wet feeds – 937 kg/ha
Prawn yield using commercial feeds – 1519 kg/ha
In 230 days
Indicated the prospects of rice prawn integration
Integrating other components

- Coconut, banana, yams and other crops on the bunds.
- Fish
- Ducks
- Buffaloe
One acre paddy polder can additionally hold:

- 2000 fish fingerlings
- 300 broiler ducks
- 1-2 buffaloes
- 20 coconut palms on the bund
- 40 banana plants
- 20-40 yams/cassava
- Single line fodder of 80m length.
Multi level integration of crops-livestock- fish-duck
Complementary effects

- On land preparation
- Manuring
- Weeding
- Plant protection
Zero tilled rice field after fish harvest ready for planting

Fallow period 3 days
Economic benefits

- Cost of production rice reduced by 17.6 percent
- Increase in yield up to 50%
- Multilevel integration increased the returns 3-4 fold.
Ecological benefits

- Reduction in use of agricultural chemicals
- Improvements in soil conditions
- Recycling of agricultural wastes
- Perceptible improvement in soil biological properties.
CONCLUSIONS

- In wetlands rice should be the pivotal crop.
- Multiple cropping of rice as monoculture systems are not sustainable.
- Use of increased external inputs year after year erode the biodiversity base and upset ecological balance.
- Shift to biodiversity based multi commodity enterprises suited to local agro ecological conditions can perform better.
- Such systems can significantly reduce high energy inputs and cost of production.
- Farming system approach is capable of reducing carbon emission and sequestering of carbon in soils and plants.
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**Note:**
- The table above presents the cost of production of paddy before and after fish integration, along with the income and profit. The expenses are categorized into various tasks such as land preparation, bunding, seed and sowing, weeding, plant protection, manuring/liming, and other inputs. The total expenses are compared for the years 1995 (Puncha) and 1996 (Virippu) before fish integration, and 1996 (Puncha) and 1997 (Virippu) after fish integration. The income is calculated from the sale of paddy and straw, and the profit is the difference between the total income and total expenses.
Prawn Yield using local wet feeds – 937 kg/ha
Prawn yield using commercial feeds – 1519 kg/ha
In 230 days
Indicated the prospects of rice prawn integration
Integrating other components

- Coconut, banana, yams and other crops on the bunds.
- Fish
- Ducks
- Buffaloe
One acre paddy polder can additionally hold

- 2000 fish fingerlings
- 300 broiler ducks
- 1-2 buffaloes
- 20 coconut palms on the bund
- 40 banana plants
- 20-40 yams/cassava
- Single line fodder of 80m length.
Multi level integration of crops-livestock- fish-duck
Complementary effects

- On land preparation
- Manuring
- Weeding
- Plant protection
Zero tilled rice field after fish harvest ready for planting

Fallow period 3 days
Economic benefits

✓ Cost of production rice reduced by 17.6 percent
✓ Increase in yield up to 50%
✓ Multilevel integration increased the returns 3-4 fold.
Ecological benefits

- Reduction in use of agricultural chemicals
- Improvements in soil conditions
- Recycling of agricultural wastes
- Perceptible improvement in soil biological properties.
CONCLUSIONS

- In wetlands rice should be the pivotal crop.
- Multiple cropping of rice as monoculture systems are not sustainable.
- Use of increased external inputs year after year erode the biodiversity base and upset ecological balance.
- Shift to biodiversity based multi commodity enterprises suited to local agro ecological conditions can perform better.
- Such systems can significantly reduce high energy inputs and cost of production.
- Farming system approach is capable of reducing carbon emission and sequestering of carbon in soils and plants.