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Cropping System Intensification for Small-holder Farmers in Coastal Salt-affected areas in West Bengal, India – Options and Determinants

Subhasis Mandal, *Principal Scientist*

B. Maji, S. K. Sarangi, K. K. Mahanta, U.K. Mandal, D. Burman, S. Digar, Md. Mainuddin and P. C. Sharma

ICAR-CSSRI-RRS, Canning Town, West Bengal, India

Email: S.Mandal@icar.gov.in /subhasis2006@gmail.com

Study area

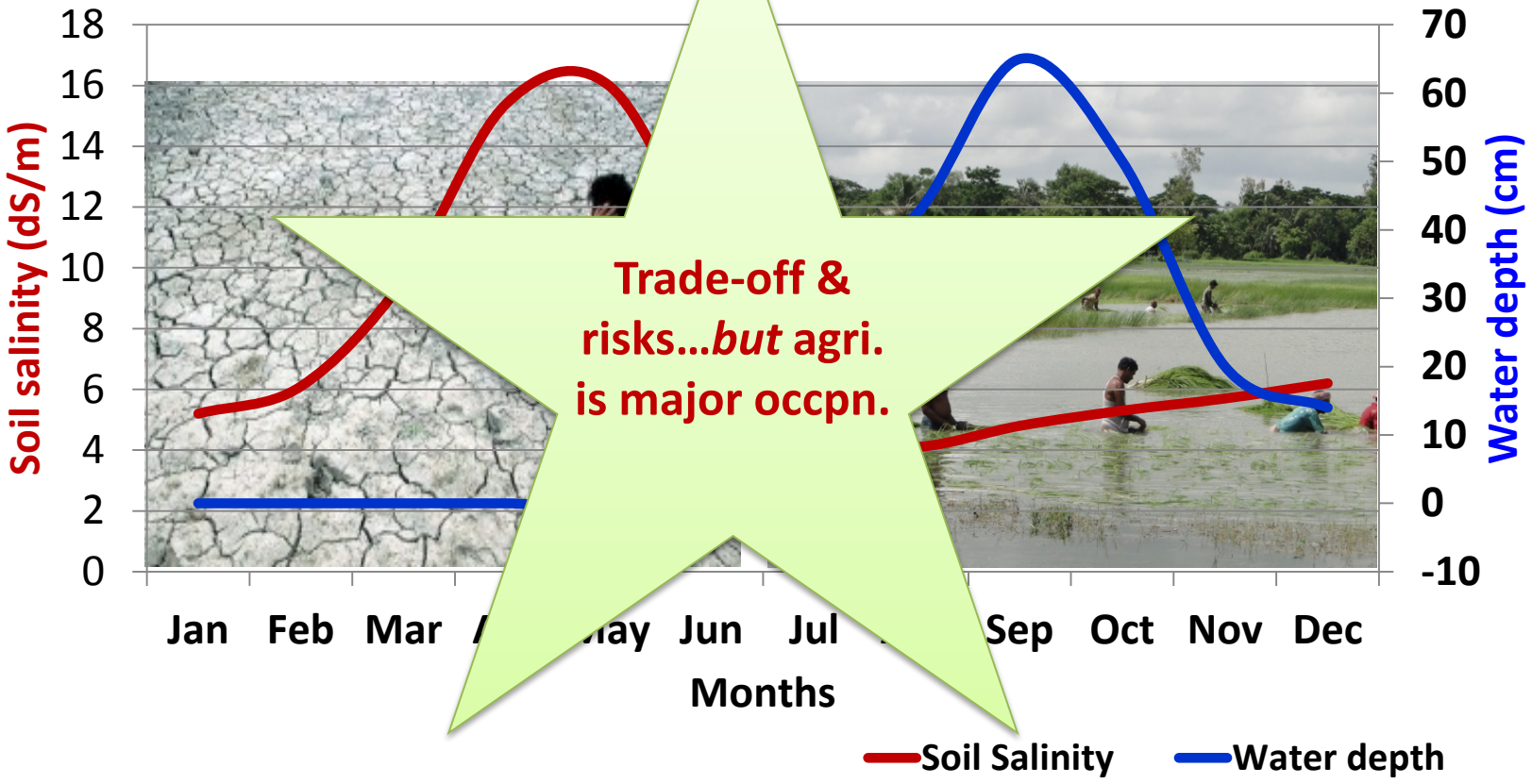
Overall the region is complex, fragile, risk prone and agriculture-aquaculture supports livelihoods to 4.4 million people

Coastal region: Challenges for Agriculture

Boro/Rabi/summer (dry)	*Aman/Kharif (wet)*

- 80% fallow
- Fresh water scarcity & salinity (*flash rain*)
- *Rabi* rice ~3 t/ha

- Deep water logging & drainage congestion (*1818 mm avg. rainfall*)
- *Kharif rice* ~ 2 t/ha



Trade-off & risks…*but* agri. is major occpn.

Interventions made

- No of field experiments involving 204 framers (39% female) covering 25 ha during 2016-17 to 2018-19
- Most experiments are in *rabi* (dry) season (77% and 74% in terms of area and no of farmers, respectively)
- Short duration paddy varieties in *kharif* (wet) season
- A number of crops (over 15 nos.) tried under experiments to understand feasibility
- Integrated nutrient management of soil, acid saline soils
- Drip irrigation system – solar powered & low cost
- Also covered non-collaborative farmers (214) - input support
- Providing small pump to 3 women farmer groups (5 in each group) -access irrigation water from canal

Data and Methodology

- The study pertains to ACIAR funded research project on CSI4CZ (2016-2020) under implementation in Bangladesh and West Bengal (India).
- **Methods of data collection**
  - *Baseline socio-economic survey on farmers (2017-18)*
    - *FGD and primary survey (90 households), case study, key informants*
  - *Researcher managed experimental data*
  - *Farmers data on agricultural practices*
  - *Incremental costs and return*
- **Analytical techniques**
  - *Descriptive statistics – mean, max., min., SD, CV*
  - *Farm budgeting techniques for economics of cultivation*
  - *Financial viability analysis (IRR, BCR, NPV and Payback period)*
  - *Determinants analysis through multiple linear regression model*
  - *Yield gap analysis (demonstration vs farmers practice)*

Socio-economic status of the farmers in the study sites

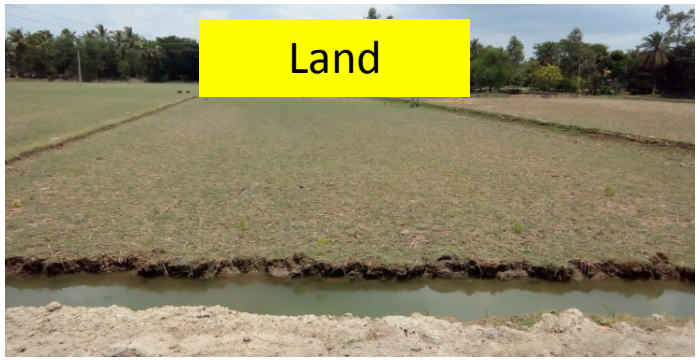
Particulars	Average	Min	Max	Standard Deviation
Operational area (ha)	0.48	0.13	2.00	± 3.043
Family size (no)	4.85	2	9	± 1.419
Age of respondents (years)	47.63	30	75	± 10.056
Area under crops				
-*kharif* paddy (ha)	0.44	0.13	1.33	± 0.294
-*Rabi* paddy (ha)	0.22	0.13	0.40	±0.109
-Homestead land (ha)	0.07	0	0.17	± 4.6225
-Mixed Vegetables and others (ha)	0.11	0	0.33	±11.06
-Potato	0.03	0	0.13	±2.591
Agricultural income (Rs/hh/year)	21086	750	93790	± 19842.23
Off-farm income(Rs/hh/year)	15450	6780	18600	± 8950.52

Over 98% farmers are marginal - operating less than a hectare of land, hh -households

1 AUD = 48 INR (Rs) approx.

Households and Cropping systems


People


Land


Potato


Paddy (*wet season*)


Home


Homestead


Pond, water, fish


Mixed crop


Paddy *(dry season)*

Cropping pattern practiced by farm-households

Particulars	% of farmers practiced
Farmers with operational land	93
Landless farmers	7
Crops	
-*Kharif* paddy (wet season)	98
-*Rabi* paddy (dry season)	18
-Potato	66
-Mixed vegetables plot	93
-Homestead plot	98

Cropping intensity 123 % (without homestead land) & 142 % (with homestead land)

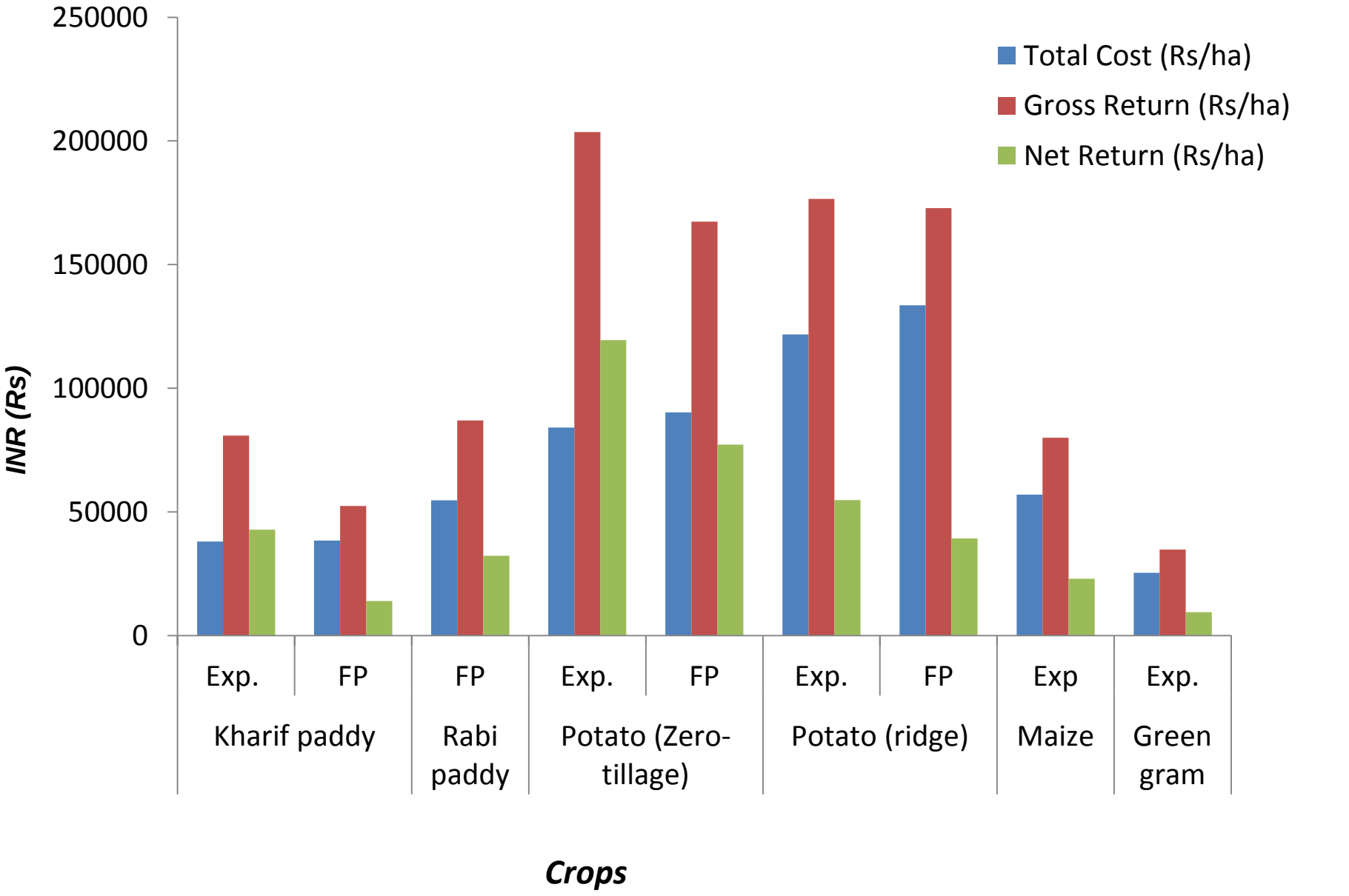
Can we intensify the existing cropping systems ????

Cropping systems – Farmers practiced & Emerged

Farmers practice	Evolved /Improved
Kharif paddy-fallow	*Kharif paddy(improved)-fallow*
Kharif paddy-rabi paddy	*Kharif paddy-green gram*
Kharif paddy- potato	*Kharif paddy-ZT potato*
Mixed cropping system (homestead)	*Kharif paddy-ZT potato-green gram*
Mixed cropping (fields)	*Mixed cropping system with drip irrigation system*
	Kharif paddy-maize

A number of crops under experiments for cropping systems

Economics of crops – Experimental & Farmers practice

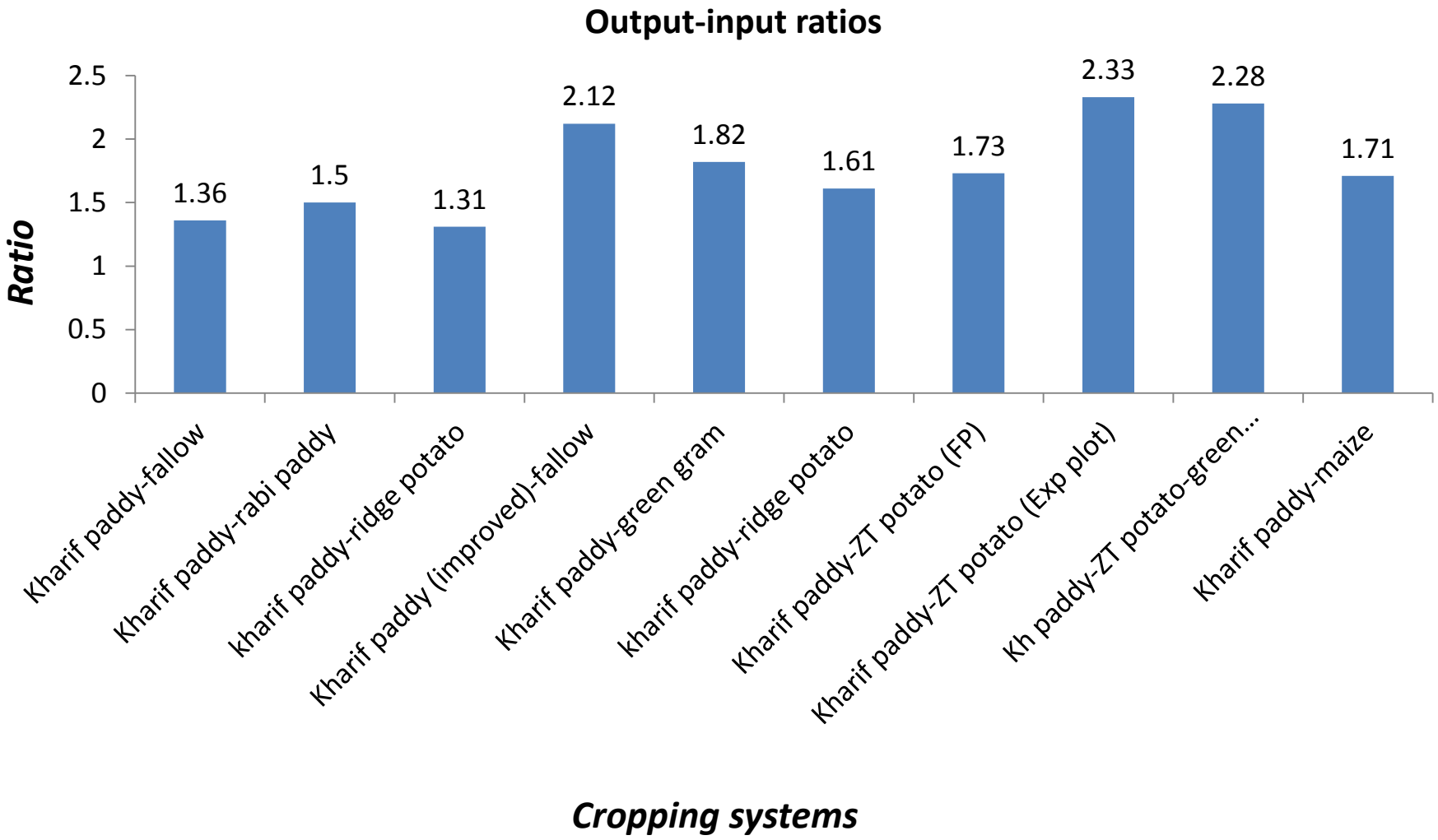


Economics of cropping systems

Cropping system	Total Cost (Rs/ha)	Gross Return (Rs/ha)	Net Return (Rs/ha)	Output-input ratio
Kharif paddy-fallow	38393	52350	13957	1.36
Kharif paddy-rabi paddy	93110	139294	46184	1.50
kharif paddy-ridge potato	171905	225150	53245	1.31
Kharif paddy (improved)-fallow	38046	80835	42789	2.12
Kharif paddy-green gram	63384	115635	52251	1.82
kharif paddy-ridge potato	159824	257415	97591	1.61
Kharif paddy-ZT potato (Farmers plot)	142990	246750	103760	1.73
Kharif paddy-ZT potato (Exp plot)	**122125**	**284415**	**162290**	**2.33**
Kh paddy-ZT potato-green gram (exp plot)	**160171**	**365250**	**205079**	**2.28**
Kharif paddy-maize	95031	162278	67247	1.71

Rs. is INR. 1 AUD = 48 INR (approx)

Output-input ratios of cropping systems



Drip irrigation system – solar powered & low cost

Particulars	System Total (solar powered)	System Total* (Low cost drip irrigation)
Total production (kg)	1267	1465
Average selling price (Rs/kg)	21	17
Gross return (Rs)	25679	24103
Interest rate on working capital (Rs)	668	390
Total cost (Rs)	11136	6888
Net return (Rs)	14543	17606
Output-input ratio	**2.31**	**3.50**
Cropping intensity (%)	over 300	over 300

Okhra, knol-khol, chilli, bitter gourd, broccoli, cabbage, cucumber, cauliflower, bitter gourds, yam etc.

~500 sq.m.

Financial feasibility of drip irrigation systems

Criteria	Solar powered drip irrigation system			Low cost drip irrigation system
	Owned capital	*Double area*	*Double area & 80% subsidy*	
Payback period (year)	6.50	3.41	1.16	1.69
Internal rate of return (%)	-2.17	13	58	38
Net present value (Rs)	-69340	3346	92576	47040
Benefit cost ratio	0.69	1.01	1.30	1.61
Initial investment (INR)	166382			39700

Total cost of initial investment was reduced by 76%

Determinants of cropping system intensification

The final multiple regression model is specified as below-

$Y = f(X_1, X_2, X_3, X_4) + e_i$ Or

$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + e_i$

Where,

Y = Cropping intensity (%) estimated at individual farm-level

X_1 = Operational holdings (ha) of individual farmers

X_2 = Net income from agriculture (Rs/ha) of individual farmer

X_3 = Number of adult members in the family

X_4 = Number of perennial ponds with the farm-family

e_i = denotes error term

The regression co-efficient (b_i) were estimated

Age of farmers, experience in farming in years, educational status, number of adult family members, operational holding size, distance from nearest market, net income from agriculture and number of perennial pond were included in the model initially and stepwise regression was run.

Factors affecting cropping intensification

Factors	Co-efficient	Standard Error
Constant	4.6598***	0.1321
Operational holding size in hectare (X_1)	**-0.0678****	0.0336
Net income from agriculture in Rs./ha (X_2)	0.0671***	0.0288
No. of adult members in the family (X_3)	0.1016	0.0628
No. of perennial ponds (X_4)	0.1672***	0.0416
F-value	8.4929***	
Adjusted R-square	0.4748	
No. of observation (N)	68	

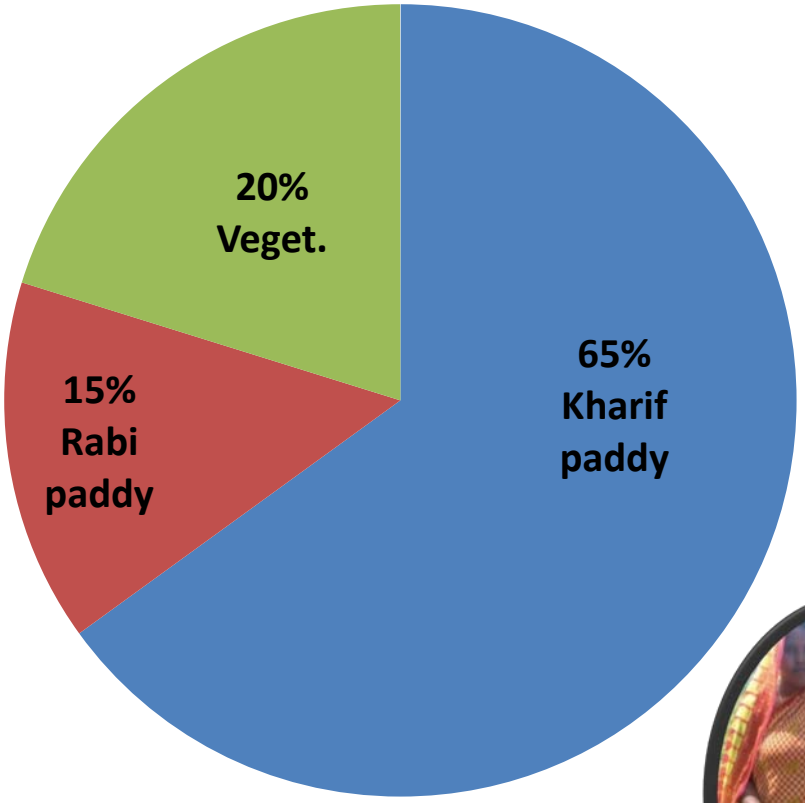
,,*** indicates significant at 10%, 5% and 1% level of significance*

Women participation in agricultural operation

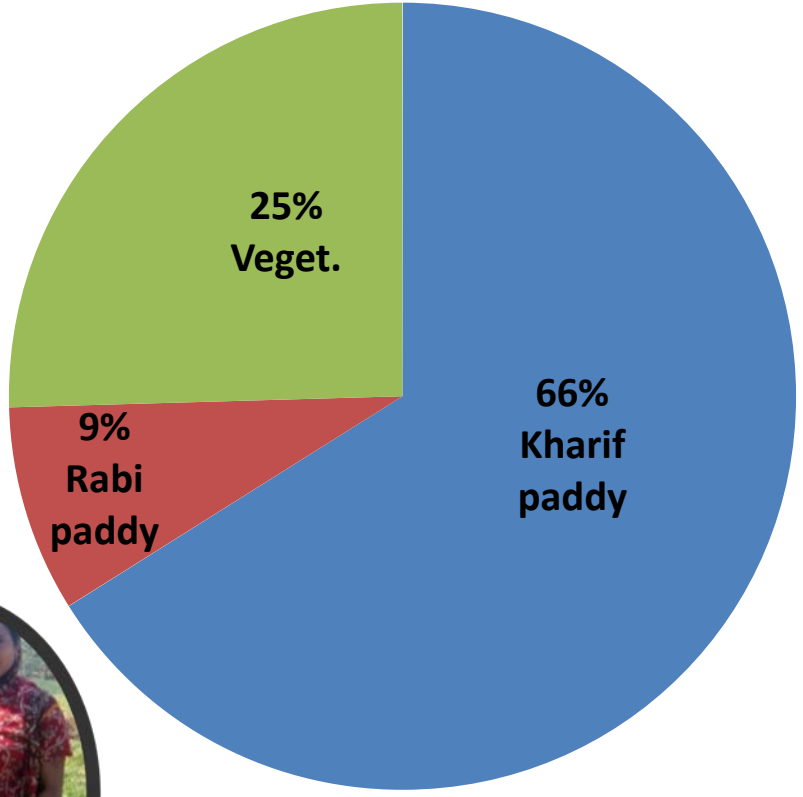
- Women folk daily work schedule starting from 4.30 am up to sleep at 10 pm (~18 hours)
- Active participation in homestead gardening throughout the year (~ 2-3 hours daily)
- Seasonal activities - transplanting of rice (almost ~35% are women labourers), intercultural operations, weeding, harvesting of paddy & vegetables
- Sometime (wet season) full time labourers (8 hours a day) or participation increased (~45%) during male out-migration
- Higher cropping intensity increases work load marginally (1-2 hours) but they are happy to participate so long it is profitable.
- More preference to grow vegetables than other field crops

Cropping pattern choice of women farmer

Male headed household



Female headed household



Overall economic and social benefits of the project interventions

- Overall (2016-17 to 2018-19) project engaged a total of 168 collaborative farmers (25 ha) under active experimentation and also benefitted other 832 farmers covering 108 ha.
- The shared cost was Rs. 6091 per ha and Rs. 7877, excluding and including drip irrigation system, respectively.
- For all interventions, incremental return was estimated as Rs. 33701 per ha.
- Incremental return in *dry* season was due to higher cropping intensities (from 123% to 200 or 300%).
- Total incremental return was Rs. 1.62 million with incremental cost (Rs. 1.05 million).
- Return to investment in terms of IRR (42%), NPV (Rs. 1.67 million) and BCR (1.26) indicated research investment was encouraging.

1 AUD = 48 INR (Rs.) (approx.)

Community engagement

- Farmers encouraged by receiving the quality inputs supplied and technical help provided for crop management during entire cropping seasons – more farmers wanted to be part of the project
- Land less farmers and women farmers were also engaged
- Field demonstration increased confidence level of farmers in managing their salt affected land
- Increased level of enthusiasm among the farmers and their participation has been very active

Conclusion

- Higher agricultural income possible by adopting new or improved cropping systems and farmers have additional options for increasing the cropping intensity.
- Low cost drip irrigation system with mixed cropping systems is financially viable and can be promoted
- Active role of women farmers in farming and higher cropping systems (particularly vegetable based) would benefit women farmers with marginal increase in workload
- Overall return to investment on cropping system intensifications were gainful


THANK YOU