Leibniz Centre for
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(ZALF)

The impact of salinity on paddy production and possible varietal portfolio transition: A Vietnamese case study

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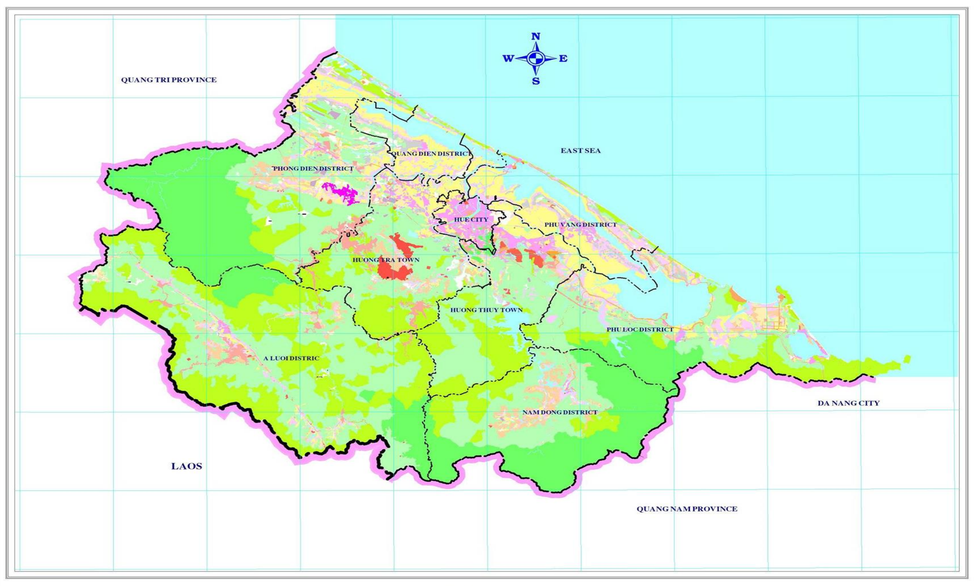


Challenge

Soil salinization is limiting crop productivity and threatening food security. In the north central coastal region of Vietnam, saltwater intrusion due to irrigation in the dry season is a major concern for rice farming.

Objectives

1. Investigate impacts of salinity on rice yield and production variability in four communes of Thua Thien-Hue Province.
2. Options in the portfolio of rice cultivars, which would offer farmers the potential to increase yield and decrease yield variability simultaneously.

Data Collection

Primary data were collected from four different coastal communes in two districts (Quang Dien and Phu Vang) by using pre-tested questionnaires in personal interviews in 268 farms/households. Data on rice production (winter-spring crop and summer-autumn crop, 2016) related to inputs, rice varieties, yield, soil salinity level, etc. were collected.

In order to measure the level of salinity at the surveyed farms, Electrical conductivity (EC) values of the soil samples were measured.

Statistical analysis

The Just and Pope production function

$$Y_i = f(Z_i;\ \alpha) + \varepsilon_i$$
$$\varepsilon_i = h(X_i;\ \gamma) + E_i$$

Gross margin analysis

The gross margin $(P_i Y_i - C_i)$ for each variety at different salinity levels for each season is also calculated in an effort to broaden the understanding of the impact of salinity on the viability of rice farm enterprises in Vietnam.

Rice varietal portfolio analysis

$$Max\ \pi = \sum_{i}^{n} x_i (P_i\, Y_i - C_i)$$

This analysis was repeated three times: for Salinity Class 1, Class 2, and for Classes 3 and 4 together. These three analyses were conducted separately to capture the cultivars' specific response to different salinity levels.

Results and discussions

Salinity (EC values) has a significant impact on average yields, while variability was generally unaffected; this ultimately means that yields will be consistently low under saline conditions.

Table 1: Mean yield regression

Cultivar:	*KD*		*HT1*		*TH5*		*X21*		*Xi23*		*All cultivars*	
Variables	Coeff.	t	Coeff.	t	Coeff.	t	Coeff.	t	Coeff.	t	Coeff.	t
Area	2.9815	8.95	2.1220	4.34	3.0526	4.91	2.3058	1.58	1.8435	0.76	3.0230	11.72
Season	-0.3700	-10.53	-0.2599	-4.79	-0.4062	-4.96	-0.5088	-3.41	-0.2667	-1.43	-0.3899	-15.06
N	0.0010	1.84	0.0021	2.22	0.0025	1.99	0.0023	0.67	0.0000		0.0007	2.01
P	0.0016	3.22	0.0011	2.92	0.0029	2.26	0.0003	0.16	0.0051	1.56	0.0002	1.22
K	0.0034	3.68	0.0032	2.71	0.0031	1.16	0.0053	0.93	-0.0034	-0.35	0.0042	7.03
Pesticide	0.0674	3.46	0.0464	1.30	0.1128	2.24	-0.1158	-1.21	0.0000		0.1113	7.45
Tech	0.0000	2.29	0.0000	-0.55	0.0000		0.0000	2.14	0.0000		0.0000	1.24
Irrigation	0.2489	6.95	0.1073	2.10	0.2541	3.18	-0.0208	-0.14	0.0000		0.1922	7.07
Hired labour	0.0000	-2.03	0.0000	-1.18	0.0000	-1.49	0.0000	-0.79	0.0000	0.49	0.0000	-3.12
EC	-0.2464	-25.55	-0.2214	-14.68	-0.2582	-11.83	-0.1953	-6.07	-0.1720	-3.10	-0.2348	-31.29
_cons	3.4209	8.46	4.4387	8.07	2.9147	5.38	-0.4355	-0.16	3.5047	2.64	4.2307	17.91

Table 2: Yield variance regression

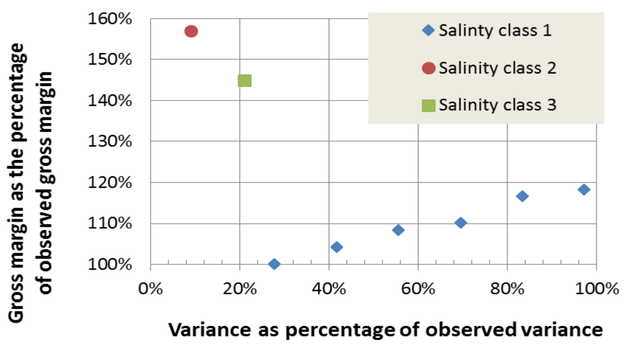
Cultivar	KD		HT1		TH5		X21		Xi23		All cultivars	
Variables	Coeff.	t	Coeff.	t	Coeff.	t	Coeff.	t	Coeff.	t	Coeff.	t
Area	-3.6411	-1.71	-1.2189	-0.35	-10.4537	-2.42	-8.1038	-1.06	-24.9171	-1.72	-3.4613	-2.28
Season	0.0927	0.41	0.3609	0.94	0.2379	0.48	1.7841	2.27	-0.8853	-0.8	0.1513	0.99
N	0.0105	3.12	0.0102	1.48	0.0007	0.1	-0.007	-0.38	0		0.003	1.4
P	0.0027	0.84	0.0061	2.21	-0.0045	-0.58	-0.0001	-0.01	-0.0431	-2.23	-0.0023	-2.25
K	-0.0026	-0.44	0.0033	0.39	0.023	1.44	-0.02	-0.68	0.0111	0.19	0.0088	2.53
Pesticide	0.0668	0.54	0.0109	0.04	-0.0951	-0.31	0.7851	1.56	0		0.0453	0.52
Tech	0	0.04	0	-0.42				-2.55	0		0	-2.51
Irrigation	-0.5131	-2.24	0.4605	1.27	-0.5506	-1.14	1.1818	1.47	0		-0.1639	-1.02
Hired labour	0	1.1	0	0.14	0	0.29	0	1.7	0	0.13	0	1.4
EC	-0.0958	-1.56	-0.0657	-0.61	0.0573	0.43	-0.2107	-1.24	-0.3945	-1.2	-0.1146	-2.59
_Cons	-5.6321	-2.18	-7.3163	-1.87	-2.6362	-0.8	29.8071	2.04	16.6341	2.11	-0.4111	-0.3

Table 3: Gross Margin (GM)

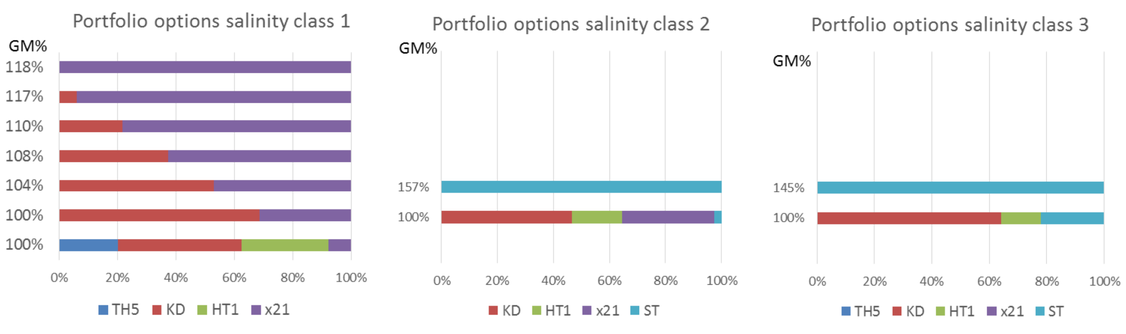
Salinity level	*0*		*2*		*3*		*4*		*Total*	
Season	1	2	1	2	1	2	1	2	1	2
Cultivars	*Mean GM (1000 VND/ha)*	*Mean GM (1000 VND/ha)*	*Mean GM (1000 VND/ha)*	*Mean GM (1000 VND/ha)*	*Mean GM (1000 VND/ha)*	*Mean GM (1000 VND/ha)*	*Mean GM (1000 VND/ha)*	*Mean GM (1000 VND/ha)*	*Mean GM (1000 VND/ha)*	*Mean GM (1000 VND/ha)*
HT1	19.8	13.5	14.6	9.2		5.9	-	0	19.3	12.9
KD	18.5	11.7	13.7	6.7	11.3	4.7	-	0	17.8	11.1
ML48	0	0	20.7	0	0	16.5	-	15.1	20.7	16.0
RVT	0	0	19.8	0	0	16.1	-	0	19.8	16.1
TH5	21.5	13.4	14.9	7.2	0	3.0	-	0	20.8	12.6
X21	19.9	15.0	16.5	11.0	0	8.0	-	0	19.5	14.2
Xi23	18.2	12.0	0	0	0	4.8	-	0	18.2	11.3
Total	19.3	12.6	14.6	7.6	11.3	7.3	-	10.1	18.7	11.9

Salt-resistant cultivars can offer significant economic gains, especially in dry season

Table 4: Gross Margin-Variability 'Trade-off' and varietal portfolio transition



Salinity Class 1: a complete shift to the X21 variety increase in gross margins of up to 20%, without any change in variability; or a mix of the X21 and KD cultivars to minimise variability by up to 72%.



***Salinity Class 2*:** the varietal mix needs to consist solely of ML48 and RVT, which are salt-tolerant cultivars. The gross margin increases up to 50%

Salinity Classes 3 and 4: also, the portfolio would need to be ML48 and RVT, which are salt-tolerant cultivars, to maximise yields. This changed portfolio shows an improvement of 45%, while offering a marked reduction in variability.

Conclusion

- Salinity has impact on rice yield and leads to gross margin reduction.
- Salt-tolerant cultivars show higher yields and lower variance at higher salinity.
- Rearranging varietal portfolios as a response to salinity could not only improve profits, but also reduce production risks.

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