

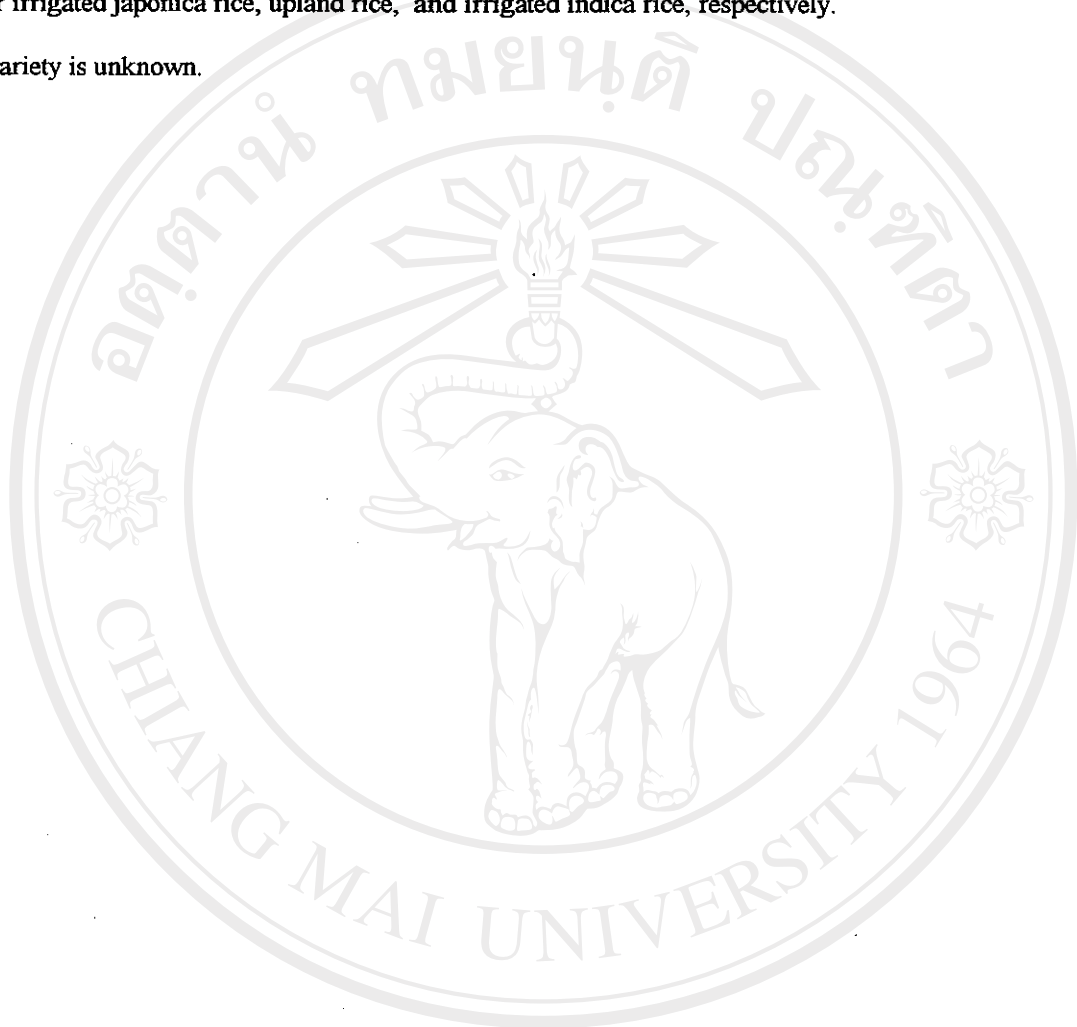
Appendix A Characteristics of 60 milled rice samples (collected from domestic market), Yunnan 1994.

No	Variety name	PI	ZN	P	PR	AMY	HEA	GEL	CHK	ALK	GL	GW	R	D1	D2	D	D0
1	*	3.00	25.98	0.390	7.40	1.33	90.9	84	1	4	6.41	3.13	2.05	0	0	1	2
2	*	1.90	18.22	0.127	6.40	25.70	71.8	66	75	3	6.32	2.41	2.62	0	0	1	3
3	*	2.00	17.92	0.154	7.14	24.45	86.5	63	35	2	6.02	2.34	2.57	0	0	1	3
4	*	1.90	21.00	0.072	7.06	2.06	65.3	96	1	6	5.84	2.15	2.72	0	0	1	3
5	*	2.60	19.82	0.352	8.57	3.00	71.5	90	1	4	5.88	2.70	2.18	0	0	1	3
6	*	3.50	18.54	0.152	7.38	2.46	41.1	94	1	6	6.52	2.04	3.20	0	0	1	2
7	*	1.80	19.77	0.112	8.92	17.97	75.5	89	55	5	5.64	1.93	2.92	0	0	1	2
8	*	1.90	21.25	0.117	6.90	1.69	75.9	96	1	6	6.00	2.17	2.76	0	0	1	3
9	Guichao 2	2.40	19.11	0.170	6.86	25.63	81.6	84	100	5	5.19	1.83	2.84	0	0	1	3
10	*	1.80	21.38	0.173	7.40	20.94	85.5	80	20	2	5.88	2.14	2.75	0	0	1	2
11	Diantun 502	2.40	20.44	0.109	7.14	15.59	58.2	48	25	6	7.36	3.12	2.36	0	0	1	3
12	Dianlong 201	2.30	19.39	0.103	6.22	14.90	61.0	69	10	6	7.38	3.13	2.36	0	0	1	3
13	*	1.95	18.26	0.122	6.34	25.34	65.6	58	55	2	6.21	2.42	2.57	0	0	1	3
14	*	2.00	21.00	0.152	7.22	20.00	87.5	77	70	4	5.31	1.87	2.84	0	0	1	2
15	Shanyou 63	1.90	18.19	0.152	7.38	22.65	79.3	100	35	2	5.94	2.27	2.62	0	0	1	3
16	Diyou 63	1.92	16.37	0.148	6.84	22.55	58.5	92	25	2	6.09	2.33	2.61	0	0	1	3
17	Shanyou 63	1.90	17.35	0.125	6.48	24.14	64.0	90	40	2	6.08	2.33	2.61	0	0	1	3
18	Ganyou 12	1.88	15.14	0.133	6.19	22.48	50.2	75	50	2	5.96	2.28	2.61	0	0	1	3
19	Dianrui 456	3.50	18.00	0.136	6.78	13.95	95.0	51	15	6	7.15	3.24	2.21	0	0	1	3
20	791	2.20	18.78	0.119	6.88	20.79	92.9	60	35	7	4.71	1.65	2.85	0	0	1	3
21	Daintun 502	3.60	22.51	0.120	6.25	12.99	82.0	51	15	5	6.99	2.97	2.35	1	0	2	3
22	Thai rice	4.20	19.24	0.096	6.19	19.77	99.7	73	0	4	6.78	3.29	2.06	1	0	2	3
23	Korea rice	2.45	15.35	0.126	5.27	19.10	87.5	80	25	7	4.80	1.67	2.87	1	0	2	1
24	*	2.60	20.89	0.266	7.56	19.96	89.0	59	1	6	5.31	1.82	2.92	1	0	2	2
25	Dongbei rice	2.30	16.89	0.118	5.56	18.79	74.1	87	50	7	4.84	1.63	2.97	1	0	2	1
26	*	2.20	15.16	0.112	5.41	16.88	79.2	76	0	4	5.08	1.70	2.99	1	0	2	1
27	*	2.00	14.75	0.122	6.72	17.80	95.0	77	50	7	4.98	1.74	2.86	1	0	2	1
28	Thai rice	4.80	19.30	0.112	7.20	18.69	99.2	77	5	4	7.29	3.33	2.19	1	0	2	3
29	*	2.30	22.94	0.121	8.00	4.03	86.0	95	1	6	4.58	1.43	3.20	1	0	2	1
30	Donting rice	2.50	18.61	0.110	8.41	14.94	88.7	92	15	5	8.68	3.48	2.49	1	0	2	3
31	Diantun 502	3.50	22.00	0.166	7.92	14.52	84.7	46	25	6	7.30	3.01	2.43	1	0	2	3
32	*	4.20	22.09	0.230	5.50	2.00	73.3	100	1	6	5.96	2.28	2.61	1	0	2	2
33	*	4.50	20.83	0.278	7.50	1.38	85.4	100	1	5	6.59	2.70	2.44	1	0	2	2
34	Chugeng 3	2.20	20.41	0.138	6.43	16.23	88.1	94	25	6	4.70	1.59	2.96	1	0	2	1
35	6536	2.10	17.60	0.117	7.12	17.86	92.7	84	70	6	5.15	1.77	2.91	1	0	2	1
36	6536	2.05	20.85	0.166	6.87	16.51	89.0	86	10	6	4.77	1.64	2.91	1	0	2	1
37	Babao rice	4.80	25.05	0.400	9.82	20.28	96.5	39	1	2	6.48	2.87	2.26	1	0	2	2
38	Hunan	3.80	24.52	0.176	7.68	3.22	90.0	100	1	5	7.01	2.90	2.42	1	0	2	3
39	Xinan 175	2.40	15.27	0.154	7.20	16.28	89.0	100	30	6	4.90	1.62	3.02	1	0	2	1
40	Xinan 175	2.30	13.98	0.142	7.20	16.23	90.4	100	20	5	5.20	1.66	3.13	1	0	2	1
41	Hexi 2	1.98	14.11	0.134	7.38	15.94	78.4	80	25	7	4.86	1.68	2.89	0	1	3	1
42	Dianyu 1	2.04	14.54	0.144	7.10	16.27	86.1	74	30	7	4.87	1.73	2.82	0	1	3	1
43	87-66	2.10	18.67	0.132	6.78	15.83	73.1	81	85	7	4.96	1.62	3.06	0	1	3	1
44	Hexi 17	2.04	15.83	0.126	6.13	17.21	81.0	74	60	7	4.97	1.63	3.05	0	1	3	1
45	Dayu 66	2.10	14.50	0.123	5.89	14.08	89.3	84	35	7	5.06	1.64	3.09	0	1	3	1
46	You 37	2.00	9.96	0.116	6.59	15.68	65.8	84	25	7	5.22	1.80	2.90	0	1	3	1
47	You 37	2.04	12.28	0.126	7.02	15.45	59.4	79	30	7	5.16	1.87	2.76	0	1	3	1
48	Chugeng	1.82	23.32	0.166	7.14	15.03	89.4	85	20	6	4.82	1.67	2.89	0	1	3	1
49	Jianshu rice	2.40	18.22	0.155	7.14	3.52	97.8	84	1	5	4.88	1.76	2.77	0	1	3	1
50	*	2.52	15.94	0.096	7.08	1.42	74.1	90	1	7	4.50	1.54	2.92	0	1	3	1
51	Dongbei rice	2.20	15.15	0.179	5.58	16.77	94.5	82	35	5	5.11	1.71	2.99	0	1	3	1
52	*	2.80	19.88	0.130	6.07	10.91	84.9	59	40	7	7.42	3.31	2.24	0	1	3	3
53	Dongbei rice	2.18	16.35	0.171	7.26	15.63	92.4	72	15	7	4.70	1.59	2.96	0	1	3	1
54	Chugeng	2.00	18.24	0.186	6.84	15.15	88.2	84	40	7	4.82	1.58	3.05	0	1	3	1
55	Hexi 2	2.04	13.45	0.117	5.64	9.09	73.5	78	25	7	4.77	1.65	2.89	0	1	3	1
56	*	2.04	14.00	0.142	6.60	8.85	69.7	85	70	7	4.71	1.58	2.98	0	1	3	1
57	Hexi 11	2.20	10.34	0.104	5.69	7.87	83.2	80	10	7	5.07	1.71	2.96	0	1	3	1
58	Hexi 66	2.20	14.09	0.094	6.72	16.82	82.3	74	40	7	4.88	1.69	2.89	0	1	3	1
59	Hexi 17	2.00	12.98	0.118	5.91	15.95	78.0	77	80	7	4.89	1.73	2.83	0	1	3	1
60	Hunnan	1.94	24.14	0.148	7.91	15.46	80.3	55	50	6	5.09	1.74	2.93	0	1	3	1

Note: PI=price (yuan/kg) of milled rice; ZN=zinc content (mg/kg); P=phosphorus content (%); PR=protein content (%); AMY=amylose content (%); HEA=percent head rice of total milled rice; GEL=gel consistency; ALK=alkali spreading value; CHK=chalkiness score (%), GL=grain length (mm); GW=grain width (mm); R=grain ratio of GL/G.

Dummy variables: D1=1 standard for Kunming, D2=1 standard for Dali, Xishuangbanna is base area which D1, D2 equal to zero. D=1, 2, 3 standard for Xishuangbanna, Kunming, and Dali. D0=1, 2, 3 standard for irrigated japonica rice, upland rice, and irrigated indica rice, respectively.

\*Name of variety is unknown.

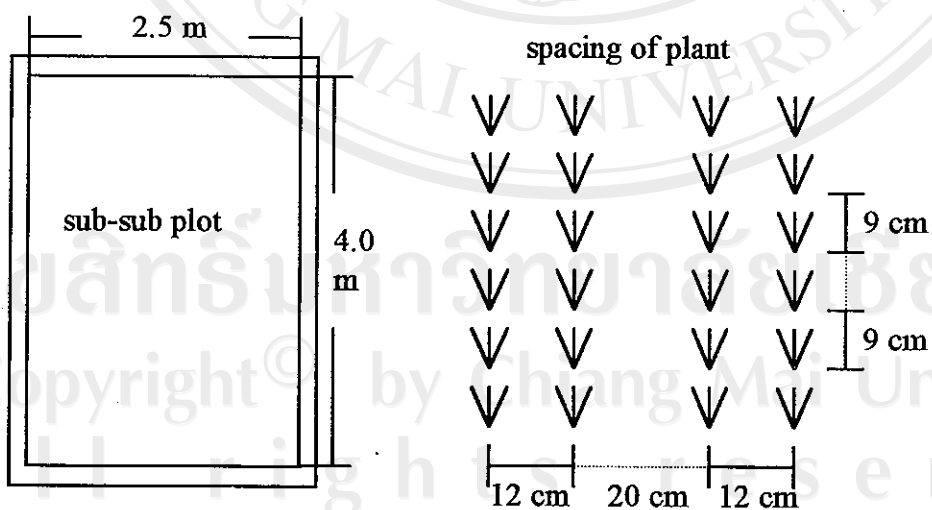


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+Zn			-Zn			Trt.
V1	V2	V3	V1	V2	V3	P1
V2	V3	V1	V2	V3	V1	
V3	V1	V2	V3	V1	V2	
V2	V3	V1	V2	V3	V1	P2
V1	V2	V3	V1	V2	V3	
V3	V1	V2	V3	V1	V2	
V3	V1	V2	V3	V1	V2	P3
V2	V3	V1	V2	V3	V1	
V1	V2	V3	V1	V2	V3	

Appendix b-1 Layout of Field Experiment.

Treatment, -Zn and +Zn: 0, 5 kg Zn /ha; P1, P2, P3: 60, 150, 200 kg P<sub>2</sub>O<sub>5</sub> /ha; V1, V2, V3: Xunza 29, Hexi 35; and Yungeng 34, respectively.



Appendix b-2 Diagram size of per experimental unit and spacing of plant

## Appendix C Field Experimental Results

### Appendix c-1 Effects of Zn and P application on plant development\* with three rice varieties.

Treatment**	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
<b>Panicle shooting</b>						
Xunza 29	133	129	129	129	130	128
Hexi 35	131	130	131	131	129	130
Yungeng 34	135	135	135	134	133	130
<b>Flowering</b>						
Xunza 29	142	139	140	139	138	138
Hexi 35	142	139	141	138	138	139
Yungeng 34	144	141	141	141	142	139
<b>Maturity<sup>a</sup></b>						
Xunza 29	198	196	196	196	194	194
Hexi 35	198	196	195	197	195	195
Yungeng 34	201	200	198	199	198	198

\* The days after sowing. Sowing date was March 21, recorded as 0.

\*\* -Zn, +Zn: 0, 5 kg Zn /ha, respectively.

P1, P2, P3: 60, 150, 200 kg P<sub>2</sub>O<sub>5</sub> /ha, respectively.

<sup>a</sup>= Maturity, indicating that all the grains turned yellow except one or two green grains at the bottom.

### Appendix c-2 Effects of Zn and P application on grain yield t/ha of three rice varieties.

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	8.13	7.62	7.42	7.83	8.33	6.92
Hexi 35	8.42	8.83	10.10	8.33	11.33	11.83
Yungeng 34	8.17	10.08	10.17	9.58	10.08	10.88

### Appendix c-3 Effects of Zn and P application on panicle weight g/plant of three rice varieties.

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	21.5	22.4	22.1	20.4	23.4	20.7
Hexi 35	22.7	24.2	27.0	23.4	25.1	29.9
Yungeng 34	23.6	26.5	27.0	23.1	25.2	28.1

**Appendix c-4 Effects of Zn and P application on g/1000-grain-weight of three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	24.84	25.58	25.40	25.54	24.38	25.25
Hexi 35	26.75	26.93	26.21	27.30	26.92	27.38
Yungeng 34	30.20	29.46	31.09	30.76	30.96	31.29

**Appendix c-5 Effects of Zn and P application on filled grain % of total grain with three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	84.7	82.3	83.7	89.0	84.3	83.7
Hexi 35	85.7	87.3	89.7	93.0	91.0	94.3
Yungeng 34	79.3	80.3	80.3	84.3	78.3	79.7

**Appendix c-6 Effects of Zn and P application on numbers of productive tiller/plant with three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	5.6	5.8	6.2	6.0	6.0	5.8
Hexi 35	5.0	4.7	5.8	4.7	4.8	5.4
Yungeng 34	4.3	4.0	4.6	4.5	4.6	4.6

**Appendix c-7 Effects of Zn and P application on total grain numbers/panicle with three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	172.9	195.1	184.5	179.5	176.7	181.9
Hexi 35	199.1	197.6	184.1	190.0	195.7	195.2
Yungeng 34	206.9	218.7	221.2	217.7	241.2	258.0

**Appendix c-8 Effects of Zn and P application on total biomass t/ha of three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	17.3	15.6	16.2	15.3	17.3	15.4
Hexi 35	16.0	16.8	19.0	15.7	20.9	21.3
Yungeng 34	17.4	20.7	20.4	20.0	20.4	21.8

**Appendix c-9 Effects of Zn and P application on harvest index (HI) of three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	0.47	0.49	0.46	0.51	0.48	0.45
Hexi 35	0.53	0.54	0.53	0.53	0.54	0.56
Yungeng 34	0.47	0.49	0.50	0.48	0.50	0.50

**Appendix b-10 Effects of Zn and P application plant height cm with three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	85.0	83.9	89.3	80.0	83.5	81.5
Hexi 35	98.0	99.3	101.9	91.6	94.1	94.9
Yungeng 34	109.4	109.4	109.1	104.5	106.8	107.8

**Appendix c-11 Effects of Zn and P application on Zn content mg/kg of stem with three rice varieties (at final harvest stage).**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	39.05	45.34	45.28	44.92	46.02	40.18
Hexi 35	21.84	20.36	20.98	25.76	20.24	24.03
Yungeng 34	25.64	24.81	31.16	36.30	32.62	30.78

**Appendix c-12 Effects of Zn and P application on Zn content mg/kg of leaf blade with three rice varieties (at final harvest stage).**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	18.34	17.99	18.63	18.39	19.55	17.69
Hexi 35	20.48	14.32	16.49	15.96	16.47	21.07
Yungeng 34	19.08	16.68	19.90	21.02	21.44	20.85

**Appendix c-13 Effects of Zn and P application on Zn content mg/kg of grain\* with three rice varieties (at final harvest stage).**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	13.85	15.00	16.83	16.65	15.16	16.46
Hexi 35	14.01	12.82	13.72	15.15	15.52	12.10
Yungeng 34	13.02	12.16	13.63	15.10	12.94	13.00

\*brown rice (at 14% of grain moisture), Zn contents were measured by applying atom absorption.

**Appendix c-14 Effects of Zn and P application on total amount of Zn content g/ha of grain with three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	112.5	114.0	124.9	130.4	126.1	113.6
Hexi 35	118.0	113.4	137.9	125.9	175.7	143.0
Yungeng 34	108.2	122.9	138.2	145.2	130.5	141.3

**Appendix c-15 Effects of Zn and P application on total amount of Zn uptake g/ha of plant three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	377.2	365.6	407.9	369.2	422.8	357.1
Hexi 35	276.9	254.7	307.5	278.2	351.3	355.0
Yungeng 34	316.2	343.0	397.2	442.7	408.1	421.7

**Appendix c-16 Effects of Zn and P application on Zn proportion\* in stem, blade leaf, grain with three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
<b>Stem</b>						
Xunza 29	0.48	0.49	0.49	0.46	0.49	0.47
Hexi 35	0.29	0.31	0.30	0.34	0.27	0.32
Yungeng 34	0.38	0.38	0.39	0.42	0.40	0.40
<b>Leaf</b>						
Xunza 29	0.22	0.19	0.20	0.19	0.20	0.21
Hexi 35	0.28	0.22	0.24	0.21	0.22	0.28
Yungeng 34	0.28	0.26	0.26	0.25	0.27	0.27
<b>Grain</b>						
Xunza 29	0.30	0.31	0.31	0.35	0.30	0.32
Hexi 35	0.43	0.46	0.46	0.45	0.50	0.40
Yungeng 34	0.34	0.36	0.35	0.33	0.32	0.34

**Appendix c-17 Effects of Zn and P application on P content % of stem with three rice varieties (at final harvest stage).**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	0.079	0.090	0.099	0.065	0.100	0.128
Hexi 35	0.061	0.075	0.070	0.052	0.056	0.098
Yungeng 34	0.057	0.080	0.101	0.059	0.083	0.089



**Appendix c-18 Effects of Zn and P application on P content % of leaf blade with three rice varieties (at final harvest stage).**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	0.106	0.143	0.121	0.111	0.127	0.162
Hexi 35	0.097	0.130	0.118	0.098	0.120	0.117
Yungeng 34	0.089	0.092	0.118	0.090	0.117	0.119

**Appendix c-19 Effects of Zn and P application on % P content of grain with three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	0.124	0.119	0.146	0.122	0.126	0.130
Hexi 35	0.123	0.123	0.124	0.120	0.130	0.121
Yungeng 34	0.144	0.106	0.132	0.116	0.121	0.115

**Appendix c-20 Effects of Zn and P application on the total amount P kg/ha of grain with three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	10.1	9.1	10.8	9.6	10.5	9.0
Hexi 35	10.4	10.8	12.5	10.0	14.7	14.3
Yungeng 34	11.8	10.7	13.4	11.1	12.1	12.5

**Appendix c-21 Effects of Zn and P application on the total amount of P uptake kg/ha of plant with three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	18.6	18.3	20.6	16.1	20.7	21.3
Hexi 35	16.3	18.7	21.1	15.5	23.1	24.5
Yungeng 34	18.4	19.8	24.8	18.9	22.3	23.8

Appendix c-22 Effects of Zn and P application on P proportion\* in stem, blade leaf, grain of three rice varieties.

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
<b>Stem</b>						
Xunza 29	0.20	0.20	0.21	0.15	0.21	0.25
Hexi 35	0.14	0.15	0.15	0.12	0.12	0.19
Yungeng 34	0.14	0.21	0.21	0.16	0.18	0.20
<b>Leaf</b>						
Xunza 29	0.26	0.31	0.26	0.26	0.28	0.32
Hexi 35	0.23	0.27	0.25	0.23	0.25	0.23
Yungeng 34	0.22	0.25	0.24	0.25	0.26	0.27
<b>Grain</b>						
Xunza 29	0.54	0.49	0.52	0.59	0.51	0.42
Hexi 35	0.64	0.58	0.60	0.65	0.63	0.58
Yungeng 34	0.64	0.54	0.54	0.59	0.55	0.52

Appendix c-23 Effects of Zn and P application on length (mm) of grain with three rice varieties.

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	4.66	4.71	4.69	4.75	4.74	4.72
Hexi 35	4.77	4.72	4.74	4.76	4.81	4.75
Yungeng 34	5.33	5.23	5.21	5.27	5.21	5.27

Appendix c-24 Effects of Zn and P application on ratio of grain length to grain width (L/W) with three rice varieties.

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	1.63	1.59	1.60	1.64	1.63	1.64
Hexi 35	1.58	1.56	1.60	1.57	1.60	1.61
Yungeng 34	1.82	1.79	1.77	1.77	1.81	1.82

**Appendix c-25 Effects of Zn and P application on degree of grain chalkiness with three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	3.5	3.8	3.8	5.2	6.3	3.6
Hexi 35	4.8	1.7	2.8	2.0	2.7	2.3
Yungeng 34	12.2	14.6	15.0	13.9	10.0	13.0

**Appendix c-26 Effects of Zn and P application on degree of grain hardness\* with three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	53.8	50.3	48.5	39.8	40.8	40.9
Hexi 35	60.3	50.1	58.8	47.2	40.8	48.0
Yungeng 34	47.0	50.0	53.5	39.7	39.5	46.0

\*Indicating stress which just made grain cracked. Measured by device, namely KQ-1, and the stress expressed as Newton/grain.

**Appendix c-27 Effects of Zn and P application on of brown rice (%) with three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	84.3	84.4	83.8	83.8	83.8	83.9
Hexi 35	83.8	85.3	85.4	83.8	83.4	87.1
Yungeng 34	83.2	83.9	84.2	83.6	86.3	86.7

**Appendix c-28 Effects of Zn and P application on milled rice (%) with three rice varieties.**

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	76.9	76.5	76.5	76.1	76.2	76.4
Hexi 35	76.6	77.1	77.8	75.5	75.5	79.4
Yungeng 34	74.9	74.6	75.0	74.4	77.3	77.4

Appendix c-29 Effects of Zn and P application on head rice recovery<sup>a</sup> (%) with three rice varieties.

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	66.5	66.4	64.6	66.3	68.9	68.1
Hexi 35	67.9	68.9	71.1	65.2	67.7	70.4
Yungeng 34	66.3	69.3	69.1	64.3	66.2	68.0

Appendix c-30 Effects of Zn and P application on protein content (%) of brown rice with three rice varieties.

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	9.12	10.02	10.65	8.79	9.96	9.50
Hexi 35	9.08	8.98	9.76	8.52	8.31	8.50
Yungeng 34	9.30	9.56	10.11	8.51	8.90	8.57

Appendix c-31 Effects of Zn and P application on total amount of protein (kg/ha) of brown rice with three rice varieties.

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	74.1	76.1	78.9	68.7	82.8	65.8
Hexi 35	76.4	79.4	98.3	70.9	94.2	100.5
Yungeng 34	75.7	96.3	102.5	81.4	90.0	92.8

Appendix c-32 Effects of Zn and P application on amylose content (%) of milled rice with three rice varieties.

Treatment	-Zn			+Zn		
	P1	P2	P3	P1	P2	P3
Xunza 29	19.63	20.45	19.04	21.66	20.16	21.54
Hexi 35	16.78	17.37	17.22	17.72	17.28	17.66
Yungeng 34	18.01	18.52	18.90	19.27	19.21	19.30

## Appendix D Analysis of Variance (ANOVA) of the Field Experiment

### Appendix d-1 ANOVA for date of Panicle emergency, Flowering, and Maturity (the days after sowing).

Source of variance	DF	Panicle emergency		Flowering stage		Maturity stage	
		MS	P	MS	P	MS	P
Replication	2	4.574	0.269	8.685	0.108	6.241	0.053
Zinc (A)	1	29.630	0.052	42.667	0.024	44.463	0.008
Error	2	1.685		1.056		0.352	
Phosphorus (B)	2	13.019	0.073	8.963	0.272	11.241	0.097
Error	4	2.407		4.880		2.546	
A×B	2	3.574	0.405	12.667	0.018	10.019	0.053
Error	4	3.130		0.972		1.491	
Genotype (C)	2	83.019	0.000	23.463	0.000	25.796	0.000
A×C	2	3.574	0.315	2.167	0.420	4.463	0.149
B×C	4	2.685	0.473	4.741	0.132	4.519	0.114
A×B×C	4	5.185	0.170	0.833	0.844	1.185	0.703
Error	24	2.944		2.407		2.167	

### Appendix d-2 ANOVA for Grain yield, 1000-grain-weight, and Panicle weight.

Source of variance	DF	1000-grain-weight (g)		Panicle weight (g/pl.)		Grain yield t/ha	
		MS	P	MS	P	MS	P
Replication	2	0.599	0.540	0.743	0.589	8.28	0.907
Zinc (A)	1	2.241	0.216	0.918	0.451	638.60	0.107
Error	2	0.702		1.066		81.32	
Phosphorus (B)	2	0.522	0.421	52.073	0.001	683.50	0.030
Error	4	0.482		0.844		71.11	
A×B	2	0.339	0.817	1.537	0.613	59.36	0.547
Error	4	1.600		2.771		84.17	
Genotype (C)	2	142.66	0.000	84.245	0.000	2670.30	0.000
A×C	2	0.897	0.232	5.536	0.119	223.63	0.022
B×C	4	0.582	0.423	13.818	0.002	463.56	0.000
A×B×C	4	1.164	0.125	2.845	0.338	171.27	0.024
Error	24	0.577		2.376		49.99	

Appendix d-3 ANOVA for Filled grain, Grain numbers, Productive tiller numbers.

Source of variance	DF	Filled grain (%)		No. of grain /panicle		No. of prod. tiller /pl.	
		MS	P	MS	P	MS	P
Replication	2	0.00035	0.825	1426.70	0.198	0.1973	0.867
Zinc (A)	1	0.00987	0.134	15.23	0.350	0.0504	0.862
Error	2	0.00164		351.67		1.2901	
Phosphorus (B)	2	0.00194	0.425	576.25	0.667	0.9156	0.0894
Error	4	0.00181		1284.25		0.1952	
A×B	2	0.00275	0.214	274.25	0.735	0.3951	0.530
Error	4	0.00118		824.54		0.5291	
Genotype (C)	2	0.04239	0.000	10047.0	0.001	9.6210	0.000
A×C	2	0.00234	0.288	1023.90	0.361	0.2673	0.400
B×C	4	0.00141	0.543	401.65	0.795	0.2827	0.423
A×B×C	4	0.00029	0.957	189.44	0.938	0.0645	0.919
Error	24	0.00178		964.08		0.2806	

Appendix d-4 ANOVA for Plant height, Total biomass, and Harvest index (HI).

Source of variance	DF	Plant height (cm)		Total biomass (t/ha)		Harvest index (HI)	
		MS	P	MS	P	MS	P
Replication	2	27.445	0.124	175.75	0.732	0.00147	0.347
Zinc (A)	1	276.260	0.014	1195.90	0.256	0.00157	0.347
Error	2	3.891		480.96		0.00078	
Phosphorus (B)	2	32.118	0.402	2185.50	0.044	0.00032	0.700
Error	4	27.797		290.69		0.00080	
A×B	2	10.555	0.176	332.42	0.450	0.00031	0.779
Error	4	3.819		338.09		0.00120	
Genotype (C)	2	2591.200	0.000	6828.30	0.000	0.01919	0.000
A×C	2	12.035	0.305	642.11	0.185	0.00004	0.971
B×C	4	2.036	0.930	898.30	0.067	0.00174	0.243
A×B×C	4	8.319	0.500	637.54	0.162	0.00048	0.803
Error	24	9.633		354.67		0.00118	

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Appendix d-5 ANOVA for zinc (Zn) content of stem, leaf blade, and grain (mg/kg).

Source of variance	DF	Zn content of stem		Zn content of leaf		Zn content of grain	
		MS	P	MS	P	MS	P
Replication	2	87.38	0.125	0.757	0.946	5.424	0.173
Zinc (A)	1	115.93	0.093	18.447	0.360	8.252	0.114
Error	2	12.49		13.30		1.133	
Phosphorus (B)	2	2.27	0.953	9.605	0.469	2.184	0.276
Error	4	46.51		10.436		1.207	
A×B	2	65.48	0.03	15.522	0.138	10.009	0.040
Error	4	8.06		4.600		1.243	
Genotype (C)	2	2027.4	0.000	25.402	0.003	26.956	0.000
A×C	2	36.02	0.019	6.716	0.158	0.022	0.982
B×C	4	24.79	0.029	6.771	0.125	5.096	0.010
A×B×C	4	17.85	0.084	12.984	0.015	2.157	0.168
Error	24	7.62		3.362		1.219	

Appendix d-6 ANOVA for total amount of Zn in grain (g/ha), and total amount of Zn uptake of plant (g/ha).

Source of variance	DF	Total amount of Zn in grain (g/ha)		Total amount of Zn uptake by plant (g/ha)	
		MS	P	MS	P
Replication	2	4.687	0.311	18.916	0.535
Zinc (A)	1	3.337	0.058	21.588	0.088
Error	2	2.116		21.764	
Phosphorus (B)	2	4.565	0.159	43.363	0.483
Error	4	1.514		49.456	
A×B	2	9.942	0.119	48.860	0.204
Error	4	2.619		20.155	
Genotype (C)	2	1.127	0.010	40.259	0.000
A×C	2	3.989	0.158	61.175	0.064
B×C	4	3.798	0.144	13.611	0.613
A×B×C	4	7.135	0.020	34.542	0.178
Error	24	2.001		20.021	

Appendix d-7 ANOVA for Zn proportion (%) in stem, leaf, and grain.

Source of variance	DF	Stem		Leaf		Grain	
		MS	P	MS	P	MS	P
Replication	2	0.00261	0.197	0.00246	0.643	0.00353	0.350
Zinc (A)	1	0.00051	0.467	0.00058	0.752	0.00000	0.975
Error	2	0.00064		0.00444		0.00190	
Phosphorus (B)	2	0.00000	0.978	0.00079	0.437	0.00106	0.647
Error	4	0.00161		0.00077		0.00218	
A×B	2	0.00115	0.299	0.00548	0.058	0.00187	0.268
Error	4	0.00069		0.00087		0.00101	
Genotype (C)	2	0.13650	0.000	0.01664	0.000	0.0938	0.000
A×C	2	0.00155	0.200	0.00007	0.913	0.00175	0.387
B×C	4	0.00082	0.471	0.00065	0.543	0.00225	0.308
A×B×C	4	0.00123	0.273	0.00054	0.626	0.00187	0.400
Error	24	0.00090		0.00083		0.00177	

Appendix d-8 ANOVA for phosphorus (P) content(%) of stem, leaf blade, and grain.

Source of variance	DF	P content of stem		P content of leaf		P content of grain	
		MS	P	MS	P	MS	P
Replication	2	0.00027	0.521	0.0004	0.557	0.00027	0.748
Zinc (A)	1	0.00007	0.686	0.0004	0.475	0.00028	0.613
Error	2	0.00059		0.0005		0.00081	
Phosphorus (B)	2	0.01120	0.068	0.0039	0.019	0.00026	0.056
Error	4	0.00396		0.0003		0.00004	
A×B	2	0.00120	0.424	0.0003	0.232	0.00069	0.206
Error	4	0.00220		0.0001		0.00029	
Genotype (C)	2	0.00570	0.000	0.0027	0.000	0.00015	0.342
A×C	2	0.00027	0.550	0.0002	0.233	0.00013	0.397
B×C	4	0.00049	0.697	0.0002	0.270	0.00035	0.066
A×B×C	4	0.00230	0.067	0.0007	0.010	0.00016	0.349
Error	24	0.00530		0.0002		0.00014	

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Appendix d-9 ANOVA for total amount of P in grain (kg/ha), and total amount of P uptake of plant (kg/ha).

Source of variance	DF	Total amount of P in grain (kg/ha)		Total amount of P uptake by plant (kg/ha)	
		MS	P	MS	P
Replication	2	24.06	0.847	15.536	0.849
Zinc (A)	1	27.678	0.693	149.30	0.321
Error	2	133.14		87.332	
Phosphorus (B)	2	118.37	0.0503	1313.2	0.134
Error	4	17.117		85.895	
A×B	2	112.34	0.0700	180.41	0.034
Error	4	20.208		20.483	
Genotype (C)	2	291.98	0.000	198.73	0.070
A×C	2	61.891	0.079	58.815	0.428
B×C	4	53.059	0.076	63.932	0.449
A×B×C	4	13.79	0.647	33.141	0.739
Error	24	21.945		66.833	

Appendix d-10 ANOVA for P proportion (%) in stem, leaf, and grain.

Source of variance	DF	Stem		Leaf		Grain	
		MS	P	MS	P	MS	P
Replication	2	0.00004	0.982	0.00184	0.603	0.00243	0.805
Zinc (A)	1	0.00003	0.912	0.00063	0.682	0.00036	0.866
Error	2	0.00233		0.00280		0.01000	
Phosphorus (B)	2	0.01171	0.113	0.00408	0.0455	0.02638	0.059
Error	4	0.00297		0.00055		0.00425	
A×B	2	0.00247	0.404	0.00121	0.485	0.00658	0.334
Error	4	0.00216		0.00139		0.00451	
Genotype (C)	2	0.01644	0.000	0.00832	0.003	0.04423	0.000
A×C	2	0.00014	0.862	0.00134	0.302	0.00133	0.589
B×C	4	0.00079	0.502	0.00035	0.858	0.00098	0.808
A×B×C	4	0.00195	0.109	0.00120	0.366	0.00293	0.339
Error	24	0.00092		0.00107		0.00245	

Appendix d-11 ANOVA for Length (L), width (W) of grain and Ratio of L/W.

Source of variance	DF	Grain length (mm)		Grain width (mm)		Ratio of L/W	
		MS	P	MS	P	MS	P
Replication	2	0.0063	0.355	0.0030	0.654	0.0004	0.947
Zinc (A)	1	0.0083	0.261	0.0002	0.873	0.0074	0.399
Error	2	0.0035		0.0057		0.0065	
Phosphorus (B)	2	0.0039	0.375	0.0019	0.536	0.0008	0.824
Error	4	0.0031		0.0026		0.0038	
A×B	2	0.0014	0.705	0.0027	0.518	0.0019	0.081
Error	4	0.0037		0.0035		0.0004	
Genotype (C)	2	1.6370	0.000	0.0570	0.000	0.2420	0.000
A×C	2	0.0033	0.598	0.0011	0.706	0.0009	0.574
B×C	4	0.0037	0.674	0.0011	0.844	0.0009	0.684
A×B×C	4	0.0048	0.561	0.0017	0.730	0.0007	0.763
Error	24	0.0063		0.0032		0.0015	

Appendix d-12 ANOVA for Output of brown rice, Milled rice recovery, and Head rice recovery (%).

Source of variance	DF	Output of brown rice		Milled rice recovery		Head rice recovery	
		MS	P	MS	P	MS	P
Replication	2	1.562	0.660	1.207	0.413	0.650	0.306
Zinc (A)	1	2.622	0.451	0.759	0.445	4.167	0.062
Error	2	3.035		0.852		0.287	
Phosphorus (B)	2	9.465	0.238	8.397	0.334	29.708	0.045
Error	4	4.511		5.755		4.021	
A×B	2	3.251	0.091	5.072	0.091	5.351	0.763
Error	4	0.703		1.093		18.441	
Genotype (C)	2	2.896	0.374	8.836	0.062	15.104	0.163
A×C	2	6.001	0.142	5.481	0.166	21.657	0.080
B×C	4	4.079	0.250	3.821	0.280	8.853	0.358
A×B×C	4	2.025	0.589	2.026	0.589	1.630	0.930
Error	24	2.826		2.829		7.712	

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## Appendix E Summary of Agronomic and Quality Characteristics of Rice Varieties

### Appendix e-1 Plant development, yield and yield components, and agronomic characteristics of three varieties.

Characteristics	Xunza 29	Hexi 35	Yungeng 34
Panicle emergence (day)	129.7	130.2	133.6
Flowering (day)	139.4	139.6	141.5
Maturity (day)	195.4	195.9	197.7
Grain yield (t/ha)	7.70	9.80	9.83
Panicle weight (g/plant)	21.8	25.4	25.6
1000-grain-weight (g)	25.1	26.9	30.6
No. of productive tiller/plant	5.9	5.0	4.4
No. of grain/panicle	181.7	193.6	227.3
Plant height (cm)	83.9	96.6	107.8
Total biomass (t/ha)	16.2	18.3	20.1
Harvest index (HI)	0.48	0.49	0.54

### Appendix e-2 Zn and P uptake and distribution in plant of three varieties (at maturity).

Characteristics	Xunza 29	Hexi 35	Yungeng 34
Zn content in stem (mg/kg)	43.5	22.2	30.2
in whole leaf	18.4	17.5	19.8
in whole kernel	15.7	13.9	13.3
Total Zn in grain (g/ha)	120.2	131.1	135.7
Total uptake Zn (g/ha)	383.3	303.9	388.2
P content in stem (%)	0.094	0.067	0.078
in whole leaf	0.128	0.113	0.104
in whole kernel	0.127	0.124	0.122
Total P in grain (kg/ha)	9.8	12.1	11.9
Total uptake P (kg/ha)	19.3	19.9	21.3

### Appendix e-3 Grain physical and chemical quality characteristics of three varieties.

Characteristics	Xunza 29	Hexi 35	Yungeng 34
Grain length (mm)	4.71	4.76	5.26
Grain width (mm)	2.91	3.01	2.91
Chalkiness score (%)	4.4	2.7	13.1
Hardness (Newton/grain)	45.7	50.9	45.9
Yield of brown rice (%)	84.0	84.8	84.6
Milled rice recovery (%)	76.4	77.0	75.6
Head rice recovery (%)	66.8	68.5	67.2
Protein content (%)	9.7	8.9	9.2
Total protein (kg/ha)	74.4	86.6	89.8
Amylose content (%)	20.5	17.3	18.9

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