Effect of Fertilization on Soil Available Nutrients and Crop Responses in the Southwest China

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Effect of changing fertilizer application on crop yields in the southwest China

Total fertilizer consumption in the southwest China （1990-2004）

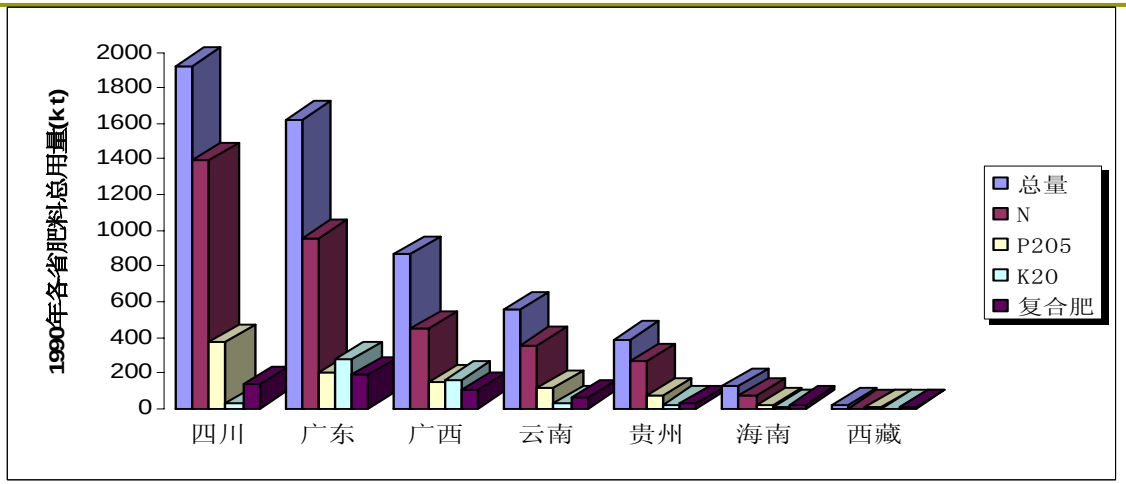
Year	Total	N	P_2O_5	K_2O	Complex	Ratio
	k t	k t	k t	k t	k t	$N:P_2O_5:K_2O$
1990	5491	3487	930	527	540	1:0.27:0.15
1995	7311	4031	1289	810	1184	1:0.32:0.20
2000	8306	4419	1308	1015	1563	1:0.30:0.23
2004	9448	4601	1438	1254	2148	1:0.31:0.27

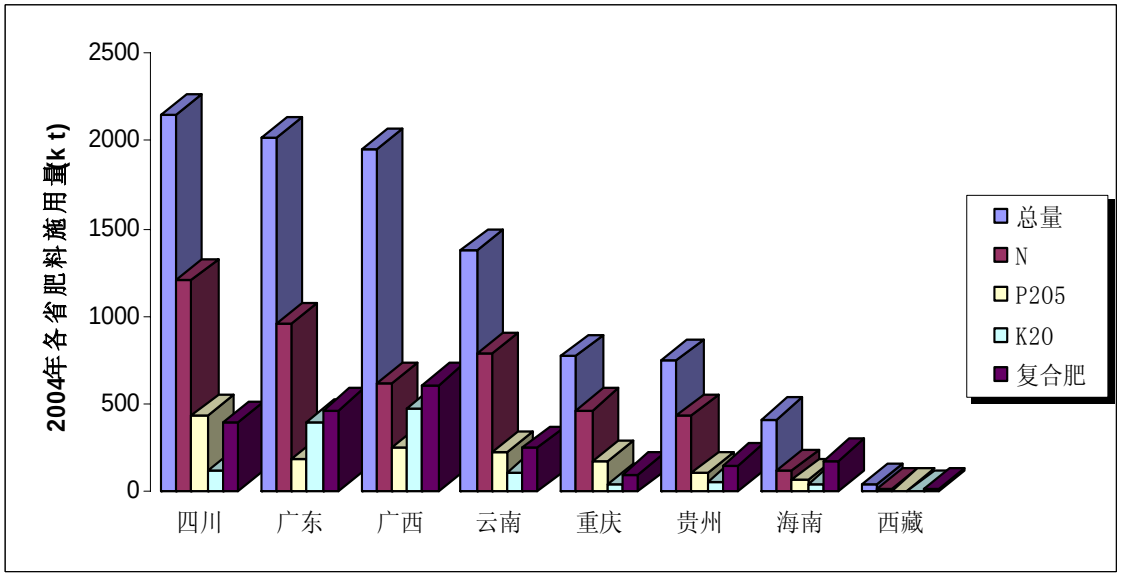
Fertilizer consumption per unit area （1990-2004）

Year	Planting area (k ha)	Fertilizer application rate (kg/ha)				
		Total	N	P_2O_5	K_2O	Complex
1990	31698.0	173	110	29	17	17
1995	34410.0	212	117	37	24	34
2000	36350.6	228	122	36	28	43
2004	35642.1	265	129	40	35	60

Total fertilizer consumption by province （1990 vs 2004）

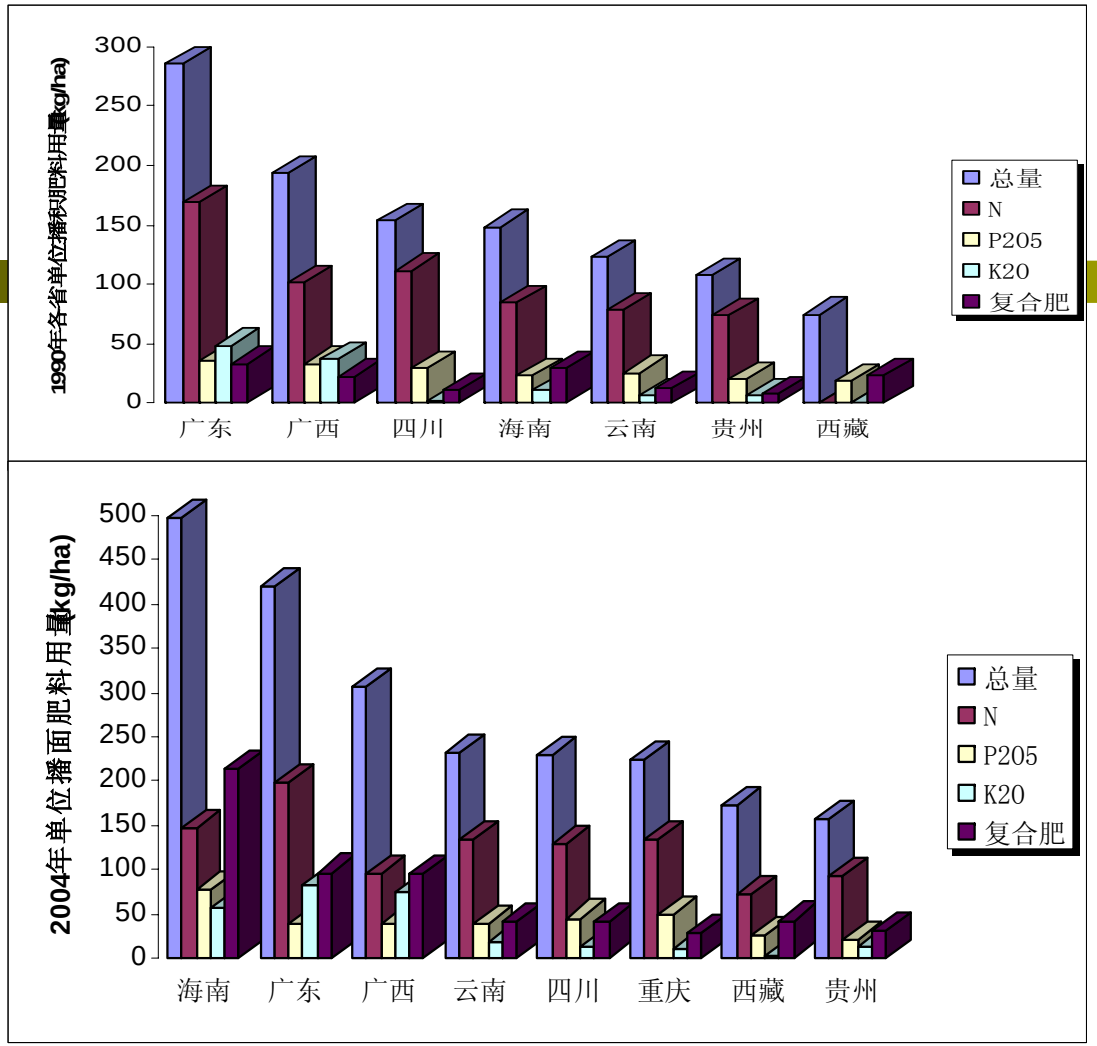
In the past 14 years，sequence of 8 provinces in fertilizer consumption remained the same, but quantity increased considerably and N:P_2O_5:K_2O ratio improved. Consumption of K surpassed P in Guangdong and Guangxi (2.1:1 and1.9:1). Similar situation was seen in Hunan (1.4:1) and Fujian (1.4:1) .





Fertilizer application rates by province (1990 vs 2004)

In the past 14 years, fertilizer application rates increased rapidly in the southwest China. The fast growing provinces were Hainan, Guangdong and Guangxi, the slowest was Guizhou. No N or K fertilizers were used in Tibet before 1990.



Planting areas and yields of major crops in the southwest China (1990-2004)

Area: k ha; yield: kg/ha

Year	Rice		Corn		Wheat		Potato		SW potato	
	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield
1990	11033	4305	3912	2408	3389	1545	1017	1953	1722	1788
1995	10330	4723	3987	2880	3619	1806	1205	2511	2615	1930
2000	9862	5924	4414	3934	3369	2527	1460	3473	2692	2706
2004	9461	5748	4192	4201	2567	2628	1719	3177	2363	3686

Planting areas and yields of major crops in the southwest China (1990-2004)

Area: k ha; Yield: kg/ha

Year	Rape seed		Fruit		Tea		Vegetables		Tobacco	
	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield
1990	**1330**	**842**	**1174**	**5108**	**374**	**445**	**1854**	**n/a**	**709**	**1048**
1995	**1443**	**1121**	**1767**	**4780**	**391**	**451**	**2817**	**14882**	**890**	**1016**
2000	**1652**	**1459**	**2638**	**6189**	**391**	**642**	**3950**	**21354**	**761**	**1618**
2004	**1710**	**1672**	**2940**	**9278**	**493**	**616**	**4612**	**21661**	**841**	**1668**

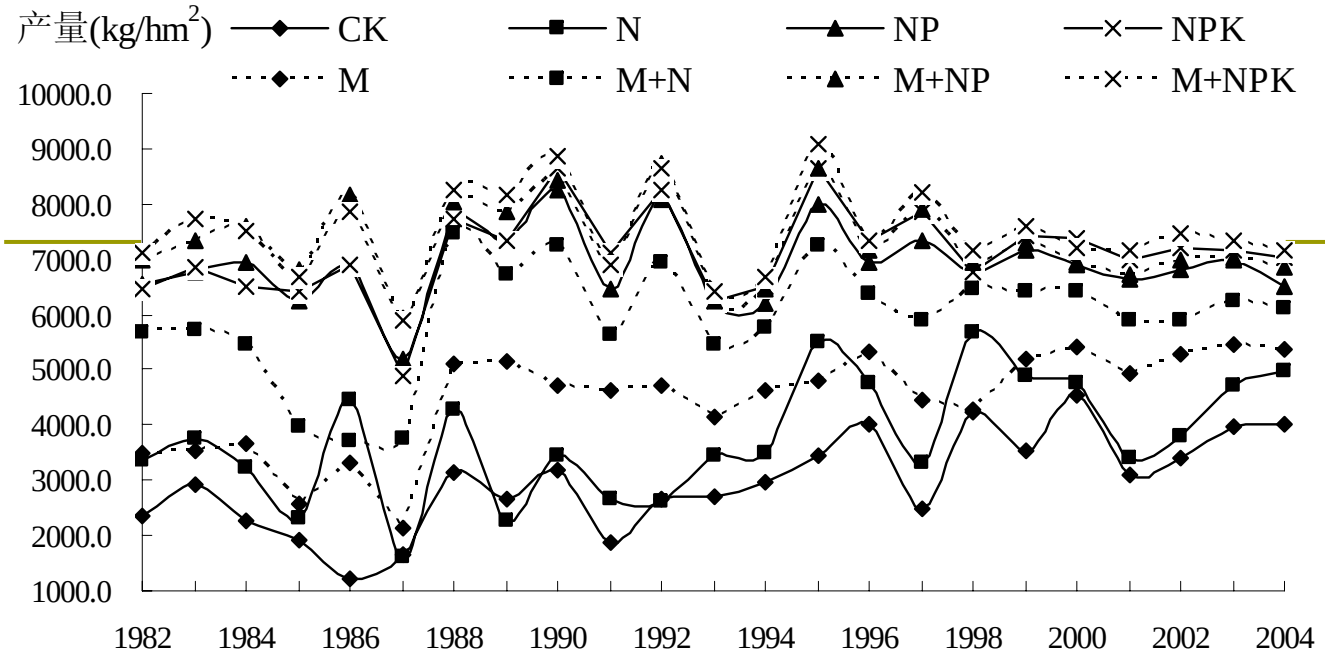
Effect of changing fertilizer application on soil available nutrients

Soil nutrient status in 48 soils in China during 80's- early 90's

Treatment	Deficient soil		Relative yield range (%)	Relative yield (%)	Location
	No	%			
-N	48	100	10-79	38.1	All 10 provinces
-P	46	96	15-85	44.9	All 10 provinces
-K	23	48	39-89	73	All 10 provinces
-Zn	25	52	55-88	74.4	All 10 provinces
-S	14	29	42-88	72.5	GD,JL,HuB,LN, SD,YN,HLJ
-B	11	23	66-91	81.5	GD,HuB,LN, SD,YN
-Mo	10	21	64-92	78.9	GD, HuB,LN, SD,YN
-Cu	6	13	72-89	80.9	GD,HuB,LN, JX,SD,HeB
-Mg	4	8	69-86	76.8	SD,HuB,LN, JX,SD,HeB
-Co	3	6	16-78	40	GD,HuB,JX
-Mn	3	6	77-84	80.3	GD,SD,YN
-Fe	2	4	46-70	58	GD,HeB

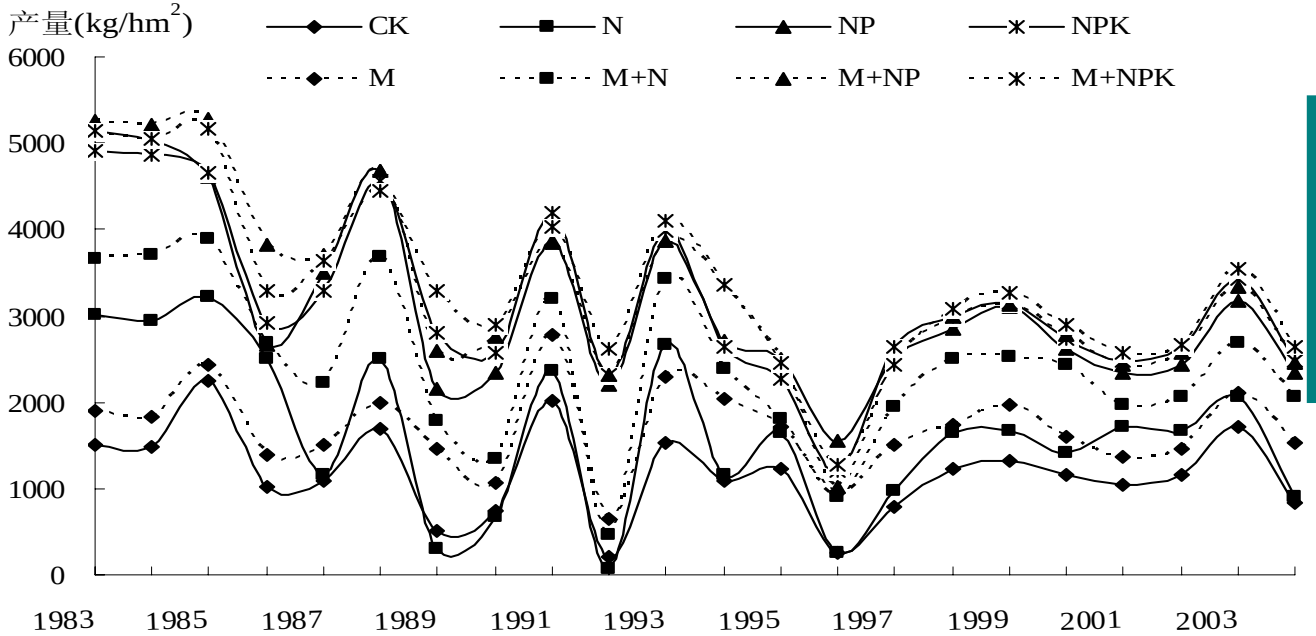
Soil nutrient status in 48 soils in China during 90's- early 21st centenary

Crop	Sample No	N def. %	P def. %	K def. %	Remarks
Grains	515	95.92	90.87	82.91	Southwest
	59	100.00	18.64	88.14	Tibet
Vegetables	17	100.00	35.29	35.29	Southwest
Sugar cane	17	82.35	47.06	41.18	GX,YN
Tobacco	48	100.00	0.00	0.00	YN,GZ
Fruits	152	98.68	63.16	10.53	Southwest
Banana	20	100.00	0.00	10.00	GD,GX,HN



Up: Effect of long term fertilization on rice yield on a calcareous purple soil in Sichuan

Below: Effect of long term fertilization on wheat yield on a calcareous purple soil in Sichuan



Order of fertilizer treatment effect on crop yield：MNPK，NPK，MNP，NP、MN，M，N，CK

Effect of a 5-year fertilizer treatments on rice yield in Liangping county, Chongqing

unit：kg/ha

处　理	2001	2002	2003	2004	2005	X±S
0-0-0	6395**	5815**	4073**	4253**	4130**	4933±1091.3
135-90-90(OPT)	8978	7653	7240	8155	6925	7789.9±808.4
135-90-45	8480**	6868**	6650**	7900	6283**	7236±918.8
135-90-0	8025**	5566**	5598**	5173**	6015**	6075.1±1130
135-90-135	8998	7573	7288	8448	6752	7811.4±903.5
135-0-90	8395**	6418**	6610**	6323**	5910**	6731±964.7
135-135-90	8580*	7650	7153	8355	6290**	7605.5±928.6
90-90-90	8575*	7403	7023	8050	6408**	7491.5±849.8
180-90-90	8878	7468	7140	7668	6136**	7457.6±988.6
135-90-90-Zn	8678	7630	7268	7698	6630	7580.5±745.1
135-90(CaMg)-90	8723	7880	7093	8098	6825	7723.5±769.4

Soil K balance in the long term fertilizer experiment in Sichuan（1982-2004）

（kg/ha）

Balance	CK	N	NP	NPK	M	MN	MNP	MNPK
Input	0	0	0	3930	0	0	0	3930
Crop removal	2908	3291	6488	7684	4715	6151	7541	8605
Soil balance	-2908	-3291	-6488	-3754	-4715	-6151	-7541	-4675
K fertilizer efficiency （%）	-	-	-	30.44	-	-	-	53.86

Note: K input from rain, irrigation and K loss due to leaching are not considered here.

Soil total K and slowly available K have been decreasing for all treatments.

Crop responses to potash application with time

Effect of K with balanced fertilization on grain crops in 80's in the southwest China

Crop	Yield increase from balanced K	Yield increase by K	
	kg/ha	kg/kg K_2O	%
Rice	949	9.30	15.44
Corn	1552	13.15	29.79
Wheat	809	8.43	27.62
Rape seed	422	3.91	29.99
Sweet potato	5885	52.08	23.86

Effect of K with balanced fertilization on grain crops in 90's in the southwest China

Crop	Yield increase from balanced K	Yield increase by K	
	kg/ha	kg/kg K_2O	%
Rice	287-905	3.2-10	4.1-11.6 ↓
Corn	732-2880	8.1-32	17.5-66
Wheat	642-1053	9.5-15.6	19.5-44.7
Sweet potato	2655-6795	59-101	15.6-46.9
Rape seed	228-840	5.1-6.2	19.3-59.3

Effect of K with balanced fertilization on grain crops in early 21st centenary in the southwest China

Crop	Yield increase by K application	
	kg/ kg K_2O	%
Rice	7.5	11.7 ↓
Corn	10.7	24.6 ↓
Wheat	12.2	27.9 ↓
Sweet potato	65.9	21.8 ↓
Rape seed	2.9	16.8 ↓

Effect of K with balanced fertilization on cash crops in 80's in the southwest China

Crop	Yield increase from balanced K	Yield increase by K	
	kg/ha	kg/kg K_2O	%
Peanut	878	10.21	25.55
Sugar cane	21325	188.72	27.83
Cassava	7365	40.92	55.54
Banana	2085	2.32	7.31
Mango			
Citrus	6483	43.22	17.39
Pineapple			
Litchi	4151	27.67	55.68
Longan			

Effect of K with balanced fertilization on cash crops in 90's in the southwest China

Crop	Yield increase from balanced K	Yield increase by K	
	kg/ha	kg/ kg K_2O	%
Peanut	1385	3.4	40.5
Sugar cane	25745	102	38.9
Cassava	6238	85.5	38.8 ↓
Banana	11925	6.8	63.1
Mango	2212	5.9	34.4
Citrus	4409	11.8	16.9 ↓
Pineapple	11094	36.9	29.2
Litchi	2853	7.6	30.9 ↓
Longan	1110	3.0	33.2

资料来源：谭宏伟，2001

Effect of K with balanced fertilization on cash crops in early 21st centenary in the southwest China

Crop	Yield increase from balanced K	Yield increase by K	
	kg/ha	kg/ kg K_2O	%
Tea	2061	9	21.16
Sugar cane	38850	104	44.32
Cassava	8550	27	26.30 ↓
Banana	24257	13	75.28
Mango	2520	4.2	21.20 ↓
Citrus	2790	5.5	17.20
Pineapple	9344	14	26.27 ↓
Litchi	6734	8	37.30
Longan	6146	3	21.41 ↓

Summary

- With less arable land and more population, relying on fertilizer and other agronomic input to improve crop yield will continue in future.
- Regional N:P_2O_5:K_2O application ratio has been improving, but considerable variation in N:P_2O_5:K_2O application ratio exists between crops. High rates of P and K tend to be applied to crops with higher economic values.

Summary

- Soil available P and K have the trend of elevation, especially for P. In fields where high value crops such as tobacco and banana are grown, accumulation of P and K is remarkable.
- Responses of grain crops and most cash crops to K fertilizers have been decreasing. The future work on potash research should be focused on improving its use efficiency and economical return in application.

Questions to be answered

- In the long term fertilizer experiment conducted on purple soil, why do NPK and M+NPK treatments cause continued reduction of rice and wheat yields, while CK, N, or M+N treatments can maintain crop yields at its original levels or at certain levels without further drop？
- Can we use the results generated from the single rice-wheat rotation to guide the nutrient management for the multi-rotation systems?

Thank you !