广东省农业科学院水稻研究所
RICE RESEARCH INSTITUTE OF GUANGDONG ACADEMY OF AGRICULTURAL SCIENCES

2014 IFA Norman Borlaug Award presentation

Using fertilizers more wisely in rice production by adopting "three controls" technology

Xuhua Zhong

The Rice Research Institute of Guangdong Academy of Agricultural Sciences (GDRRI)

27 May 2014, Sydney Australia

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Contents

1. Introduction

Guangdong and Rice

- Guangdong has a population of 100 million. Food self-sufficiency is <40%.
- Rice is the most important food in Guangdong
  - 80% food crop planting area, 90% production
- Rice is part of culture in Guangdong
  - the only province named after rice (粤)
  - the only provincial capital city named after rice panicle (穗), the city of five goats
- Farmers are relatively rich and willing to input more

Problems in rice production in Guangdong

1. Low NUE: N input is 194 kgN/ha, RE_N is 24%
2. Low yield： 5.4 t/ha, 17% lower than national average
3. Diseases and insects: warm climate + high N input
4. Lodging: esp. coastal region

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Recovery efficiency of N

China	30~35%
Guangdong	24%
Jiangsu	20%

Water Eutrophication (Yangdong, 2009)

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Damage from diseases and insects

How to solve the problems?

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2. Development of “three controls” technology

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Strategy to solving the problems: 3 controls

- **Control of fertilizer, esp. N**
  - **Reduced cost and pollution, increased NUE**
- **Control of unproductive tillers**
  - **Reduced lodging, increased productive tiller % and yield stability**
- **Control of diseases and insects**
  - **Reduced pesticide use, increased food safety and biological diversity**

Field experiments in farmer's field in Gaoyao and Xinxing (2001~2003)

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Guangzhou, 2004~2005

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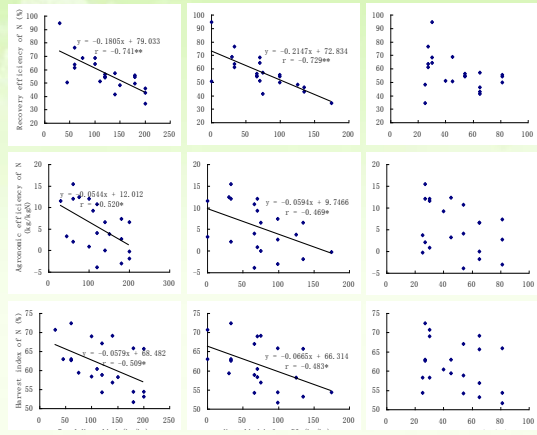
NUE and N timing

RE(%)

AE(kg/kg)

NHI



Total N | Basal + tiller N | N after PI

To increase NUE:

a) Total N reduced
b) Basal and tiller N reduced

PI= panicle initiation

Recovery efficiency of N（%）

Source	Basal	Tillering	After PI
Zhong et al.(2006)	31.1	18.4	71.3
Li et al.(1986)	-	21.3	53.3~53.9
Jiang et al.(1998)	35.8	26.9~29.2	50.2~60.6

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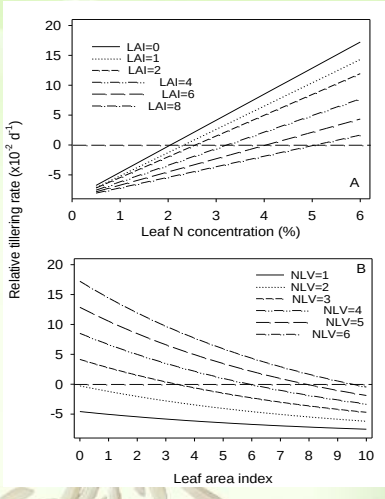
Tillering and N_{LV}&LAI



$$RTR=a(N_{LV}\, e^{-k\,LAI} - b)$$

To increase PTP:

a. control leaf N at tillering stage

b. increase leaf N after PI to avoid tiller death

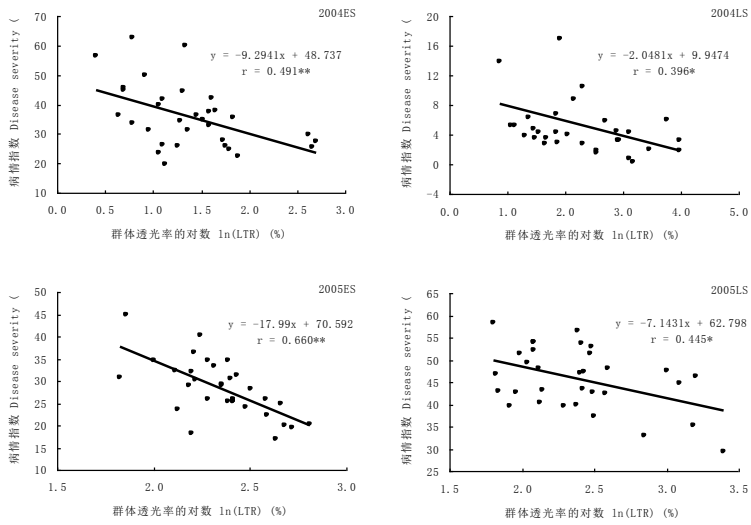
c. Control of N, rather than water, is the best way to avoid unproductive tillers

(Zhong et al., 2003. J Plant Nutri)

Relationship between diseases index (ShBI) and canopy indices

Stage	*canopy index*	*2004 ES* (*n*=32)	*2004 LS* (*n*=32)	*2005 ES* (*n*=32)	*2005 LS* (*n*=32)	*pooled*
PI	Tiller no.	0.362*	0.473**	0.326ns	0.355*	-0.076ns
	SPAD	0.263ns	0.391*	0.171ns	0.458**	0.083ns
	Tiller x SPAD	0.372*	0.485**	0.348ns	0.425*	-0.020ns
HD	Tiller no.	0.241ns	0.442*	0.365*	0.466**	0.255**
	SPAD	0.449**	0.400*	0.087ns	0.492**	0.158ns
	Tiller x SPAD	0.369*	0.467**	0.329	0.536**	0.246**
	LAI	0.342ns	0.451**	0.479**	0.632**	0.367**
	LAI x SPAD	0.411*	0.463**	0.438*	0.629**	0.359**

Note: ES= early season, LS= late season.



ShBI and light transmission

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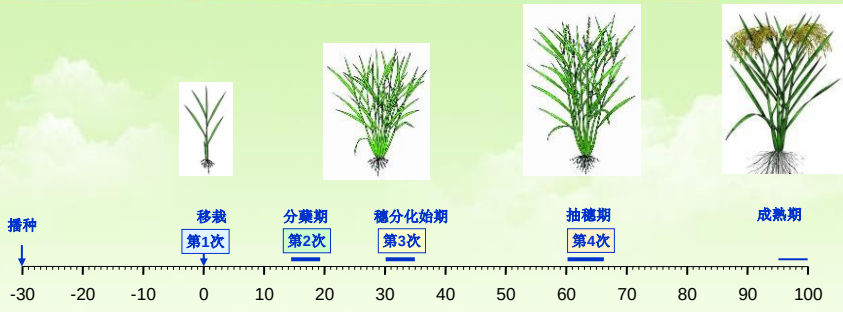

播种 | 移栽 第1次 | 分蘖期 第2次 | 穗分化始期 第3次 | 抽穗期 第4次 | 成熟期

-30 -20 -10 0 10 20 30 40 50 60 70 80 90 100

第1次施肥 基肥	第2次施肥 移栽后15– 18 天	第3次施肥 移栽后30-35天	第4次施肥 移栽后60 – 65天
N: 7 kg 尿素* 或者 20 kg 碳铵 P: 20 kg 过磷酸钙	叶色诊断施 N (尿素)	叶色诊断施 N (尿素)	叶色诊断施 N (尿素)
	LCC < 3.5 6 kg	LCC < 3.5 7 kg	LCC < 3.5 2 kg
	LCC = 3.5-4 4 kg	LCC = 3.5-4 6 kg	否则 0 kg
	LCC > 4 3 kg	LCC > 4 4 kg	
	K: 4 kg 氯化钾	K: 5 kg 氯化钾	

早稻
目标产量: 6 – 7 t ha^{-1}
无氮区产量: 4 t ha^{-1}
全生育期: 125 – 135天

* 表中施肥量均为每667m^{2}用量

Procedure of “three controls” technology

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3. Demonstration and extension

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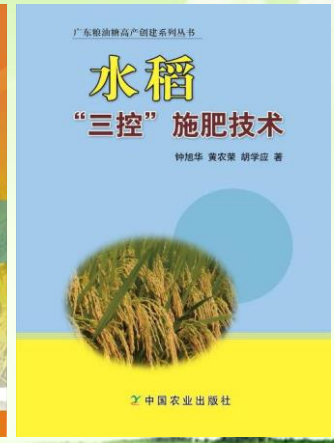
(1) Technical materials



Leaflets and user's manual

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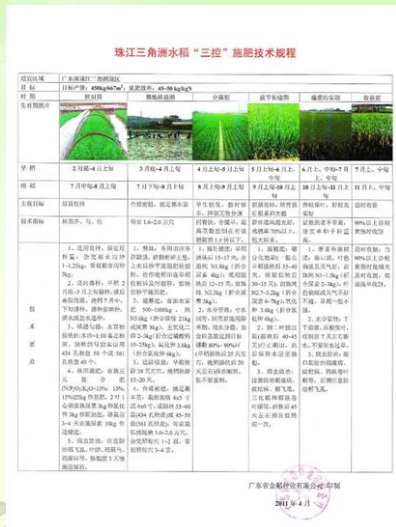
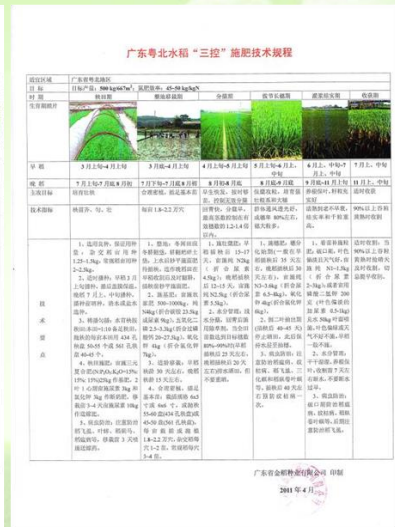
Region-based leaflets in Guangdong


珠江三角洲水稻“三控”施肥技术规程


广东粤北水稻“三控”施肥技术规程

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Season-based leaflets in Jiangxi

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(2) Tools: website, CD, software

Three controls information website

CD

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Giving a lecture (in the CD)

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The software for three controls technology

Home page

Recommendation

(Developed by GDRRI and IRRI)

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(3) On-farm demonstration

Demonstration sites in Guangdong (until 2009)

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Gaoyao demonstration base

Two demonstration bases established in 2009


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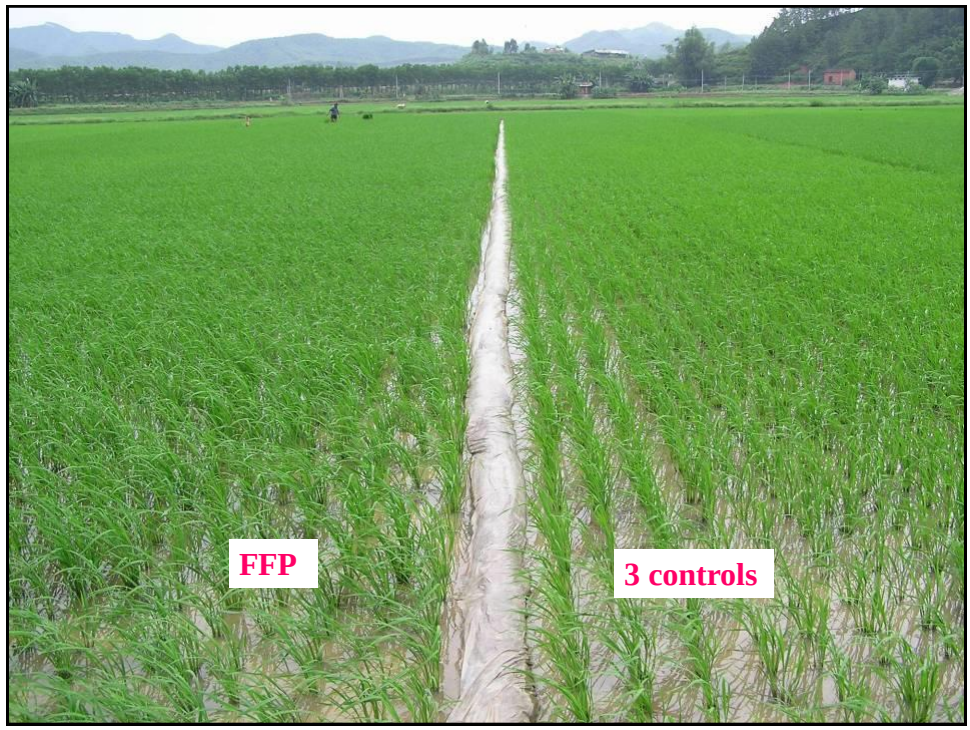
Officials, technicians, farmers visiting demonstration bases


On-farm demonstration at Boxi village, Liantang township, Gaoyao county, Guangdong province
FFP
3 controls


FFP
3 controls


FFP
3 controls


FFP
3 controls
2007/ 9/29


林尚其
对照
CK
林尚其
三控
Three controls
FFP
3 controls

2008ES，after typhoon, Boxi, Liantang, Gaoyao

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(4) Training and technical service

- Training at different levels: provincial, county, township, village, etc
- Solving technical problems
- Farmer's day
- Interaction with farmers

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Training at different levels

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Solving technical problems

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Farmer's day

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Interaction with farmers


Talking to a farmer


Farmers giving comments


Farmers voting


Farmers visiting expt station

4. Effectiveness and impacts

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Grain yield, fertilizer cost and net income

	Three controls	Farmer's practice	Difference	Difference %
Grain yield (t/ha)	6.89	6.15	+0.74	+12.0
N input (kg/ha)	147.3	185.25	-38.0	-20.5
Fertilizer cost (US$/ha)	274.8	354.8	-80.0	-22.5
Net income (US$/ha)	1906	1450	+456	+31.4

Note: 1 US$=6.2 RMB

Fertilizer N input and recovery efficiency

Year	Season	Variety	N input (kgN/667m²)		N uptake (kgN/667m²)		Recovery efficiency (%)		
			3C	FP	3C	FP	3C	FP	Difference
2006	LS	YJRZ	11.87	12.49	9.55	8.45	43.1	32.1	11.0
2009	ES	HHZ	10.00	11.33	8.52	7.85	39.4	28.9	10.5
2009	ES	YZ889	10.00	11.33	9.27	7.47	43.0	22.1	20.9
	LS	YZ889	12.00	13.33	9.13	7.99	36.9	24.6	12.3
2010	ES	YZ889	10.00	11.33	8.29	6.67	31.5	13.5	18.0
	LS	YZ889	12.00	13.33	9.33	8.35	42.8	31.3	11.5
Average			10.98	12.19	9.01	7.80	39.5	25.4	14.1

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Impact on policy

- **Ministry of Agriculture-recommended technology**
- **Government-recommended technology in Guangdong**
- **Provincial standard in Guangdong**
- **Technology for non-point pollution prevention project in Guangdong**

Recommended by Ministry of Agriculture of China

中华人民共和国农业部
Ministry of Agriculture of the People's Republic of China
信息公开

索 引 号：07B090403201200115　　信息所属单位：科技教育司
信息名称：农业部办公厅关于推介发布2012年主导品种和主推技术的通知
文　　号：农办科〔2012〕9号
生成日期：　　公开日期：2012年02月15日
内容概述：

农业部办公厅关于推介发布2012年主导品种和主推技术的通知

各省、自治区、直辖市及计划单列市农业（农牧、农村经济）、农机、畜牧兽医、农垦、渔业厅（委、局、
江省农垦总局，广东省农垦总局：

为贯彻落实中央一号文件精神，进一步强化农业科技推广应用，引导农民科学选用优良品种和先进适用技术，
田，根据农业部《农业主导品种和主推技术推介发布办法》，我部组织遴选了2012年160个农业主导品种和100项主

请各地高度重视，结合“全国农业科技促进年”活动，加大主导品种和主推技术的推广应用，依托国家现代农
目，充分发挥农业科技试验示范基地作用，组织专家、技术指导员，在关键农时、关键技术环节集中开展主导品种
示范户推广应用，推进良种良法配套。同时，要充分利用电视、广播、报刊、网络等媒体进行广泛宣传，营造良好
种和先进适用技术的意识

水稻（10项）
（一）水稻机插及其育秧技术
（二）水稻钵苗机插及摆栽技术
（三）水稻旱育栽培技术
（四）水稻抛秧栽培技术
（五）水稻“三控”技术
（六）水稻精确定量栽培技术

Recommended by Department of Agriculture of Guangdong province

Government recommendation in Guangdong

Provincial standard

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Impact on farmer's mind and behavior

南方日报 高度决定影响力 返回南方报网

2012年7月11日 星期三 返回首页 版面导航 标题导航

下一篇 放大 缩小 默认

省农科院研发的水稻“三控”技术应用突破四千万亩

“计划生育”让水稻“减肥”又增产

钟旭华博士深入田间地头向农户传授“三控”技术。

如果有人告诉你，有一种水稻种植技术，可以让农户减少20%的氮肥，却能增加10%的产量，还可少打农药，稻秆还抗倒伏，你会相信吗？

Awareness on:
Nutrient use efficiency
Environment protection
Healthy canopy
Food safety
Sustainability

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Reports in media

People's Daily

Science and Technology Daily

Farmer's Daily

China Radio

Receiving the first-class award of science and technology in Guangdong (25 February 2013)

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5. Summary

1. The “three controls” technology was successfully developed in Guangdong, China to solve the problems in rice production such as low yield, low nitrogen use efficiency, heavy damage from diseases and insects, etc.
2. By use of “three controls” technology, farmers can typically achieve a 10% increase in grain yield and save 20% fertilizer-N input. N recovery efficiency is increased from <30% for farmer’s practice to 40% . Environmental pollution is significantly reduced.
3. The “three controls” technology is welcomed by farmers as an effective, reliable, cost-saving and easy-to-use technology. It is now one of the most widely adopted technologies for rice production in China.
4. To enhance farmer’s adoption to the new technology, continuous efforts has been made, include training, on-farm demonstration, farmer’s day, technical service, and interaction with farmers. Brochures, leaflets, posters, videos, and other technical materials were developed and distributed to local technicians and farmers.

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Acknowledgement

- International Rice Research Institute (IRRI)
- Department of Science and Technology, Guangdong
- Administration of foreign affairs, Guangdong
- National Administration of foreign affairs, China
- National Natural Science Foundation China
- Guangdong Natural Science Foundation
- Ministry of Agriculture, China
- General Station for Agricultural Technology Extension, Guangdong
- Ministry of Science and Technology, China
- Shenzhen Batian Ecotypic Engineering Co. Ltd

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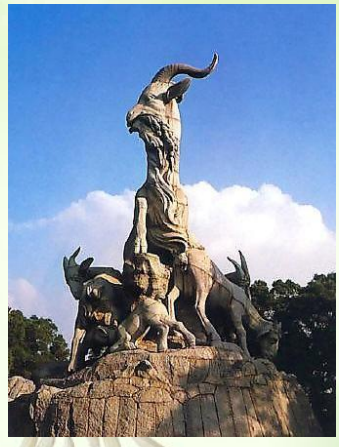
Thank you very much for your attention!



Welcome to Guangzhou, the city of rice panicle!