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Farmer experience with Bt cotton in China

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'Sustainability of Bt cotton in China'*

CHINA'S POSITION IN WORLD COTTON

| Country | Cotton farmers (millions) | Cotton area (m ha) | Average cotton holding per farm (ha) | Lint yield (kg/ha) |
|-----------------|---------------------------|--------------------|--------------------------------------|--------------------|
| China | 11.00 | 4.8 | 0.4 | 1,103 |
| India | 4.00 | 8.7 | 2.2 | 350 |
| Pakistan | 1.50 | 3.1 | 2.1 | 593 |
| West Asia | 0.13 | 1.0 | 8.0 | - |
| South East Asia | 0.25 | 0.5 | 2.0 | - |
| USA | 0.03 | 5.6 | 187.0 | 790 |
| Australia | 0.001 | 0.4 | 330.0 | 1,658 |
| World | 20.00 | 33.5 | - | 635 |

COTTON INSECTICIDE COSTS TO FARMERS

| Region | \$ Millions |
|---------------|--------------------|
| Asia | 811 |
| USA | 340 |
| Africa | 194 |
| Australia | 57 |
| Europe | 5 |
| Global Total | 1,719 |

Bt Cotton in China

- Introduced 1994 – commercialised 1997
- In 9 provinces. 58% of the national crop in 2003.
- Bt area growing at 33% per annum
- North Eastern Provinces (Shandong, Hubei etc) - close to 100% Bt
- Western provinces (Xinjiang) - substantial Bt plantings although bollworm pests are minor
- >5 million Bt farmers, >75% all the world's GM farmers

Pests of cotton in China

Killed by Cry1Ac

- Bollworms
 - cotton bollworm
 - pink bollworm
 - spiny/spotted bollworms



Not affected

- Leafworms
- Aphids
- Jassids
- Mites
- Plant bugs

BT Cotton material

Monsanto

(Cry1Ac)

33B, 99B

- High input
- High yielding
- Expensive
- US Acala varieties
- not fully IPM compatible

50-70% of the eastern cotton market

Chinese Academy of Agricultural Sciences

Sciences

(Cy1Ac and 1Ab and CpTPI)

13 varieties

- Lower input
- Generally lower yielding
- Cheaper
- Locally adapted varieties
- more IPM compatible

30-50% of the market and growing

* *Unregistered Bt varieties of variable quality are also widespread*

Our information

| | | | | |
|--------------------------------------|---|-----------------------|----------------------|------------------------------------|
| EC – FPV Inco Dev prog. | ■ | NATESC | P.Yang | Shandong |
| | ■ | Bio. Cont. Inst. CAAS | F-H Wan | Hebei |
| | ■ | Nanjing Ag Univ | Y.Wu | |
| | ■ | NRI (UK) | D.Russell | |
| | ■ | CIRAD (FR) | J-M Vassal | |
| | ■ | DIAS (DK) | G.Lovei | |
| | ■ | CABI | A.Poswal | |
| Chinese Academy of Sciences | ■ | CAS | J. Huang | Shandong |
| | ■ | Rutgers Univ (USA) | C.Pray, S.Rozelle | Hebei Henan Anhui Jiangsu |

* Plus other literature sources

Farmer use of Bt cotton

- Bt cotton is varietal (*not hybrid as in India*)
- 17% of area intercropped with vegetables, maize, peanuts or watermelon
- Bt seed cost 50-60% more than non-Bt cotton (*c.\$US21/ha increase*)
- <50% of Bt cotton area is farmer-saved seed (*29% in Shandong*)
- Large amount of unauthorised movement of germplasm

Bt seed cost in relation to other inputs (Shandong 2002-3)

| INPUT | Cost/ha | % total costs |
|--------------|----------------|----------------------|
| Seed | \$61 | 10% |
| Fertiliser | \$271 | 43% |
| Pesticide | \$112 | 18% |
| Labour | \$186 | 29% |

* Land rent 363 \$US/ha

Economics of Bt cotton

(Shandong 2002-3)

| | |
|--|------------------------------|
| Yield | 4,109 Kg/ha (seed cotton) |
| Net profit from cotton* | 1,024 US\$/ha |
| Increase in net profit over non-Bt | c.47% |
| Total farm income - all sources (avg.0.25ha cotton) | c.1,000 \$US |
| Increase in total farm income | c.12% |

* No price difference for Bt cotton

Health implications of Bt use

■ The problem

- 600,000 cases of pesticide poisoning in 1995 (1% died)
 - Non-Bt farmers 22% (small sample)
 - 5% of Bt farmers (large sample)

■ Reduction in toxic material applied

(Huang et al 2001)

- Pyrethroids 95%
- Organochlorines 88%
- Organophosphates 82%

(Yang et al 2003)

- 60% reduction in all insecticides
- 80% reduction in bollworm sprays

Non-target impacts (lab)

Using : *Bt* : 33B and GK12

Non-Bt: Si-main3 (parent of GK12)

Pests

| | | |
|----------|--------------------------|-------------------------------------|
| Leafworm | <i>Spodoptera litura</i> | Some growth reduction and mortality |
| Whitefly | <i>Bemisia tabacci</i> | No effect |

Decomposers

| | | |
|------------|--------------------------|-----------|
| Springtail | <i>Sinella curviseta</i> | No effect |
|------------|--------------------------|-----------|

Predators

| | | |
|-------------|---------------------------|--|
| Ladybeetles | <i>Propylaea japonica</i> | No effect |
| | <i>Harmonia axyridis</i> | Lighter when fed on affected pests |
| Lacewings | <i>Chrysopa sinica</i> | Longer development on <i>Bt</i> . |
| | <i>Chrysopa formosa</i> | Smaller cocoon mass, longer pre-ovip. period, fewer eggs |

Non-target impacts (field)

Using : Bt: 33B,99B,GK-12, GK12, SGK-321

Non-Bt: Si-main3, Si-yuan 321

Pests

| | | |
|----------------|------------------------|-----------|
| Green leaf bug | <i>Lygus lucorum</i> | No effect |
| Whitefly | <i>Bemisia tabacci</i> | No effect |

Decomposers

| | | |
|-------------|--|--|
| Springtails | | More species and individuals but lower diversity index |
|-------------|--|--|

Predators

| | | |
|-------------|---------------------------|--|
| Ladybeetles | <i>Propylaea japonica</i> | No effect |
| Spiders | <i>Many species</i> | Bt – 11 fams. 25 species Pesticide – 8 fams. 12 species IPM – 9 fams. 14 species |

Farmer* understanding of the Bt cotton system

Why grow it?

- Saves labour - 95%
- Requires less spraying - 91%
- Higher yields - 88%
- More profitable – 85%

Is it safe?

- Safe to eat – 75%
- Safe in blankets – 72%

Is bollworm still a problem?

- It is – 65%

Identification of natural enemies?

- Ladybirds – 50%
- Lacewings – 17%
- Spiders – 12%

Identification of mites and diseases?

- Not at all

* No differences with gender or educational level

Improving IPM integration of Bt cotton

- Farmers in Shandong spray 12.7 times/season on Bt cotton (range 6-22)!

FAO Farmer Field School on Cotton IPM in Asia (6 countries, \$12 mill)

- Demonstrating an IPM benefit and a Bt benefit and an added benefit from IPM on Bt cotton.
- Working on enhancing farmer benefit from Bt

Evolved resistance to Bt in cotton bollworms (*H.armigera*)

- No definite field resistance yet
- c.1/1000 insects carries resistance gene (apparently recessive unlike India where it is dominant)
- Lab selection of field survivors quickly produces resistant strains
- Modeling suggests 2004-5 as the first year of significant resistance in NE China

Stacked gene Bt products in China

Cry1Ac/Cry2Ab
cotton

- Better bollworm mortality
- Extends effectiveness to leafworms
- Should delay resistance

Cry1Ac/ Cowpea
trypsin inhibitor
cotton

- Provides a moderate level of suppression of number of key pests
- Should delay resistance

Stacked gene Bt products for India

Cry1Ac/Cry2Ab cotton

- Better bollworm mortality
- Extends effectiveness to leafworms
- Should delay resistance

Dual gene Bt cabbage and cauliflower

- Effective control of diamondback moth
- Will delay resistance
- Public/private partnership will focus benefits on growers and consumers

THANK YOU
for your attention