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Fact Sheet on Pesticide Use in Cotton Production

Produced by

The Expert Panel on Social, Environmental and Economic Performance of Cotton Production (SEEP)

Pesticide Use

Focal Countries: Australia, Brazil, India, Togo, Turkey and USA

1. Definition / Description of the issue

Pesticide use - Scope of the issue:

Countries are facing the challenge of intensifying agricultural production to meet increasing demands for food, feed and fibre generated by growing populations and changes in dietary patterns. The intensification of agriculture achieved so far has been primarily based on the use of synthetic inputs, including pesticides, to complement or replace natural processes; and on crop engineering to increase genetic production potential. This model of modern agriculture has allowed for a significant increase in crop production in some parts of the world. It has, however, also proved to cause negative impacts on the natural capital, including soil and water depletion and contamination, which are compromising the ability of agro-ecosystems to sustain and eventually increase the current production levels.

The irrational use of pesticides compromises the pest-regulating services inherent to agro-ecosystems, thus exacerbating pest problems. Prolonged over-reliance on pesticides has had destructive effects on natural control mechanisms, and the development of pesticide resistance resulting in increases in pest outbreaks and insurgence of new pests in different regions and cropping systems. Changes in pest management practices to more sustainable approaches with reduced reliance on pesticides are required with particularly urgency in countries lacking the capacity to mitigate the risks of pesticide use to farmers, workers and consumers as well as to the environment.

Recognizing that in many crops there is often considerable scope for pesticide use reduction through prevention of pest development and use of non-chemical pest management techniques has brought about a renewed interest in Integrated Pest Management (IPM). IPM is the preferred approach to crop protection and it is regarded as a pillar of both sustainable intensification of crop production and pesticide risk reduction (FAO, 2011).

The use of crop protection chemicals on cotton peaked in the 1990s when cotton accounted for

some 20% of all insecticides[1] applied annually for agricultural purposes. Over the last two decades, governments, research institutes and cotton industry organizations of many cotton-producing countries have enacted policies and interventions to promote a broader approach to pest management and mitigate reliance on chemicals. Some governments have promoted the adoption of IPM[2] through the implementation of large-scale programmes. Since 1996, biotech cotton crops have been gradually introduced in thirteen cotton-producing countries[3] to control lepidopteran pests. Finally, further strengthening of regulatory control of pesticide use for health or environmental reasons in several countries has had an effect on the spectrum of pesticides available for use in cotton. The results attained in terms of reductions in pesticide use and associated risks emanating from these interventions vary from country to country and depend on a number of factors such as enforcement of regulations, removal of pesticide subsidies, the availability of viable alternatives and farmer support programs, etc.

Present and future focus : Sustainable Intensification of Crop Production:

FAO urges governments of developing countries to pursue further intensification of agricultural production with a more systemic approach to managing natural resources that protects and enhances the biological processes underpinning production. Sustainable intensification of agriculture means producing more from the same area of land, with less use of non-renewable inputs. It builds and complements the natural processes that support plant growth, including pollination, natural predation for pest control, nutrient cycling and soil regeneration. It is largely based on farmers' knowledge and skills and local solutions at the reach of smallholders' capacity. The principles of sustainable intensification are described in FAO latest guidelines for policy makers titled, "Save and Grow," (FAO, 2011).

2. Range of data

Worldwide overview

Worldwide, the annual sales of crop protection chemicals on cotton expressed in value increased from USD 2,564 million in 1999 to USD 3,038 million in 2009 (Table 1). The more accurate units to measure changes in pesticide use are kg of active ingredient per hectare of cultivated land or per kg of seedcotton produced. These figures are however often not available at global and country levels, and so sales data must be used. Sales values are affected by several factors, for instance by inflation and the development of newer (more expensive) molecules, etc. and there are therefore limitations to their use as proxys of pesticide.

[1] Insecticides are a subset of pesticides.

[2] "Integrated pest management (IPM) means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimise risks to human health and the environment. IPM emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.", FAO, 2002.

[3] Argentina, Australia, Brazil, Burkina Faso, Colombia, Costa Rica, China, India, Mexico, Myanmar, Pakistan, South Africa, and the USA.

Table 1. Annual Crop Protection Chemicals, Sales on cotton, in USD million at ex-manufacturer level

North America	*Year*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
	Herbicides	283	307	333	316	304	319	335	325	270	280	285
	Insecticides	330	387	319	306	315	326	327	302	245	219	267
	Fungicides	13	13	10	10	10	10	10	10	8	7	9
	Others	167	158	133	130	130	134	145	146	127	113	126
	Total	**793**	**865**	**795**	**762**	**759**	**789**	**817**	**783**	**650**	**619**	**687**

Latin America	*Year*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
incl: Mexico	Herbicides	74	77	77	65	72	98	104	116	158	188	162
	Insecticides	154	215	200	170	201	245	267	301	388	446	453
	Fungicides	7	8	7	6	7	9	9	11	14	17	16
	Others	10	10	15	14	15	20	21	24	32	37	33
	Total	**245**	**310**	**299**	**255**	**295**	**372**	**401**	**452**	**592**	**688**	**664**

West Europe	*Year*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
	Herbicides	10	8	10	10	12	14	13	13	14	16	13
	Insecticides	8	7	8	8	10	11	10	10	12	14	11
	Fungicides	0	0	0	0	0	0	0	0	0	0	0
	Others	2	2	2	2	2	2	2	2	2	2	2
	Total	**20**	**17**	**20**	**20**	**24**	**27**	**25**	**25**	**28**	**32**	**26**

	Year	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
East Europe	Herbicides	49	44	47	46	48	56	67	70	81	98	93
includes: Central	Insecticides	141	132	140	142	152	168	183	191	216	244	283
Asian States of	Fungicides	27	24	27	28	29	34	39	41	46	55	62
FSU	Others	30	32	34	33	34	39	40	42	46	50	57
	Total	**247**	**232**	**248**	**249**	**263**	**297**	**329**	**344**	**389**	**447**	**495**

	Year	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Far East-Pacific	Herbicides	141	146	173	152	137	165	163	148	161	177	154
includes: China,	Insecticides	382	365	351	295	290	324	303	250	257	264	267
SE Asia,	Fungicides	2	2	2	2	2	3	3	2	2	2	2
Australia, NZ,etc	Others	31	31	31	28	23	28	28	24	24	24	24
	Total	**556**	**544**	**557**	**477**	**452**	**520**	**497**	**424**	**444**	**467**	**447**

Rest of World	*Year*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
includes: India,	Herbicides	120	93	100	96	100	125	137	144	156	185	149
Turkey, Pakistan	Insecticides	516	442	449	430	455	544	520	448	464	482	490
& Africa	Fungicides	16	10	12	11	12	14	15	16	16	19	18
	Others	51	49	51	47	48	57	60	62	64	67	62
	Total	**703**	**594**	**612**	**584**	**615**	**740**	**732**	**670**	**700**	**753**	**719**

Global Total	*Year*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
	Herbicides	677	675	740	685	673	777	819	816	840	944	856
	Insecticides	1531	1548	1467	1351	1423	1618	1610	1502	1582	1669	1771
	Fungicides	65	57	58	57	60	70	76	80	86	100	107
	Others	291	282	266	254	252	280	296	300	295	293	304
	Total	**2564**	**2562**	**2531**	**2347**	**2408**	**2745**	**2801**	**2698**	**2803**	**3006**	**3038**

Source: Cropnosis Limited, 2010

The proportion of global insecticide sales on cotton, compared to sales for all crops, declined from 18.4% in 2003 to 14.1% in 2009 (Table 2).

Table 2. Proportion of insecticides sales for various crops worldwide 2004-2010

	2003	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010 F*
Corn	571	622	627	607	722	824	784	811
Cotton	1,423	1,618	1,610	1,502	1,582	1,669	1,440	1,500
F&V	3,060	3,460	3,540	3,519	3,953	4,658	4,591	4,774
Rice	1,049	1,135	1,114	1,057	1,080	1,225	1,242	1,279
Other crops	1,635	1,800	1,836	1,786	2,030	2,282	2,138	2 249
Total	**7,738**	**8,635**	**8,727**	**8,471**	**9,367**	**10,658**	**10,195**	**10,613**

	2003	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010 F*
Corn	7.4%	7.2%	7.2%	7.2%	7.7%	7.7%	7.7%	7.6%
Cotton	18.4%	18.7%	18.4%	17.7%	16.9%	15.7%	14.1%	14.1%
F&V	39.5%	40.1%	40.6%	41.5%	42.2%	43.7%	45.0%	45.0%
Rice	13.6%	13.1%	12.8%	12.5%	11.5%	11.5%	12.2%	12.1%
Other crops	21.1%	20.8%	21.0%	21.1%	21.7%	21.4%	21.0%	21.2%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Cropnosis Limited, 2010

Country wise information

Data reported in this section for Australia, Brazil, India, Togo, Turkey and USA are extracted from the study published by SEEP in 2010 (and 2012 for Togo) and are available at - : http://icac.org/social-environmental-economic-performance/seep-documents.

Analysis of the most recent information available for each country resulted in the following figures for pesticide use on cotton in active ingredients per hectare:

1 kg a.i./ha in Australia (2007)
4.9 kg a.i./ha in Brazil (2006)
0.9 kg a.i./ha In India (2006)
1.1 kg a.i./ha in Togo (2010)
0.6 kg a.i./ha in Turkey (2006)
1.2 kg a.i./ha in the USA (2006)

In Australia, India, Turkey and USA, pesticide use levels in 2006/07 were lower than levels in 1994/95. The national average pesticide use per hectare of cotton in these countries was below or around 1kg of active ingredient. In Togo, pesticide use decreased from 3.05 kg a.i./ha in 1990 to around 1 kg/ha in 2010.

The reduction in pesticide use was obtained without detrimental effects on cotton yields. No correlation between variation in pesticide use over time and cotton yields was highlighted.
Australia achieved a decrease in per-hectare average pesticide use over the studied period, while

the average cotton yield per hectare increased. Turkey achieved the second highest cotton yield per hectare among the five countries, despite the lowest average amount of pesticides use per hectare of cotton. In Brazil, average yields grew in parallel with an intensification of the use of pesticides. In 2006, these countries cumulatively applied 19,000 tons of active ingredients (excluding herbicides) on cotton.

The key factors that have influenced the changes in pesticide use registered in these countries were pesticide policy and regulations, IPM programmes and the introduction of new technologies.
Organophosphates were the major group of insecticides used in all countries. The active ingredients causing 50% of the hazard to human health according to WHO hazard classification, and to the environment according to the Environmental Toxic Load Index (ETL)[4], in the six studied countries are listed in the table 3.

Table 3: The most commonly applied highly-hazardous pesticides in cotton in 2006 (for Australia 2007) in the six focal countries

Human Health (Acute)	**Environment**		
	Fish	***Daphnia***	**Bees**
Aldicarb Dicrotophos Methamidophos Methomyl Monocrotophos Parathion-methyl Profenofos Zeta-cypermethrin	Chlorpyrifos Diafenthiuron Endosulfan Lambda-cyhalothrin Zeta-cypermethrin	Chlorpyrifos Cypermethrin Ethion Lambda-cyhalothrin Zeta-cypermethrin	Aldicarb Cyfluthrin Deltamethrin Dimetoate, Imidacloprid Monocrotophos Spinosad Thiodicarb Zeta-cypermethrin

Toxicity to human health - The average amount of pesticides applied per hectare of cotton of highly hazardous and extremely hazardous substances decreased over time in Australia, USA, India, Togo and Turkey. However, in 2006 these substances were still being used on cotton at the rate of 0.89, 0.35 and 0.21 kg a.i./ ha, respectively, in Brazil, the USA and India. In Australia and Turkey, the use was significantly lower at 0.07 kg a.i./ha. The most recent data (2010 for Togo, 2007 for Australia, and 2006 for the other 4 countries) show that only a few substances were applied in cotton that are known to be carcinogenic, genotoxic, or toxic to human reproduction.

Leaching potential to groundwater - The active ingredients with high to very high potential to leach to groundwater that are applied on cotton in the six countries was low.

Toxicity to fish, aquatic species and algae - the average amount of pesticides, which are highly to very highly toxic to fish, that were applied per hectare of cotton in 2006 was 2.5 kg a.i./ ha in Brazil, 1.06 kg a.i./ ha in Togo, 0.42 kg a.i./ ha in Australia, and 0.37 kg a.i./ ha in India. Most of the pesticides used on cotton were highly to very highly toxic to Daphnia. Togo has used only three

[4] ETL was developed by the Alterra Research Group and represents the average amount of toxic pressure posed by the pesticides applied on one (1) hectare of cotton in one (1) year. The ETL can only be used to evaluate the impact of changes in pesticide use on environmental hazards between years and countries. The indicator is based on quantitative information on pesticide use and the environmental toxicity of the considered pesticides. ETL is not an indicator of the risk associated with the use of a pesticide, or the actual impact on organisms in the field, but rather a composite indicator for the relative hazard based on actual pesticide use. Aldicarb

highly toxic ingredients, but their shares within the total amount have substanially increased in recent years because of the recourse to the use of profenofos. A small, though not negligible amount of the pesticide used was highly toxic to very highly toxic to algae.

Toxicity to bees - Application of toxic to highly toxic substances was equivalent to 2.45, 0.49, 0.41, 0.39 and 0.32 kg a.i./ ha in Brazil, India, USA, Turkey in 2006 and Australia in 2007, respectively.

Biotech cotton - A considerable difference in pesticide use between biotech cotton and conventional cotton was recorded in Australia. In 2007, the average amount of pesticide applied per hectare was much higher in conventional cotton (4 kg a.i./ha) than in biotech cotton (0.45 kg a.i./ha)

3. Recommendations

1. SEEP recommends that WHO Hazard Class I pesticides be eliminated in countries where adequate provisions for their management are not in place (see section 6 of the Study/Alterra Report for details on "adequate provision"). In many developing countries, regulatory control over the use of pesticides to reduce health and environmental risks to acceptable levels is still incomplete or not sufficiently enforced due to the lack of technical expertise and resources. In these countries, the use of pesticides that fall in WHO Hazard Class I poses a direct and a real risk to people handling such substances. Countries are encouraged to use the International Code of Conduct on the Distribution and Use of Pesticides (refer to section 6) to enhance their capacity to reduce risks related to pesticide use.

2. SEEP recommends that cotton-producing countries where the use of pesticide is higher than 1 kg of a.i. per ha should analyse the causes of such use and address these causes. Five of the six countries studied have been able to reduce their average pesticide use per hectare to around or below 1 kg of a.i, regardless of the type of farming systems prevalent and the pest load occurring (Figure 3 in the Study).

3. SEEP recommends that the use of active ingredients that account for the highest contribution to the environmental toxicity load (listed under section 2.2 of this Summary) should be minimized to reduce the environmental hazards to aquatic organisms and bees.

4. SEEP recommends that pesticides known to pose possible risk of harm to the unborn child or to breast-fed children should be eliminated from the cotton production system. Active ingredients falling into this category were used at an almost negligible rate in the five countries studied, and elimination of these products from cotton cultivation would seem attainable.

5. SEEP recommends that governments, with the involvement of all concerned stakeholders in the cotton sector, make a strong effort to promote best management practices in plant protection and to reduce reliance on pesticides and subsequent risks to the environment and human health. Integrated pest management (IPM) should be the major instrument to achieve and sustain long-term reductions in pesticide use in the cotton industry. The experience of countries that have already enacted effective IPM programmes should be considered by countries that are still devising strategies to reduce pesticide use.

6. SEEP recommends that governments consider both environmental and health risks while formulating clear policy statements relative to pesticide risk reduction. This requires close collaboration with the responsible authorities.

7. SEEP recommends that governments promote the collection of reliable crop-specific quality data related to pesticide use. Accurate data are indispensable for the follow-up of risk assessment studies, although schemes of data collection might vary according to country conditions.

8. SEEP recommends that follow-up risk assessment studies be conducted. The Study (Alterra Report) provided important insights into the social and environmental sustainability of cotton cultivation. It is important to note that the evaluation of hazards alone does not allow drawing definitive conclusions on the actual risks posed to the environment and human health by the use of pesticides in a specific context.

6. Referenced literature

SEEP publications available at- : http://icac.org/social-environmental-economic-performance/seep-documents:

- Alterra Report on Pesticide Use in Cotton in Australia, Brazil, India Turkey and USA, 2010
- An Interpretative Summary of the Study on: Pesticide use in cotton in Australia, Brazil, India, Turkey and the USA, 2011
- Pesticide Use in Togo, 2012

FAO, 2011. Save and Grow. A policymaker's guide to the sustainable intensification of smallholder crop production available at- : http://www.fao.org/ag/save-and-grow/