

## **State and market interaction: cotton variety and seed market development in China**

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### **Abstract.**

China is ranking first in cotton production for more than 20 years. The adoption of GM cotton, since 1997, through the marketing of many varieties, has enabled it to maintain its rank by overcoming the pest resistance to insecticide. The varietal contribution has resulted from a radical change in the legal framework to enhance the variety and seed markets. Nevertheless, today, all cotton sector stakeholders do recognize that there is a big issue of excessive competition from a great number of varieties leading to variety and seed mixture. This situation has led the Chinese Government to decide on a new support policy called "quality seed subsidy policy". The Chinese policy in the areas of varieties and seeds hence is providing an interesting case of interaction between policy and market within less than twenty years.

Our paper is a contribution to analyse the cotton variety and seed market development of the last twenty years by focussing on the interaction between State intervention and market. A change in the cotton policy, consisting of liberalizing the variety and seed markets, could prove to be quite successful where the capacities for breeding and investment exist prior to the policy change. This success nevertheless will remain a short term one if no regulation is provided to prevent the market development from excessive and unfair competition. The case analysed is a good illustration of the shortfalls of unregulated competition. It is however ineffective to regulate by imposing what farmers should use. Such a direct intervention in the market is showing undesired effects on the viability of seed companies.

**Keywords:** China; cotton; Bt; seed market; property right; variety; regulation; competition

## **Interaction marché et Etat : développement des marchés de variétés et semences de coton en Chine**

### **Résumé**

La Chine est premier producteur mondial de coton depuis plus de 20 ans. L'adoption du coton transgénique, dès 1997, à travers de nombreuses variétés, lui a permis de maintenir son rang en surmontant le problème de résistance aux insecticides. La contribution variétale a résulté d'un changement radical du cadre légal pour promouvoir les marchés des variétés et des semences. Néanmoins, aujourd'hui, tous les acteurs du secteur coton admettent qu'il y a un gros problème de concurrence excessive à partir d'un grand nombre de variétés, responsable des mélanges de variétés et de semences. Cette situation a conduit le gouvernement chinois à décider une nouvelle politique de soutien à l'utilisation des semences de qualité. L'évolution de la politique chinoise dans le domaine des variétés et des semences offre un cas intéressant d'interaction entre l'Etat et le marché en l'espace de vingt ans.

Notre papier est une contribution pour analyser le développement des marchés des variétés et des semences en nous penchant sur les interactions entre Etat et marché. Un changement dans la politique cotonnière, consistant à libérer les marchés des variétés et des semences, peut se révéler efficace quand les compétences et les capacités d'investissements existent au moment du changement de politique. Le succès qui en résulte serait de courte durée en absence de regulation pour protéger le développement des marchés d'une concurrence excessive et déloyale. Le cas étudié est une illustration des limites d'une concurrence non régulée. Il est cependant inefficace de réguler en imposant ce que les paysans doivent utiliser. Une telle approche induit déjà des effets pervers en menaçant la viabilité des sociétés semencières.

**Mots clés:** Chine, coton, Bt, semence, propriété intellectuelle, variété, régulation, concurrence

## **1 Introduction**

China is ranking first in cotton production for more than 20 years, owing in particular to its high yield performance. The production increase of the country has nevertheless been halted by the outbreak of pest resistance to insecticides around 1992/93, notably in the three main cotton provinces along the Yellow River Valley (Hebei, Shandong and Henan; hereafter the Yellow Three). The commercial release of Bt-cotton in 1997 clearly has permitted the re-launch of cotton production in China and a new step of yield gain. These achievements lead to appraise the Chinese experience in using Bt-cotton as a positive one, based on substantial reduction of production cost through decrease of pest control costs [1, 2]. The Chinese experience is however particular because the Bt-cotton adoption has materialized through the adoption of a very wide range of varieties, notably of Chinese origin along the varieties introduced from Monsanto. This fact is indicative of how positively improved varieties could contribute to cotton production.

The contribution of variety development has resulted from a radical change in the legal framework. The acknowledgement of the breeders' right has dramatically promoted the development and launch of new varieties, thanks to a very rich germplasm and a very dense breeding network in the country. Nevertheless, there are shortcomings associated to the vibrant competition in the variety and seed markets. Today; all cotton sector stakeholders do recognize that there is a big issue of excessive competition from a great number of varieties leading to variety and seed mixture [3-5]. This issue is detrimental to cotton producers who are not getting the quality seeds they deserve. It also means wastage of resources in research as long as new varieties could become quickly mixed and lose the advantageous features they bring. This situation has led the Chinese Government to decide on a new support policy called "Quality Seed Subsidy Policy" (hereafter QSSP). The Chinese policy in the areas of varieties and seeds hence is providing an interesting case of interaction between policy and market within less than twenty years.

Our paper is a contribution to analyse the cotton variety and seed market development of the last twenty years. It targets at showing that market could develop effectively after its forces are freed, to the extent that it runs at the expense of all stakeholders and that public action is felt again necessary. The success of the new public intervention nevertheless is not guaranteed and must comply with market forces.

This paper is structured to report and analyse the three phases of the State and market interaction. Section two describes and analyses the policy change through the legal framework which was set up to enhance the development of variety and seed markets. Section Three shows the impacts of the policy change, pointing out how positive impacts could turn to become negative. Section Four appraises the return to some State intervention whose modalities are debatable and which is unlikely to correct the negative features of the variety and seed market development.

## **2 Enhancing policy to promote new varieties and quality seeds**

Although the liberalization of the agricultural economy in China has started in 1978, for a few years, it mainly consisted of passing from a collective farming to an individual farming. The support to farmers has persisted for a long time. For cotton, the support through the fixation of guaranteed price and input subsidies has ended up at the eve of the China application to the WTO entrance. In the area of the supply of quality seeds of adapted varieties, the liberalization process has taken about the whole decade of 1990s to be completed.

The development of the cotton variety and seed markets have clearly benefitted from the adoption of a Seed Law and the Plant Variety Protection Act -hereafter PVPA. The first

ISSCRI International Conference "Rationales and evolutions of cotton policies", Montpellier, May 13-17, 2008 version of the Seed Law was issued in December 1989, with modalities of application issued in 1991. These rules, in the areas of seed production and distribution were comprehensively revised on December 1st, 2000. They guide the regulation of the variety and seed markets till today because they were little modified by the amendments introduced on August 28, 2004. Meanwhile, the breeders' right was specifically clarified in the PVPA issued on October 1<sup>st</sup> 1997, but the decree of application was issued only in June 1999 and recently revised on September 2007 with effect on January 2008.

Owing to the reported sequence of institutional measures, the real application of new rules regarding the development of variety and seed markets has been taking place only since the end of the 1990s. Although the adoption of the Seed Law was more ancient, we start by presenting the PVPA because the acknowledgement of the breeders' right was the cornerstone of the development of cotton variety and seed markets.

### **2.1. PVPA: similarities and distinction with current international rules**

Before starting indicating the particularities of the Chinese regulation of the breeders' right, it is worth noting that China has not joined the Union de Protection des Obtentions Végétales (UPOV) which is the international agreement related to the protection of breeders' right. UPOV rules have been issued firstly in 1961. They have been revised in 1971, then 1978 and finally in 1991. The last revision brought a dramatic change on a few critical rules. The privilege of farmers' seeds (the right farmers had to using the seeds obtained on their own production of previous year) has become an optional exception requiring approval of the breeder [6]. In practice, it's just like if the former privilege is removed. On the breeders' side, as far as transgenic varieties are concerned, they no longer can use existing varieties as source of variability to their breeding program without formal consent of the variety owner. We will see that the Chinese current rules governing the breeders' right are rather close to the previous versions of the UPOV rules which better took the variety users and developers into consideration.

The PVPA is composed of 46 articles within eight sections [7], the related rules are detailed in the application decree of 1999 [8]. Section one clarifies the objectives of the Act. Section three emphasizes the conditions of novelty, specificity, homogeneity and stability which are common to the notion of new variety in the world. Section seven clarifies the sanctions in case of rule violations. Section eight declares the immediate validity of the Act at the time of its issuance, on October 1<sup>st</sup> 1997 although indicating possible amendment of the rules, if needed. The rules of these sections do not present special interest in the scope of this paper.

Section two contains several articles which demonstrate the particularities of the breeders' right in China or the dramatic change that the application of the PVPA has brought in the country. Article 6 prohibits the marketing of any variety without owner's right duly allocated. The breeders' right can only be attributed to the organization or the individual which actually has carried out the new variety. Nevertheless, the breeders' right is transmissible as it is specified in article 9. The breeder can transmit his right to another entity, organisation or individual, after he has introduced his application for breeders' right or after the breeders' right has been attributed to him. This transmission must be formalized in specific contract. Nevertheless, the same article points out that the transmission to a foreign organization must previously have obtained approval by the Department of variety right registration. Two major concerns come out clearly this important article. One is to favour the exploitation of new varieties by encouraging the transmission of the breeders' right to commercial entities, in this case, the breeders' right becomes owners' right. The second concern is to restrict the exploitation by foreign entities. This article appears to be the cornerstone of the strategy to promote the development of the market of varieties in China.

However, the application of the breeders' or owners' right is restricted in two situations, both

ISSCRI International Conference "Rationales and evolutions of cotton policies", Montpellier, May 13-17, 2008 in view of enhancing the breeding activities and of safeguarding the farmers' interest.

According to Article 10, breeders do not need approval of the owner of a given variety, nor to pay any financial compensation, when he uses this variety into his breeding program. This measure is specified without distinction of the nature of the new varieties, in particular transgenic varieties. This measure complies with the UPOV rules up to their 1978 version but clearly is opposed to the restriction being set since 1991. In practice, this measure enables breeders to use an existing Bt-cotton variety and to cross with another variety to create a hybrid variety which automatically becomes Bt-cotton variety. This specificity is the legal measure which eventually greatly enhances the development and supply of new Bt-cotton varieties.

The same Article 10 mentions that farmers can use the seeds they have obtained from their production of the previous season without paying compensation to the variety owner. In other words, in China, the privilege of farmers' seeds, as it was stated in UPOV rules till 1978, remains preserved. This measure likely is destined to protect farmers' economic interest. However, as far as non-hybrid varieties are concerned, this measure contributes to restrain the market development of any new variety since farmers are not obliged to renew yearly their seeds. The market restriction has implications which could become negative to farmers as we will see later.

The Article 11 introduces another particularity which is unique in the world, as far as we know. When examining the application for breeders' right allocation, the Department in charge of it could pronounce the status of high public interest variety when it is felt that its large diffusion is of high impacts on national or public benefits. In this case, this right could be endowed to an organization other than the breeder, under the condition of financial compensation. If needed, the mentioned Department could arbitrate to help achieve a fair compensation. This measure could be applied when it is observed that the original breeder is not intending to exploit his variety or is not capable of exploiting it to the extent justified by the public interest. In the case of cotton varieties, this article has not been applied so far, not any variety has been acknowledged of the status of high public interest variety.

The Section 4 deals with the modalities for the application of breeders' right on a new variety. The Article 20 sets up the scope to examine the allocation of right to varieties bred by a foreign firm. The examination of the intellectual property application must follow special frameworks when they exist: either the agreement between China and the country to which belong the given foreign organization, or the rules of property right allocation of international organization to which this country and China are both members, or finally according to specific agreement on the basis of mutual benefit. This article actually means that the PVPA does not apply as such to varieties bred by foreign firms. This can be interpreted as a restrictive measure to the penetration of the foreign firms in the Chinese variety market.

The concern of regulating the variety market development applies also to the varieties carried out by Chinese organizations or individuals. In Article 26, these latter entities are prohibited from applying for variety protection in a foreign country without information and registration at the Department in charge of property right attribution. There is not really prerequisite condition that the related varieties must have the property right be attributed firstly in China. The fact is the concern to have a control on the property right of all varieties being carried out in China.

The Section 5 covers the modalities of control before rejecting or pronouncing the property right. They have nothing particular except the rapidity of the process. The control to assess the eligibility for property right must be completed within six months after submission for property right. This is a measure which is also favourable to the development of the variety

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The duration of the property right is fixed in the Section 6. For annual crops, this duration is established at fifteen years, as opposed to twenty years for liane, forest, fruit tree, and ornamental trees. This duration complies with what was retained in the first versions of the UPOV rules, with the concern of not excessively protect the breeders' interest. In the last version of UPOV rules, the duration has been extended to 20 years in minimum [6]. Besides, in China, the property right can be nullified under several circumstances, either the owner declares giving up his right, or he fails to pay the annual fees due for property right protection, or finally if the variety no longer complies with one of the conditions of novelty, specificity, homogeneity and stability.

## **2.2. Seed Law: seed market promotion and preservation of farmers' interest**

The rules governing currently the production and distribution of seeds are adjusted in December 2000, as mentioned above. The last amendment in 2004 brought no important changes. In reality, this Seed Law covers the production and distribution of seeds as well as the registration and certification of varieties at local and national levels. In this regard, this law complies with and complements the PVPA in the area of breeders' right.

The Seed law is composed of 11 sections totalling 78 articles. The Section 1 provides the general objectives and in particular the decentralization approach in the Law application. The Article 6 points out that provinces, autonomous regions, autonomous municipalities (Beijing, Shanghai, Tianjin, and Chongqing) are responsible of the Law application through setting up specific fund to promote the production and distribution of quality seeds.

The Section Two contains articles destined to protect seed resources in the country, through a real and effective organisation of the registration, certification, protection and circulation of seed resources (Article 9). The intellectual right of seed resources belongs to the country, any entities and individuals must get specific permission from Agriculture Department before transferring abroad, correspondingly, the introduce of seed resources from abroad must also comply with related rules from Agriculture Department. (Article 10).

The Section Three deals with the registration and certification rules of varieties within a decentralized process, at the level of local administrations (Article 11) in Provinces, Autonomous Regions and Municipalities. The Article 12 mentions that the registration and certification of new varieties complies with the protection of property right and clearly indicates that the right owner must be compensated financially when his variety is marketed. This article provides the financial incentive for the development of new varieties and sets up a dramatic change to the former situation. The Article 14 is specific to transgenic varieties whose registration and certification must comply with the specific rules of biosecurity.

Variety registration and certification is obtained at national level or provincial level (Article 15), and the resulting right restrains the marketing area to the region where certification has been endowed. Marketing release in the whole country is permitted after specific registration and certification for nationwide use, following specific application procedures (Article 16).

The Article 19 sets up the conditions for foreign companies to register their varieties. They must pass through a company established according to Chinese laws. In other words, foreign companies must set up joint ventures with Chinese partners before applying for the registration and certification of their varieties. This is indeed what Monsanto had had to do when they introduced their Bt-cotton varieties in China.

The Section Four is specific to the eligibility conditions to produce seeds. These conditions are little restrictive, they mainly correspond to technical competences (Article 21) and they are destined to encourage the public scientific and technical organizations to invest in seed

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The Section Five pertains to seed distribution. This activity must get specific authorisation which is region-specific (Article 26). All organizations or companies willing to distribute seeds must comply with the authorization application, except farmers. China has retained a rule which is seldom encountered in any other country. The Article 27 points out that farmers can sell and exchange the seeds obtained on their own farms without permission, provided that the varieties are population cultivars. In other words, farmers can somehow compete against authorized seed distributors and this potentially can reduce the size of the seed market for any new population cultivar. In the same time, it is claimed that each local administration must encourage and support scientific and technical institutions to commit with the seed distribution activities (Article 28). Indeed, the requirements to get authorization to distribute seeds (Article 29) encompass technical competence and background in seed production which are easy to be met by public scientific and technical institutions. The development of the seed distribution network is facilitated by the Article 30 which permits a company to set up new outlets in the region where it has already obtained authorisation. Only certified seeds can be marketed (Article 35) and in the case of transgenic seeds, this feature must be mentioned in the seed package. In reality, the application of this article could give rise to undesired effects if the control and certification of the seeds are not effective.

The Section Six comprises articles related to the seed use. The most important article is the acknowledgement of the farmers' liberty to use the seeds they decide for their own interest. No one, not any institution, could interfere in this right of the farmers (Article 39). In case farmers are abused by ineffective seeds, or seeds of insufficient quality, they can legally ask for compensation which should cover the expenses and the prejudice (Article 41). The Seed Law clearly retains the principle of safeguarding the farmers' interest in using seeds, at least on theory and unfortunately mainly on theory. There are many cases of spurious seeds [4] and not any farmer has got compensation for the prejudices he had suffered.

The Section Seven is an important one as it deals with the rules of ensuring quality seeds, notably the decentralized responsibilities in controlling and certifying seeds. In reality, the devices for the needed control and certification of seeds have not been adjusted and modernized to address the burden resulting from the development of variety and seed markets.

The remaining sections pertain to the rules regarding the importation and exportation of seeds, the administration of the seed sector, the sanctions in case of rule violation and the domain of application of the Seed Law. The Article 74 clearly indicates the major crops which are concerned, in particular cotton.

The Seed Law and the PVPA are established for the main crops in China, in particular cotton. They are defined to promote the development of new varieties and the supply of quality seeds to farmers. All organizations, in particular the public scientific and technical institutions, are encouraged to commit in breeding and seed production and distribution. The acknowledgement of the breeders' right with financial compensation in case of commercial release of the varieties provides the needed incentives to get into the variety and seed markets. The status of breeder and seed producer and distributor is endowed to collective or individual entities demonstrating the experience, the capabilities and the needed financial requirements. This could be namely the case of research institutions, colleges and universities or scientific and technical staff involved in the development or diffusion of new varieties. There is no restriction for breeders to integrate any new variety, even transgenic one, into their own breeding program to carry out new varieties. This measure which is quite specific to China now does sustain the dynamism of variety creation, in particular when hybrid varieties are

ISSCRI International Conference "Rationales and evolutions of cotton policies", Montpellier, May 13-17, 2008 considered. Within one year, it is possible to obtain a new hybrid variety of Bt-cotton.

In the same time that the breeding of varieties by Chinese organizations is strongly encouraged, some restrictions are imposed to varieties bred in foreign countries. The application for variety certification in this case must pass through an organisation set up according to Chinese laws. It is somehow forcing foreign breeding companies to set up joint ventures in China.

The Seed law and the PVPA also show farmer-oriented principles. Farmers are free to use the types of seeds they want, in particular the seeds they hold back from the previous season. Furthermore, they even can exchange and sell the seed they obtain without permission, hence competing with authorized seed distributors.

In a nutshell, the Chinese legislation regarding the variety and seed affairs is rather close to the first versions of the UPOV rules at the international level. This legislation ignores the evolution of the UPOV rules which have restricted the use of farmers' seeds in one hand, and in the other hand the integration of GM varieties into non-owner breeding program. The Chinese specificities are apparently sympathetic both to Chinese farmers and breeders. In fact they encompass mechanisms which induce eventually undesired effects to them. These effects have already materialized. Farmers are complaining about the quality of seeds and their high prices while breeders and seed distributors are worrying about the viability of their businesses.

The set up of the legal framework in China, since the early 1990s, has attracted the entrance of Monsanto to market its Bt-cotton varieties. This decision has really contributed to the Chinese successful adoption of Bt-cotton, as well as development of variety and seed markets, before the emergence of undesired effects.

### **3 Varieties and seed market development: from positive to negative impacts**

Till the end of the 1980s, the organisation of the production and distribution of seeds was very backward. Cotton seeds were distributed by the same organisation (National Jute and Cotton Company) which was in charge of marketing the seedcotton from farmers. Planting seeds were little differentiated from common seeds coming out the ginneries. Prior to the marketing of Bt-cotton, most seeds were fuzzed ones, distributed at very low price, if any, without guaranty of germination rate. It was hard for cotton growers to acknowledge the real value to these seeds and many of them had more confidence on the seeds they held back by themselves, in terms of the nature of variety and of germination rate.

Very clearly, the marketing of Bt-cotton in 1997 was due to the initiative of Monsanto and its seed ally Delta & Pineland company (Deltapine), to release their Bt-cotton varieties in China. Prior to the issuance of the PVPA, Monsanto has benefitted from an exemption measure to demonstrate the effectiveness of its varieties in Hebei Province since 1995. For the commercial release of the seeds of its varieties, Monsanto had had to set up a joint venture with the Hebei Seed Company in 1996. At the same time, another joint venture was set up too, involving only Chinese entities (notably involving the Chinese Academy of Agricultural Sciences) to promote the marketing of varieties carried out with the Chinese Bt-gene<sup>1</sup>. Before the issuance of the PVPA, a provisory measure was adopted by the Central Government to permit the commercial release of Bt-cotton varieties firstly in three provinces along the Yellow River Valley (Hebei, Shandong and Henan), or the Yellow Three, which were and which still are main cotton producing provinces in China and where the outbreak of pest resistance had greatly decreased cotton production. The restriction of geographic diffusion of new varieties is quite in line with the spirit of the Seed Law, but these varieties have diffused

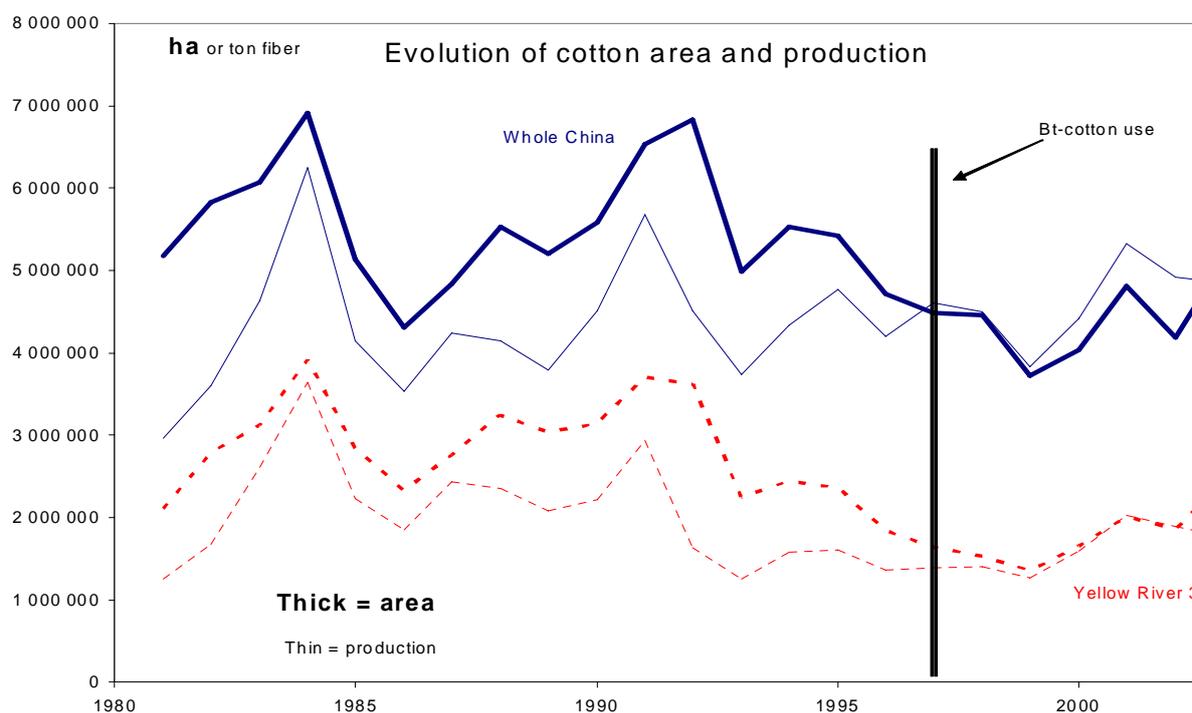
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<sup>1</sup> Monsanto Bt-gene is Cry1Ac. The Chinese Bt-gene is a synthetic construction called only Cry1A, it was obtained by the research team of Prof. Guo Sandui in Beijing.

### 3.1. Real production re-launch

The influence of the adoption of Bt-cotton has induced a re-birth of cotton production in the Yellow Three (Figure 1) which accounted for more than 40% of the Chinese production in the early 1990s before the outbreak of pest resistance to insecticides. The production has substantially fallen later on before increasing again after the widespread adoption of Bt-cotton, but these provinces have not recovered the previous production levels because of other factors of the Chinese global and agricultural economies and whose analysis goes beyond the scope of this paper.

Figure 1: Evolution of cotton area and production in China and in the main three provinces of the Yellow River Valley



### 3.2. Production increase linked to widespread adoption of Bt-cotton varieties

China is one of the rare countries where the data on the areas per variety are available for the major crops, in particular cotton, although not perfectly. Every year, the National Centre of extension and technology diffusion issues a report providing the data collected in each province and autonomous regions and municipalities. Local extension services are instructed to record the area data for the main varieties, i.e. those cultivated on more than threshold areas. For cotton, these threshold areas have fluctuated during the 1990-2006 period, moving from 100 000 mu (6667 ha), to 10 000 mu (667 ha) and finally 50 000 mu.

The analysis of the available data shows the quick and broad adoption of Bt-cotton varieties since 1997 (Table 1). In Hebei Province, where the variety diffusion has been initiated firstly, total coverage has been achieved three years after. In the whole region of the Yellow Three, coverage of 85% with Bt-cotton was encountered in 2001, four years after the promotion of

ISSCRI International Conference "Rationales and evolutions of cotton policies", Montpellier, May 13-17, 2008 this cotton. At national level, about 50% coverage was achieved five years after the Bt-cotton commercial release.

Nevertheless for all provinces individually, and at the scale of the whole country, the coverage with Bt-cotton seems stagnating at around 60-62% in 2004/05 and appears declining since then. This phenomenon has seldom been noticed so far in papers accessible to the international academic community.

Table 1: Evolution of the Bt-share in cotton area and of the share of US Bt varieties

		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Hebei	Bt share in area	3.1%	59.5%	90.3%	100.0%	91.4%	86.4%	68.7%	70.2%	65.7%	44.7%
	US share of Bt area		100.0%	94.2%	74.9%	79.1%	77.1%	76.9%	61.1%	61.1%	31.2%
Yellow Three	Bt share in area	1.4%	15.3%	49.9%	69.6%	85.1%	81.3%	78.1%	79.9%	80.9%	75.1%
	US share of Bt area		83.4%	66.2%	56.9%	70.1%	61.3%	52.1%	31.0%	25.2%	12.4%
China	Bt share in area	0.9%	6.3%	20.2%	39.8%	45.1%	48.5%	56.0%	59.1%	61.8%	55.1%
	US share of Bt area		59.2%	58.6%	52.5%	62.6%	53.8%	42.7%	25.4%	18.1%	9.3%

Source: data processed from the information provided by the annual reports of the National Centre of extension and technology diffusion

### 3.3. Significant but seriously declining share of the Monsanto varieties

The marketing of Monsanto's Bt varieties has actually contributed to the take-off of the broad use of Bt-cotton. According to the data recorded by the National Centre of extension and technology diffusion, Monsanto has tried to market eight varieties but mainly two have got real commercial success, namely DP33B during the first years then DP99B.

Monsanto varieties have got the lion's share, for a quite long period, in the places where they were firstly promoted, namely the Yellow Three (Table 1). But in all places, the Monsanto shares of Bt-cotton areas are declining steadily since 1999/2000, at the time of the PVPA destined to promote the variety market development with emphasis on variety development by national organizations. The decline of the Monsanto shares demonstrates that the PVPA policy was successful and quite immediately. It is worth noting that our figures pertain to the shares of cotton area with Bt-cotton, they are over-estimates of the seed market shares as farmers substantially do not purchase yearly the seeds they use. This is illustrated by the results of a survey conducted in 2002/2003 Hebei Province [9] showing that only 45% of the farmers totally purchase their seeds each year (Table 2). This phenomenon has persisted till recently [3].

Table 2: Farmers' behaviour is using seeds in Hebei Province

	% Farmers, cultivating 1 to 3 varieties of cotton			All farmers
	1	2	3	
Seeds through exchange with other farmers	1%	0%	0%	1%
Partial purchase of seeds	26%	29%	75%	30%
Total purchase of seeds	53%	33%	0%	45%
Using exclusively held back seeds	20%	38%	25%	25%
Total	100%	100%	100%	100%

Source: Fok et al. 2004

### 3.4. Seed market modernisation

The entrance of Monsanto into the Chinese market, along with its seed ally Deltapine has induced a dramatic modernisation of the seed market. Seeds were systematically delinted; their germination rate checked and guaranteed; they were marketed in very attractive packaging, and the distributed quantity was adapted to the cotton crop size of the growers. When fake seed appeared in the market later on, a telephone number was indicated on the seed package to enable farmers to call and check the authenticity of the seeds they have bought.

These positive outcomes were quickly extended to the seed market of other crops. From this perspective, the application of the Seed Law demonstrates positive impact although mitigated by the emergence of fake or spurious seeds. This positive impact of seed market modernisation is definitely to stay.

### 3.5. Real dynamism in the variety market

China has the tradition of offering numerous varieties to cotton growers to adapt to their local physical and climatic conditions in a large country. The exploitation of the area records according to cotton varieties (Table 3) shows that there were 199 different cotton varieties used in the whole country, before the application of the PVPA. After this Act entered into force, there were 372 cotton varieties used during the seven years which followed, and only 73 of these varieties were already cultivated in the previous period. This means that there was almost 300 new varieties being marketed and used during the seven years which followed the implementation of the PVPA. Clearly the breeding force has quickly and strongly responded to the incentives given to offer more and more new varieties.

Table 3: Evolution of the number of varieties being used with area above or not the area threshold for recording

	a	b	c	d	e
	Nber var with area recorded	Nber var with area over 6667 ha	total area of all varieties used* (ha)	mean area of all varieties used* (ha)	mean area*/year (ha)
1990- 1999	199	199	44 423 680	223 235	22 323
2000- 2006	372	203	28 854 401	77 566	11 080

\* varieties recorded with area superior to thresholds whose values have fluctuated from 667 ha to 6667 ha (or 10 000 to 100 000 mu)

The response to the new institutional framework for variety and seed markets comes from a broad range of breeding units. Cotton research indeed is widespread all over the production locations in China and it is implemented by education organisations (colleges and universities), research institutes, local agricultural departments. By analyzing the data related to the varieties submitted for national registration, and by tracking the natures of the organizations which submitted for registration during the 1999-2007 period, we come to the Table 4 which shows that there were 156 distinct breeding units behind the process. Hence, there are at least 156 active breeding units in China whose scopes of intervention are mainly provincial and district

ISSCRI International Conference "Rationales and evolutions of cotton policies", Montpellier, May 13-17, 2008 level ones, although the number of the county-level breeding units (further lower administrative level) is quite significant too, far ahead the units at central level. Research institutes constitute the first group of breeding units but the recent group of private companies, set up since 2000, is growing fast and should become the leading group soon.

**Table 4: Distribution of the breeding unit shaving submitted varieties for national registration**

Administrative level	Firms	College/Universities	Research institutes	Agri department	Total
County	9	1	11	1	22
District	35	1	31	1	68
Province	17	11	26	3	57
Central	2	1	6		9
<b>Total</b>	<b>63</b>	<b>14</b>	<b>74</b>	<b>5</b>	<b>156</b>

The great number of new varieties and the important number of breeding units which commit themselves in the variety and seed markets are signs that the Seed Law and the PVPA have succeeded in provoking a very dynamic variety and seed markets and have induced a substantial contribution of the private sectors. But the sustainability of these positive outcomes is under question because of the excessive competition which has taken place.

### **3.6. Excessive competition detrimental to the variety market sustainability**

The column "b" in the Table 3 corresponds to the number of varieties which have reached the area threshold of 100 000 mu (6667 ha) at least one year during each of the two periods considered (before and after 2000). It is quite clear that, before 2000, all varieties used have succeeded to reach this threshold, at least one year. This is not the case since 2000, for 169 varieties, or more precisely for the 99 new varieties launched since 2000 (after deduction of the 73 varieties which were yet used before 2000). This is an indication that one third of the varieties commercially released did not meet market success. Given the total area recorded for all varieties (column "c"), and if the market was equally distributed between varieties, the total area per variety can be deducted for each period (column "d"), or the mean area per year (column "e"). At national level, the yearly mean area per variety has decreased somehow substantially. In other words, the offer augmentation of varieties automatically leads to the diminution of the market share for each variety, when the market distribution is assumed to be equal. So, the more dynamical cotton breeding is, higher is the competition between varieties at the expense of the profitability to the breeding units.

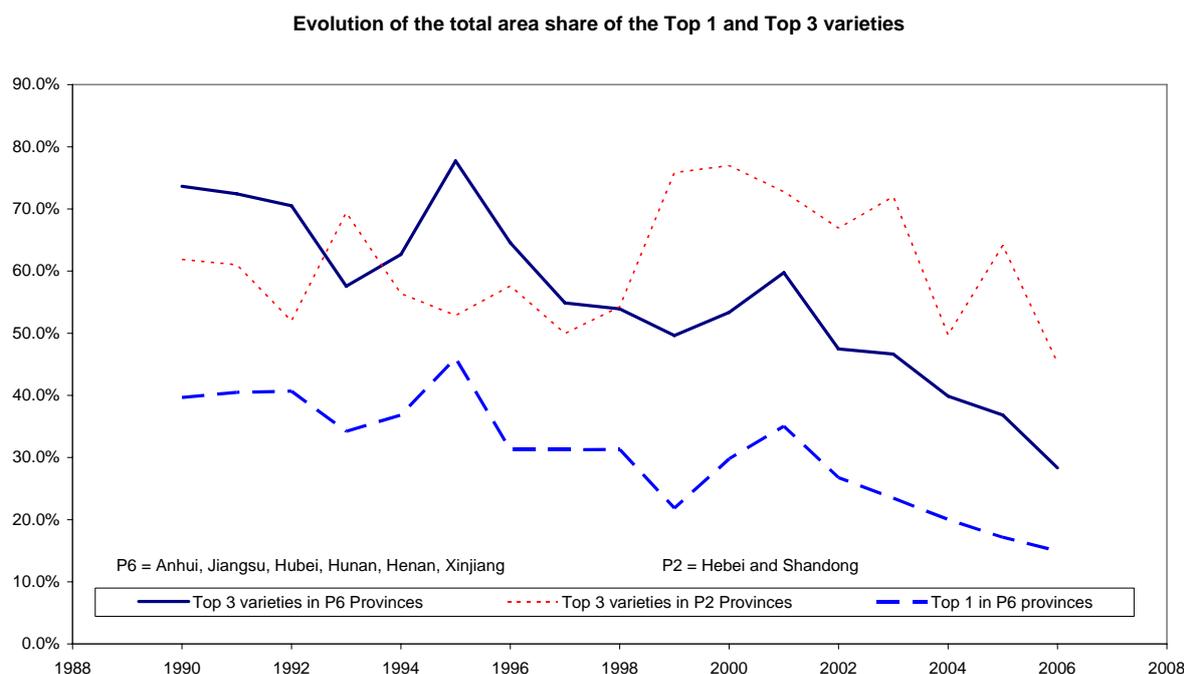
The competition between cotton varieties is even harsher because the market is far from being equally distributed between varieties. During the whole period from 1990 to 2006, there were only sixteen varieties (out of the 571 recorded) which have been grown on more than one million hectares. In total, this group has represented 48% of the total area recorded during the period.

This is illustrative of the phenomenon of market concentration which has always been high and still is. The market shares of the Top 1 or Top 3 varieties have represented 40% and 75% respectively in 1990, they have steadily decreased since then, Today, the best appreciated variety could have a market share of 15-20%, the Top 3 a market share of 30-45% and 37-60% for the Top 5 (Figure 2). The market concentration has decreased, as a direct consequence of market competition but it still persists and the profitability can hardly be expected for the varieties which fall out of the Top 5. This phenomenon derives from the farmers' habit of shifting to new varieties. The survey we conducted in 2005 in Jiangsu Province [10] shows that farmers might grow many varieties in villages, but with clear concentration on three to five varieties (Table 5) and only a few of the varieties are grown from one year to another.

Table 5: Diversity and concentration of the cotton varieties being used

	2004	2005
Total number of varieties encountered	21	26
% of farmers using		
TOP 1 variety	36.9%	24.6%
TOP 3 varieties	62.5%	57.9%
TOP 5 varieties	77.8%	73.8%

Figure 2: Evolution of the cotton area share of the Top 1 and 3 varieties



The harsh competition is illustrated by the reduced lifespan of varieties, defined here as the number of years for which a given variety has been grown on more than 100 000 mu (6667 ha). This determination has been implemented for all the 571 varieties grown during the 1990-2006 period. Globally, about one third of the marketed varieties have a lifespan of one year. More than 60% of the varieties have a lifespan at most equal to three years. For more than 80% of varieties, their lifespan is at most equal to five years. The turnover of varieties is quite frequent. From the perspective of breeding and seed distribution organizations, this means that the cost in carrying out new variety has to be recovered is quite a short period.

Consequently, for the seed distributing companies, profitability can only derived from cost reduction or increase of selling price. The first option has been favoured by less serious seed distributors which opted to market fake or spurious seeds. The second option can only be retained by serious seed distributing companies. There is in fact a third option consisting of capturing the seed market share by proposing hybrid cultivars, since farmers could no longer use their own seeds. The Table 6 does show the phenomenon of enhanced registration of hybrid varieties at national level. This marketing strategy nevertheless contributes to further increase seed price while the adoption of hybrid varieties are not justified in all production locations.

We hence come to the factors which were brought to the attention of the international scientific community regarding the reduction of the profitability of using Bt-cotton, as we have mentioned it in the introduction.

Table 6: Evolution of the numbers of varieties submitted for national registration

	No. Varieties submitted	Share of No. Varieties submitted	
		hybrid cultivars	Bt cultivars
1999	9	33.3%	0.0%
2000	27	44.4%	44.4%
2004	73	32.9%	71.2%
2007	113	58.4%	85.8%
Total	634	45.7%	68.8%

It is a very demanding work to reconstitute the evolution of cotton seed price since the application of the PVPA. This is particularly true in China because of various types of seeds (hybrid or not, Bt-cotton or not, Chinese origin or not, additional gene to Bt or not) and because of distinct crop installation (by transplanting or not), not mentioning the variation between cotton provinces. Up to now, the reconstitution remains partial, but it suffices to point out a few figures to help realize the extent of price increase during the last seven years. At the time of Bt-cotton widespread diffusion, the seed price for population cultivar was RMB 9.0/kg in 1999 in Hebei and Shandong Provinces [11]. In Hebei Province, the same type of varieties was priced at Yuan 27/kg in 2002, and Yuan 37/kg in 2003. With regard to Hybrid Bt-cotton varieties, seed price was Yuan 30/kg in 2001 and has steadily increased to Yuan 120/kg in 2007.

The complaints on the cotton seed quality and high prices pertain to what is called in China, for the last three years, the issue of seed market disorder. It is acknowledged that there are too many varieties, whose purity is quite questionable because of the lack of coordination. This situation is detrimental from several perspectives. Farmers, attempted by lower price seeds, could be frequently cheated by fake seeds, and perfect quality is not really ensured even when they buy high price seeds. The fate of the serious seed companies is seriously endangered by the unfair competition of the dishonest ones. Of course, as the field performance can be hampered by low quality seeds, China is not getting the cotton production and quality it targets at. The mixture of the varieties which could result very quickly annihilates the efforts and investment engaged at the research level.

Observers have yet pointed out that some regulation of the variety and seed markets is needed. Public action has been called upon and it is materialized since January 2007, with nevertheless questionable effectiveness.

#### **4 Public but naïve interference on variety and seed markets**

The quality cotton seed subsidy policy has been launched in early 2007 [12, 13], before the cotton cropping season. This policy is planned to last for four years, the fund for the subsidies to quality seeds for the first two years are already budgeted. In 2007, the subsidy fund was set at Yuan 500 millions (or about €50 millions) for an estimated cotton area of 2.7 millions ha. The subsidy allocation is differentiated, Yuan 150/ha in the western region of Xinjiang and Yuan 225/ha in the other provinces. The objective is to cover on average 50% of the seed cost faced by the cotton growers. The subsidy amounts actually give indications of the average seed prices in 2007. In Xinjiang where population cultivars are used and which are little Bt ones, the price of these seeds has increased up to Yuan 300/ha (€30/ha). Elsewhere, varieties are almost Bt exclusively and frequently hybrid ones, the average price has reached Yuan 450/ha (€45/ha).

As it is titled in Chinese, this is a subsidy measure destined to decrease the growers' production cost so as to improve their income. This new policy also targets at orienting the evolution of the seed market structure in order to discard the seed companies which do not have the needed capacities to provide quality seeds to farmers.

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After one year of implementation, it is yet observed that the new policy is likely not to reach the expected target [14, 15], although its implementation could be positively appraised as a tangible sign of the concern the Chinese government pays to the farmers' income. The lack of effectiveness results from the implementation modalities which are opposed to the spirit of the Seed Law.

#### **4.1. Policy in opposition to the Seed Law spirit**

The Quality Seed Subsidy Policy is the first measure to support cotton production after China has joined WTO. In practice, subsidy is managed through a decentralized way, this is in line with the Seed Law spirit, but it's the unique compliance one can find with the new subsidy policy.

The subsidy is allocated to farmers who buy seeds of varieties belonging to an eligible list that each Province and district establish. In practice, when farmers purchase seeds, they only pay the price differential between the total price and the subsidy. It is up to the seed distributor to get the subsidy amount along with the local administration in charge of the subsidy program.

The modality of restricting the subsidy program to a pre-determined list of varieties violates one of the Seed Law rule and implies several questionable effects.

Basically, by limiting the subsidy allocation to a preset list of varieties, the government is interfering on the varieties farmers should use. This is violation of the Article 39 described above and which claims that farmers are totally free in using the seeds or the varieties they want. Besides, as the subsidy is associated to the purchase of seeds, the new policy is discriminating farmers at the expense of those who do not buy seeds. Of course, this policy is destined to enhance the seed market and push farmers to buy seeds but it is violating the Article 10 of the PVPA which recognizes the farmers right of using seeds from his own production and the Article 27 of the Seed Law which permits farmers to provides seeds to other farmers either through exchange or selling. Of course, the mentioned articles are not so much clever, they likely need to be amended.

Clearly, the new subsidy policy gives back influence to local authorities in an economic sector which has got its autonomy since the application of the PVPA and the Seed Law, hence opening opportunities for a few actors to exploiting their administrative power. Even if the listing process is implemented in the most objective way, it is little realistic that an administration could know perfectly which are the varieties fitting the farmers' requirements and whose seed quality meets their expectation. The current modalities sound like deciding again what an administration thinks adapted to the farmers' needs.

#### **4.2. Questionable effects on the correction of the seed market**

The QSSP is set up in view of correcting the functioning of the variety and seed markets in which "disorder" prevails. The modality of its implementation, as described above, encompasses great risks of undesired effects.

The economic fate of a seed company is related to having its varieties being listed. The criteria to retain the list of varieties are not clear; they may vary from one province to another. The application of the modality has already led to amazing results. A small company with very marginal market share could suddenly see its development promoted if it has varieties listed [15]. How such a small company could be selected raises question. Reversely, a well established company whose seeds and services were appreciated and which enjoy a substantial market share might see its development abruptly stopped because it has got a limited number of varieties listed and/or eligible only to a limited number of districts. The lack of transparency in the listing process could justify the suspicion on the fairness and the objectiveness of the listing process.

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It is already observed quality failure of the seeds of a few varieties which have been declared eligible for subsidy[14]. It is also noted that the amounts of seeds available for several varieties were limited and unlikely sufficient to cover the farmers' demand. These observations are contributing to sustain the suspicion on the fairness of the process in selecting the list of eligible varieties.

By endangering the viability of the seed companies which have done fairly in favour of the companies which have not been efficient, the Chinese Government is taking the risk of discarding the right market players and to keep seed companies which lack sense of fairness in doing business.

#### **4.3. Questionable effects on the variety market development**

The subsidy amount is decided regardless of the type of seeds farmers use or buy and it was determined to halve the seed cost farmers have to pay when they buy good quality hybrid seeds. This means that farmers have to disburse when they buy hybrid seeds but far much less, if any, when they buy non-hybrid seeds.

Since farmers are complaining against the high level of their production cost, their reluctance to disburse money when they buy seeds could push them to select varieties of lower prices. This behaviour could push farmers to turn their back to the best seeds and varieties, hence discouraging the development of good performing varieties like hybrid cultivars. The reaction of the farmers to the subsidy modality finally will result in putting aside the best varieties or seeds, in the opposite of the target focussed in the subsidy policy. This phenomenon could lead to a sub-exploitation of the best varieties of the moment, at the expense of the whole cotton sector interest. The observation of this phenomenon should discourage breeding units to keep on investing to achieve furthermore better varieties, hence reducing the contribution of better varieties to the development of the cotton sector. It might be felt more effective to invest in influencing the variety listing decision, therefore upsetting the competition which might become less and less fair between varieties.

#### **4.4. Indirect intervention could be more effective**

To several observers of the variety and seed markets, the critical issue is the lack of adjustment of the schemes to control and certify seeds at the local level [3, 4]. Although rules are set up, in the Seed Law, to charge the local administrations of the control and certification, the related services have remained insufficiently staffed and have suffered of lack of financial means to properly operate.

It is reported that it is not uncommon to find villages where several varieties or types of varieties (Bt, hybrid or pnot) are multiplied for seed production, when a single farmer is not contracting for the multiplication of several varieties.

It is reported also that the basic quality of seeds is not ensured. The germination rate could not exceed 60%, quite far below the threshold generally retained of 98%. This fact confirms the soundness of the complaint against insufficient seed quality. Amazingly, the launch of a seed quality policy does not address at all the seed control schemes in local regions. One can think that it's much more efficient to identify the seriousness and reliability of the seed companies by assessing the way seed production supervision is implemented. Unfortunately, this is not considered so far.

## **5 Conclusion**

A change in the cotton policy, consisting of liberalizing the variety and seed market, could prove to be quite successful where the capacities for breeding and investment exist prior to the policy change.

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 This success nevertheless will remain a short term one if no regulation is provided to prevent the market development from excessive and unfair competition which could imply fragile financial viability of the seed companies and unsure seed quality to farmers. The case of the development of variety and seed markets is illustrating that excessive competition is not efficient or sustainable. Regulation is needed to prevent the desirable competition becoming excessive.

Setting up a regulation after the market has entered crisis would not necessarily succeed if the regulation modalities overlook the real market forces of demand and supply. It is not effective to impose what farmers should use. This kind of approach reveals the illusion of monitoring too much directly the market, while an indirect approach, through the improvement of the seed production control device, should have been more efficient.

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