RESEARCH PAPER

Reformation in Egypt's Cotton Programme Towards Upland Cotton : *Barbadense* vs *Hirsutum*

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Abstract

As the leading agricultural sub-sector in Egypt, Cotton provides the livelihoods for hundreds of thousands of farm families. The cotton sub-sector, including production, trading, ginning, spinning, textile manufacturing, oil extraction, and livestock feed manufacturing, is the leading employer in the country. The development of new *Barbadense* varieties requires a well-organized team operating over a very long period, generally between 15-18 years. There has been considerable interest in the past to exploit the potential of *Hirsutum* varieties in Egypt. In the early 1980s and before, Egyptian scientists in Cotton Research Institute (CRI), in universities and other research centers, conducted production trials of *Hirsutum* varieties. With proper regulations regarding the cultivation of these two types of cotton, along with regulations that are already in place and enforced by the Ministry of Agriculture, Egypt should be able to produce and profit from both types of cotton. Local production of American Upland cotton in Upper Egypt will be spun into coarse and medium yarn counts and is a potential substitute for imported raw Upland cotton and yarns, while Egyptian Long and Extra-Long Staple in North Delta will be used for the production of fine yarns and fabrics for export.

Keywords : Egypt, Cotton, Import of Upland Cotton, Barbadense, *Hirsutum*

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Introduction

Cotton Research Institute (CRI) research programs have been and continue to be the backbone of Egypt's cotton industry. The Cotton Research Institute (CRI) in Egypt is well known for development and maintenance of the fine quality *Barbadense* varieties popularly referred as Egyptian cotton. The Government of Egypt (GOE) takes the decision to conduct a research program to introduce a new species of cotton. The Cotton Research Institute takes the initiative to plan and execute the work. The CRI has a good research infrastructure to execute an active breeding program for developing new varieties and also has a well-established research program in agronomy and integrated pest management. Research to adapt the varieties to different regions of Egypt are also conducted and the developed variety is disseminated in coordination with the extension department.

Cotton Breeding Programme in Egypt

The development of new *Barbadense* varieties requires a well-organized team operating over a very long period, generally between 15-18 years. But the Ministry of Agriculture's policy does not favour the introduction of new varieties unless they offer distinct advantages over existing varieties mainly in the cost of production and farmer's profitability.

The number and qualities of cotton varieties produced till date in Egypt is clear evidence of the efforts of CRI and its expertise in the field of cotton breeding. Various breeding techniques are employed for varietal development, but Egyptian cotton breeders rely mainly on an artificial crossing, a practice that is being used since 1921. The choice of the technique is due to the fact that when a high degree of purity is maintained within populations of commercial varieties, selection and alternative breeding technique becomes less effective as a source of a new type. Since 1921, many modifications and improvements in the artificial crossing technique have added to its effectiveness.

CRI has so far developed 97 different varieties. After a variety is developed by the breeder, three or four families are selected for use in official seed releases. Every plant is used to grow individual progeny rows in the breeding nursery for use in yield tests in the following year, while the self-pollinated seed from yield tests determines the ones to be massed or pooled for development of "foundation seed". The purest available seed, "foundation seed" for each variety is used to sow the "registered seed" area in the next year and forms the original source of subsequent propagation for commercial stocks.

The CRI ensures that a different government farm is chosen for the propagation of each variety to prevent mixing and crossing. Later, after leaving the government farms "Certified seed" is placed out on a contract with the agrarian reform cooperatives and single growers, for multiplication. The seed producers agree to return the seed to the Central Administration for Seed Production of the Ministry of Agriculture. All agricultural operations and agricultural practices and ginning of contracted seed production areas are under the supervision of the seed department.

Initial experiments with *Hirsutum* cotton in Egypt

There has been considerable interest in the past to harness the potential of *Hirsutum* in Egypt. In the early 1980s and before, Egyptian scientists in CRI, in universities and other research centers conducted production trials of Hirsutum. The results of the research on Upland Cotton *(Hirsutum)* production are as follow:

The Academy of Scientific Research and Technology (ASRT-1985) in collaboration with the Ministry on Agriculture and Cotton Research Institute launched field trials program in 1981 and 1982 to evaluate 28 American Upland cotton varieties *G. Hirsutum.* The objectives of the program included:

- Introduce new varieties characterized by high yield potential and early maturity 120-130 days and suitable for Upper Egypt.
- To improve the economic use of land, by the allocation of more land for food crops.
- To improve the use of scarce water by reducing water requirements for cotton.
- To supply Medium Long Staple and cheap raw cotton to fulfill the requirements of the local spinning and textile industry.
- To assess the potential of introducing profitable crops within the cotton rotation.

Four G. *Hirsutum* varieties (McNaire 220, McNaire 235, Tamcot CAMD-E and Tamcot Sp37H) were tested and compared with several varieties of Egyptian cotton *G. Barbadense* at Nubaria Company, Alexandria University, Zagazig University, the National Research Center at Qalubia , Fayyoum, Agricultural Research center at Giza, Cairo University, Assiut University and Shandaweel Agricultural research station in Sohag Governorate. The outcome of the trials are:

1. The yields of American Upland cotton varieties were significantly higher (around 5000 kg/ha of seed cotton, 2020 kg/ ha of lint) than the Egyptian cotton varieties (around 2250 kg/ha of seed cotton, 833 kg/ ha of lint) grown in the same location, as shown in **Fig 1.**

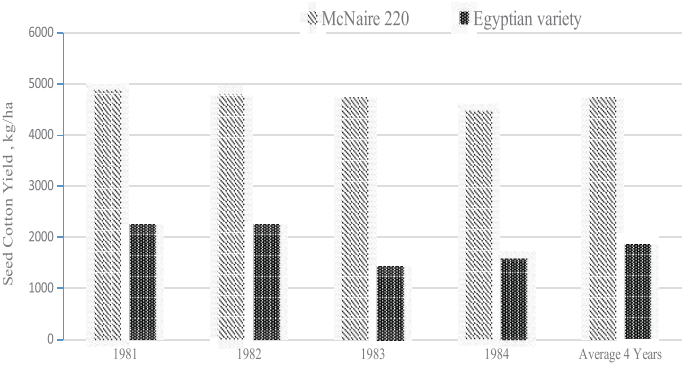

Fig. 1: Yield comparison between McNaire 220 and Egyptian cotton variety

Source: Academy of Scientific Research and Technology, Final report of Short season and high yield cotton project (1985)

2. American Upland cotton "*Hirsutum* varieties" matured much earlier than the Egyptian cotton varieties (about 120-130 days compared with 170-190 for Egyptian varieties) and could thus be cultivated after winter crops.
3. American Upland cotton "*Hirsutum* varieties" used significantly less water than Egyptian cotton. Upland cotton required five to seven irrigations, while Egyptian varieties required on an average nine irrigations.

Although the *Hirsutum* varieties seem to have certain production advantages over the Egyptian varieties, the majority of Egyptian cotton breeders were worried about the possibility of genetic contamination of the fine quality Egyptian cotton varieties by the coarse quality *Hirsutum*. As a result, the CRI terminated these trials.

Need for promotion of *Hirsutum* in Egypt?

Previous experience with *Hirsutum* was positive. If the experiments in the 1980s are good indicators, growers of *Hirsutum* in Egypt can anticipate high yields.

The introduction of *Hirsutum* cotton in Egypt would require a long commitment by CRI to maintain and constantly improve the existing varieties and develop new varieties. Should the Government commit itself to the introduction of this new species of cotton? i.e. the newly developed *Hirsutum* variety, Non-GMO and close pollinated to avoid any genetic contamination between Egyptian cotton and *Hirsutum*. Should the Government change its one cotton policy?

The strong arguments for considering to change the one cotton policy are:

First, the production of *Hirsutum* varieties in the country will assist the GOE with its goal of restructuring the domestic cotton industry.

Greater participation in the international market

As the leading agricultural subsector in Egypt, cotton provides the livelihoods of hundreds of thousands of farm families. The cotton subsector, including production, trading, ginning, spinning, textile manufacturing, oil extraction, and livestock feed manufacturing is the leading employer in the country.

The unique yarns and fabric made from Egyptian cotton are suitable for the highest quality cloth and garments. These fabrics are mainly in demand in niche markets in the USA, Europe, and the Far East. For many years, Egypt had a large market share of the international market for extra fine cotton lint and fabrics. Yet, in recent years, the market share worldwide in this category has decreased for a number of reasons **(Table 1)**. Foremost among them, a decrease in the area devoted to Egyptian cotton due to the relative profitability of competing crops in the farming system, and an increase in the share of locally grown cotton, which are utilized in the local textile manufacturing industry and GOE policy.

At the same time, the production of Egyptian cotton has declined in the last 25 years. The market for this extra fine cotton has diminished. The trend in the world and Egyptian market for cotton is towards increased utilization of shorter staple cotton. Spinning technologies have improved such that shorter staple cotton is sufficient for the production of relatively fine fabrics. In addition, the demand worldwide for fine fabrics has declined as consumer preferences have shifted towards clothes requiring denim and casual fabrics.

Government officials interviewed for this study stated repeatedly that heretofore *Hirsutum* has not been produced in Egypt because of the risk of genetic contamination of local *Barbadense*. Yet, all other major *Barbadense* producing and exporting countries grow large area of *Hirsutum* **(Table 2 & 3)**. In 2019, The United States, for example, produces more than 4.0 M Tons of *Hirsutum*. *Barbadense* accounts for only 5 percent of total US cotton production and the same holds true for India, China, Tajikistan, and other countries as well.

Moreover, trade statistics also reveal that even though a large portion of Egyptian cotton *Barbadense* is exported, and the local textile industry depends on imported medium staple cotton. **Fig. 3** illustrates the area of cotton production in Upper Egypt is diminished, it was equipped 18.9% of total area of cotton production in 2004/2005 season and reached to 7.5% in 2020/2021.

Hirsutum cotton is demanded in Egypt and around the world for the production of home textile. At present, Egypt imports large amounts of medium staple cotton and cotton yarns **Fig. 4**. **Table 4** depict the trade balance for textile in Egypt.

With proper regulations regarding cultivation of these two types of cotton, Egypt should be able to produce and profit by both types of cotton. Local production of American Upland cotton in Upper Egypt will be spun into coarse and medium yarn counts and substitute imported raw Upland cotton and yarns, while Egyptian long and extra-long staple in North Delta will be used for the production of fine yarns and fabrics for export. This will also allow the Upper Egypt farmers to grow cotton with improved production, and cater to the needs of the industries which depends on Upland cotton, reduce the dependence of the imports of the shorter staple cotton and also, allow the country to export greater amount of Egyptian cotton lint, and ensure stability to those exports. The area of Egyptian extra fine cotton production in the delta region will be maintained and focus on increasing production more than the current situation.

Conclusion: The Road ahead

1. The data currently available on *Hirsutum* cultivation in Egypt indicate a strong possibility that this species of cotton would be profitable in Upper Egypt.

Table 1 : Global Production and Share of Extra Fine Cotton

Year	Global Cotton Production (In Million tonnes)	World ELS Production (In Million Tonnes)	Share of ELS in Total Cotton, %
1981-82	14.99	0.961	6.40
1991-92	20.68	0.893	4.30
2001-02	21.67	0.769	3.50
2017-18	25.97	0.422	1.62
2019-20 (Projected)	26.75	0.41	1.54
Percentage Change in 2019-20 from 1981-82	1.78%	-0.53%	

Table 2 : World Long Staple (LS) Cotton Production (2015-21)

Country	LS Cotton Production, Tonnes					
	2015/16	**2016/17**	**2017/18**	**2018/19**	**2019/20 (P)**	**2020/21 (P)**
USA	94,275	127,369	152,407	174,000	149,000	124,000
Egypt	47,620	38,018	70,403	109,559	67,600	50,000
Sudan	450	1,000	6,000	1,000	1,000	1,000
Uzbekistan	1,000	1,000	2,000	3,000	5,000	10,000
Tajikistan	500	750	1,500	1,000	1,000	0
Turkmenistan	22,500	22,500	26,000	15,000	21,000	20,000
India	94,350	90,000	96,900	100,000	90,000	90,000
Peru	12,500	12,000	5,000	5,000	5,000	4,000
China	122,000	127,000	70,000	80,000	60,000	40,000
Israel	16,000	13,000	12,000	9,000	7,800	7,950
Spain	4,850	5,350	4,000	5,500	4,000	4,000
Total LS Cotton	416,045	437,987	446,210	503,059	411,400	350,950
**WORLD TOTAL	21,476,000	23,075,000	26,750.000	25,730,000	26,256,000	24,950,000

**Cotlook different issues, ** ICAC, Cotton Update, P- Projected*

Table 3: World LS cotton Consumption (2015-21)

Country	LS Cotton Consumption, Tonnes					
	2015/16	**2016/17**	**2017/18**	**2018/19**	**2019/20 (P)**	**2020/21 (P)**
India	145,000	155,000	155,000	195,000	160,000	175,000
China	120,000	140,000	150,000	140,000	110,000	115,000
Pakistan	35,000	36,000	38,000	37,000	32,000	35,000
Egypt	24,558	24,954	25,000	15,000	12,000	13,000
United States	5,443	6,532	6,532	5,000	3,300	4,000
Bangladesh	11,000	12,000	12,000	12,000	10,000	11,000
Latin America	13,650	9,600	12,600	13,000	15,000	16,000
Europe "Inc. Turkey"	25,800	25,300	21,500	15,000	12,000	13,000
South East Asia	16,900	19,650	26,150	21,000	17,000	18,500
Others	2,000	2,000	2,000	3,500	3,000	3,200
Total LS Cotton	399,351	431,036	448,782	456,500	374,300	403,700
**WORLD TOTAL	21,140,000	24,790,000	26,270,000	25,990,000	22,670,000	24,310,000

**Cotlook different issues, ** ICAC, Cotton Update, P- Projected*

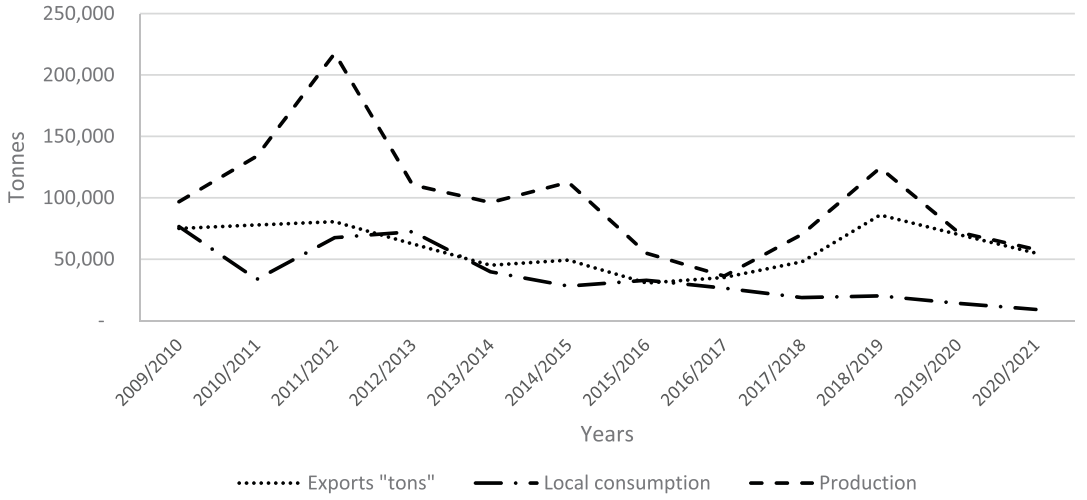

Fig. 2: Egyptian Cotton Production,Consumption and Exports in Tonnes

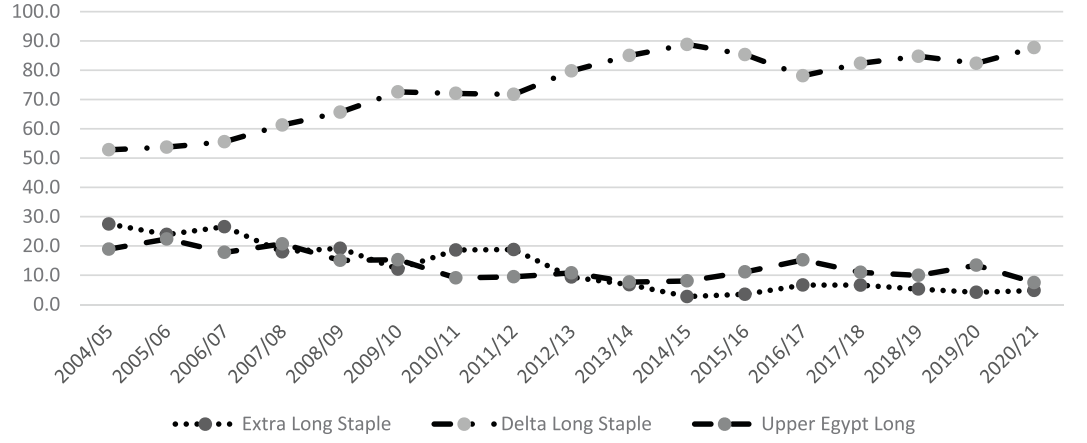

Fig. 3: Development of Egyptian ELS vs LS Area (in Percentage)

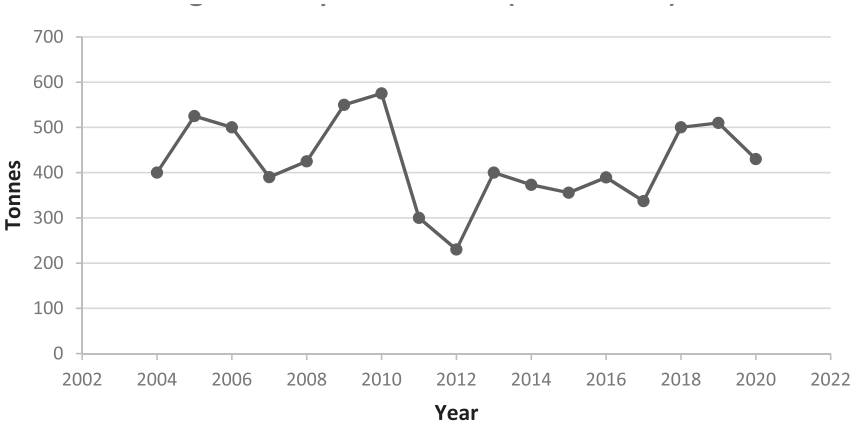

Fig. 4 : Imported cotton (‘000 Tonnes)

Table 4 : Egyptian Trade Balance of cotton products (in '000 US $)

Code	Product label	Balance in value in 2015	Balance in value in 2016	Balance in value in 2017	Balance in value in 2018	Balance in value in 2019	value in 2019	Imported value in 2019
5207	Cotton yarn put up for retail sale (excluding sewing thread)	29,252	31,633	20,723	9,094	6,658	7,492	834
5204	Cotton sewing thread, whether or not put up for retail sale	2,794	4,404	7,000	3,459	2,234	3,496	1,262
5203	Cotton, carded or combed	-3,846	1,495	153	54	261	268	7
5202	Cotton waste, incl. yarn waste and garnetted stock	1,208	-1,329	1,583	891	48	660	612
5208	Woven fabrics of cotton, containing >= 85% cotton by weight and weighing <= 200 g/m²	32,422	23,737	24,948	23,865	-1,057	36,179	37,236
5210	Woven fabrics of cotton, containing predominantly, but < 85% cotton by weight, mixed principally	-7,388	-5,769	-5,192	-7,308	-1,613	2,263	3,876
5206	Cotton yarn containing predominantly, but < 85% cotton by weight (excluding sewing thread and	-10,874	-8,712	-12,955	-10,045	-6,497	1,026	7,523
5212	Woven fabrics of cotton, containing predominantly, but < 85% cotton by weight, other than those	-21,692	-15,351	-17,507	-25,787	-23,420	3,264	26,684
5211	Woven fabrics of cotton, containing predominantly, but < 85% cotton by weight, mixed principally	-26,302	-12,814	-40,765	-35,604	-37,576	1,434	39,010
5201	Cotton, neither carded nor combed	-52,891	-75,605	-144,173	-129,759	-68,228	168,057	236,285
5209	Woven fabrics of cotton, containing >= 85% cotton by weight and weighing > 200 g/m²	-122,971	-64,467	-31,443	-147,562	-125,433	119,526	244,959
5205	Cotton yarn other than sewing thread, containing >= 85% cotton by weight (excluding that put	-35,122	-40,664	-56,061	-111,723	-163,819	127,966	291,785
Total		**215,410**	**163,442**	**253,689**	**430,425**	**418,442**	**471,631**	**890,073**

Source : (www.trademap.org)

2. Growing Upland American cotton does not mean Egypt is going to shift from Egyptian cotton to Upland cotton. The Egyptian cotton can be grown in Northern Delta in Egypt and Upland cotton can be promoted in Upper Egypt.

3. Growing non-GMO cotton and close pollinated seed is definitely recommended to avoid any changes in Ecosystem and genetic contamination with Egyptian *Barbadense* cotton.

4. In the long term, the private sector companies will designate a research station in Upper Egypt to conduct a breeding program in *Hirsutum* cotton. We thus anticipate tandem programs of research on the two species of cotton.

5. Based on the statement of Mr. Hisham Tawfik, Minister of Public Business Sector, the Cotton and Textile Industries Holding Company have initiated a process to develop such research plan.

This is a significant departure from the past. This program, at least in the initial stages, will be directed towards the production of cotton by large investors. In 2020, the first trial would be held in 100 hectares with fully mechanized cultivation from seedling to harvesting, with closed pollinated seed to avoid any genetic contamination.

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Cotton Facts: Yield (ICAC, 2003)

Plant Taxonomy

- Cotton is a member of the order *Malvales*, family *Malvaceae*. This makes it a relative of such familiar garden plants as the mallow and Rose of Sharon. *Gossypium* plants are small trees, shrubs or sub-shrubs that grow in tropical and subtropical regions of Africa, Asia, Australia and America. The genus *Gossypium*consists of 50 wild and cultivated species. Forty-five of the species are diploid, having a 2n chromosome number equal to 26.

- At least eight diploid genomes, designated A, B, C, D, E, F, G and K, are found in the genus *Gossypium*. The A genome is restricted to two species, *Gossypium arboreum*, and *G. herbaceum*of the Old World. The D genome consists of 14 currently recognized species of the New World, such as *G. thurberi* and *G. rai- mondii.* Interspecific (among species) hybridization within diploids and tetraploids has not produced any useful varieties.

- Only four species of *Gossypium*are grown on a commercial scale in the world. Also known as cultivated species, they are *G. hirsutum L.*, *G. barbadense L.*, which are called New World species; and *G. arboreum L.* and *G. herbaceum L.*, which are called Old World or Asiatic cottons. *G. arboreum* originated in the Indo-Pak sub continent. *G. herbaceum* originated in southern Africa. *G. barbadense* originated in Peru. *G. hirsutum* originated in Mexico. The origin of these four species, cultivated in four different areas of the world so far apart, indicates that they were domesticated independently of each other. *G. barbadense* is the most photoperiodic (sensitive to day length) species among the four cultivated species, which limits its cultivation to only a few countries.

- The most commonly cultivated species of cotton in the world is *G. hirsutum L*. This and *G. barbadense* are the most important agricultural cottons. Both are allotetraploids (AADD genomes) of New World origin, and presumably result from an ancient cross between an Old World A genome and a New World D genome. Euploids (exact multiplication of haploid chromosome number) of these plants have 52 somatic chromosomes, and are frequently designated as AADD. Three additional New World allotetraploids occur in the genus, including *G. tormentosum*from Hawaii, *G. mustelinum*from northeast Brazil and *G. darwinii* from the Galapagos Islands.