LATEST ACHIEVEMENTS OF ANGORA RABBIT WOOL PRODUCTION IN CHINA

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GENERAL CONDITIONS OF ANGORA RABBIT WOOL PRODUCTION IN CHINA

Brief conditions of rabbit wool export

The raising of Angora rabbit was started in 1926 and has a history of 70 years in China. Before liberation, some woollen mills made trial spinning of yarns with rabbit wool in Shanghai, but no batch production was formed, not to speak a record of rabbit wool export. The breeding of Angora rabbits in China has been developing along with the growing export of rabbit wool.

China started export its rabbit wool into the international market since 1954. During the 43 years since then, our rabbit wool production has been constantly increasing and growing. The export amount was extremely small when we first export our rabbit wool into the world market in 1954. But since 1959 when we surpassed all the other countries, our export amount has been at the first place in the world.

Table 1 : Export Amount of Rabbit Wool During Different Periods from China

Year	Annual average export amount (t)
1956-1960	200
1961-1965	439
1966-1970	727
1971-1975	1380
1976-1980	2580
1981-1985	5514
1986-1990	6964
1991-1994	7541

The years with the largest amount are 1988 (9733 tons) and 1994 (10677 tons). For these successive five-year periods, the export amount has been increasing all the way, but there were valleys during the five-year periods, and five low valleys have been experienced, two in the 1960s, one in 1970s and two in 1980s, as affected by the periodic economic crises on the international market. For example, the export amount from China was reduced to 300 tons in 1974, to 3405 tons in 1982 and to 4450 tons in 1985, but the last two figures were still higher than that of any year in the 1970s.

China has superior conditions for developing rabbit breeding with its rich grassland and abundant surplus labour. Therefore, the breeding volume of Angora rabbits has been increasing year by year all through the 1980s and 1990s.

Table 2 : Production of Rabbit Wool

Unit : 1000 rabbits, ton

	Breeding volume	Wool production
1990	24294	7151.64
1991	28180	8922
1992	47103	16409
1993	49100	17000

The production of rabbit wool of China ranks the first in the world, and 90 % of the trading volume of rabbit wool in the world market comes from the rabbit wool from China. Our main markets are in Japan, the former USSR, USA , Germany, Canada , France , Switzerland, UK, Australia, Hong Kong, Korea, etc.

The export of semi-finished product of rabbit wool yarn and finished product of rabbit wool sweaters also has a history of over 20 years in China. The rabbit wool textile industry started in China in the 1970s, and rabbit wool textile mills were set up like bamboo shoots after a spring rain in the 1980s. The rabbit wool-cotton fabric was initially made in Zhejiang, followed by the rabbit wool-acrylic fibre products in Shanghai and then the rabbit and sheep wool products. The high proportion rabbit sheep wool yarn was spinned in Zhenhua and Hongguang Wool Textile Mills in Wujiang, and melton and woolenet with rabbit wool was produced in Qidong Wool Textile Mill of Jiangsu Province. These have greatly broadened the market for rabbit wool products. At present, 30 % of the rabbit wool produced in China goes to the domestic textile mills.

Brief history of breeding Angora rabbits in China

The breeding of long wool rabbit in batches started in the 1920s in China with a long history. Since 1950s the white rabbit wool was exported to the international market, but at very small amount, being less than one ton per year. At that time the Britain and France strain Angora rabbits were introduced into China. The average wool yield of these rabbits was 350-400g, with the main breeding area in Wuxi, Yixing and Suzhou of Jiangsu, Jiaxing and Huzhou of Zhejiang and the suburb counties of Shanghai. At the end of 1950s and the beginning of 1960s, these two strains of Angora rabbits were mixed with the blood of the white rabbits of China, resulting in a China strain Angora rabbit, the so-called "fully haired ear and lion head" rabbit, with distinctively different appearance and production characters from the Britain and France strains. It features pure white, long, thin and soft wool all over the body. Its head is broad and short with medium length ears, which are covered by dense, long and thin down fibres flying over the ears, its forehead hair is very dense, down to the nose, with heavy hair on both sides. You cannot see its eyes from the side, and the whole head looks like a downy ball, hence the name " fully haired ear and lion head". Dense, long and thin down fibres cover all its legs and grow between the toes and at the bottom of the feet. Therefore it has hair on head, ears, back, belly and feet. This rabbit can be fed with coarse forage, with good adaptability and high reproduction, but is small in size, at an average of 2.5-3kg in weight, and 400 000g wool per year. The wool density is low without comose structure.

With the export of rabbit wool from China into the international market, the export amount increased significantly, and the breeding of Angora rabbits gradually expanded to Shandong, Henan, Anhui, Guangdong, Hunan, Fujian, Jiangxi and Sichuan, and over the whole country, with East China as the main bases of breeding. Starting from 1978, several batches of German strain Angora rabbits were introduced into China, most being in good quality and with high wool yield. Over the years, domestication, selection-breeding and improvement of these rabbits have been carried out in the scientific research institutes and in specialized rabbit breeding farms, so that they can settle down and reproduce in large numbers in China to bring their production characters into full play. On the other hand, mass selection, mass breeding has been carried out, rabbit competition fairs were held to appraise the various production performance of the Angora rabbits, site exams were conducted to select those for gold, silver and bronze awards, and activities to create world record were carried out. All these have promoted the constant improvement of Angora rabbit quality in China. For example, the Zhenhai Breed Rabbit Farm, the first class I rabbit farm in Zhejiang, has been developed into a first scale one since its setting up in 1988. In the first "Setting World Record Cup" competition sponsored by Hangzhou Rabbit Breeding Center and supervised by the National Rabbit Breeding Committee in 1991, the group wool yield of 300 male and female rabbits exceeded the world record with an annual wool yield of 1500g per rabbit, with the maximum above 2000g. Meanwhile, the annual wool yield of Angora rabbits in the breed rabbit farms of the Jiangsu Academy of Agricultural Sciences, at Wujin and Jinling of Jiangsu Province, Huaxing and Xinchang of Zhejiang Province, the Anhui Academy of Agricultural Sciences and at Guzhen of Anhui Province was higher than 1000g. This has contributed much to the raising of high yield and high quality German Strain Angora rabbits, to the improvement of the long wool rabbits in China and to increasing the body size and wool yield of Angora rabbits. At present, over 60% of the Angora rabbits in China are of improved ones, with an average wool yield of about 800g.

BREEDING NEW VARIETIES OF BRISTLE TYPE LONG WOOL CHINESE RABBITS

Since the mid 1980s, rabbit wool with a bristle rate of over 15 % has been in short supply, with a price normally 40 % higher than the ordinary rabbit wool. However, there is no variety of bristle long wool rabbits with high bristle rate (over 15 %) and at the same time in high wool yield (over 800g) in the world. The French Angora rabbits are the only one with high bristle rate in the world, but its bristle rate is only 12 %-15 % with the wool shearing technique when they are raised in China, and at relatively low wool yield, being about 600g. This breed of rabbits are in small number in France and the export has been stopped for preservation. The German strain rabbits have the highest wool yield in the world today, but their bristle rate is only about 5 %.

China is a major rabbit wool producer with its export amoung accounting for over 90% of the world trade volume, and the annual foreign exchange income from export of rabbit wool is over 200 million US dollars. To maintain the superiority of our rabbit wool in the international market and to meet the needs of rabbit wool textile industry both at home and aboard, the breeding of new varieties of bristle long wool rabbits was listed as a major project by the Ministry of Agriculture of PRC during 1991-1995. The project was jointly conducted by the academies of agricultural sciences of Jiangsu, Zhejiang and Anhui Provinces by multi-variety (strain)

crossing, index selection breeding, stage-selection breeding and so on, for breeding the new varieties of bristle long wool rabbits of China strain. Now we have got new varieties with respective features, briefly referred to as Su strain, Zhe strain and Wan III strain.

Index for selection breeding

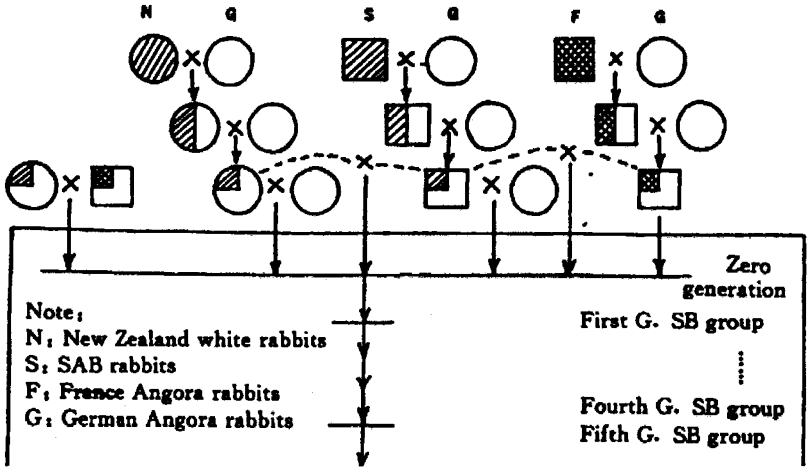
Grade I bristle long wool rabbits : bristle rate over 15 % at 12 month, annual wool yield over 800g and adult female rabbit weight over 4kg.
Grade II bristle long wool rabbits : bristle rate over 12% at 12 month, annual wool yield over 750g and adult female rabbit weight over 3.75kg.
A core group of 1800 breed rabbits was set up, 6000 female rabbits reproduced with a production group of 20 000 rabbits. In five years, 400 000 rabbits were reproduced.

Selection breeding and results

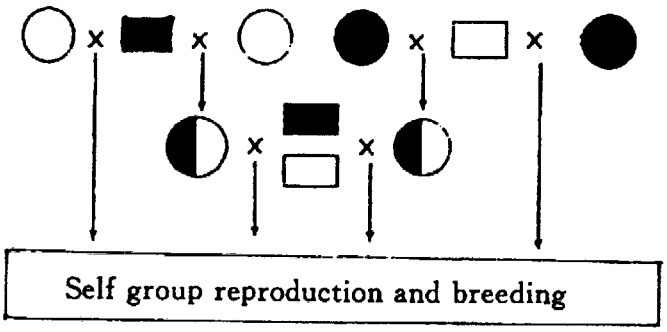
Selection breeding -

(1) Research in the Animal Husbandry and Veterinary Research Institute of Jiangsu Provincial Academy of Agricultural Sciences :
The blood of French Angora rabbits (F), New Zealand rabbits (N) and SAB rabbits were introduced into the German rabbit (G) and cross breeding were carried out between different strains and varieties (see Figure 1), for example the second generation of NGG, FGG and SABGG. Some individuals with high production performance were selected on purpose for inter-group crossing, and over 1200 breed rabbits of mixed group of bristle type of the third generation were produced. From these 250 individuals which are relatively ideal were selected at a M:F ratio of 1 : 10 and with an average bristle rate of 15.87±8.29 %, annual wool yield 744g and adult body weight at 11 months 4455g. They were used as the zero generation for across crossing stabilization, to purify and integrate the good characters for successive generation breeding. A total of five generations were breeded from 1990 to 1995.

Figure 1 : Schematic of crossing combination



(2) Research in the Animal Husbandry and Veterinary Research Institute of Zhejiang Provincial Academy of Agricultural Sciences :
Inter-strain crossing was done between French and German Angora rabbits. The first hybrid generation was obtained from forward and reverse crossing, and the second hybrid generation obtained by back crossing of the male rabbits of the two strains. Ideal individuals were selected from the hybrid first and second generations, and the identical character selection crossing method was adopted for across selection breeding for successive generations to gradually consolidate the ideal characters for completing the crossing period. Then generation selection breeding was done for five generations.



(3) Research in the Animal Husbandry and Veterinary Research Institute of Anhui Provincial Academy of Agricultural Science :

The work was started in 1982 when the blood of New Zealand meat rabbits was introduced into the German rabbits for inter-strain crossing breeding. By 1987 the Wan I strain was obtained (thin wool type). The Wan II strain coarse wool rabbits were selection breeded from the individuals with high bristle rate selected during the breeding of Wan I strain long wool rabbits as the zero generation, with selection index used for the basic group and early selection and crossing at five months. The Wan III strain was breeded on the basis of Wan II strain as the zero generation, with improved comprehensive index method and with the individual features at five and eight months as the main, by strengthening the selection breeding and crossing, after five generations.

Results of selection breeding -

(1) Reproduction performance

It can be seen from the Table 3 that after five generations of selection breeding, the Su, Zhe and Wan III strains of bristle rabbits are basically stabilized in reproduction performance, which is approaching or better than that of the zero generation in all reproduction indices.

Table 3 : Reproduction Performance Determination Results for Su, Zhe and Wan III Strains

Unit : g

Strain	Generation	No. of litters	Total litter size	Survival number born	Initial litter weight	Litter weight at 21 day	Weaning litter size	Individual weight at weaning
	0	236	8.10 ± 2.75	7.77 ± 2.85	411.4 ± 142.2	2280 ± 1335	4.98 ± 2.32	1027 ± 144
Su	One	269	7.24 ± 2.40	6.89 ± 2.34	356.0 ± 118.2	1915 ± 578	4.69 ± 1.69	1074 ± 144
	Five	100	7.14 ± 2.54	6.76 ± 2.53	350.5 ± 150.9	2775 ± 1283	5.71 ± 2.48	1030 ± 155
	0	207	.....	6.23	315.4	1326	3.93	1137
Zhe	One	130	6.56	6.02	333.5	2002	4.57	1137
	Five	218	6.77	6.28	341.0	1878	4.39	1115
	0	40	6.88 ± 1.93	6.62 ± 1.71	336.6 ± 79.7	2093 ± 489	.....	.....
Wan	One	108	7.22 ± 1.66	6.57 ± 1.40	340.4 ± 63.5	2038 ± 414	5.56 ± 1.11	848
III	Five	130	7.06 ± 1.57	6.62 ± 1.71	349.1 ± 59.5	2168 ± 363	5.65 ± 1.03	867

(2) Growing

It can be seen from the Table 4 that after five generations of selection breeding, the Su, Zhe and Wan III strains of new bristle rabbits have increased in body weight.

Table 4 : Growing Determination Results for Su, Zhe and Wan III Strains

Unit : g

Strain	Genera-tion	No. of rabbits	3 months	4 months	5 months	6 months	7 months	8 months	11 months
	0	250	2100 ± 280	2340 ± 245	2860 ± 305	3350 ± 395	3890 ± 275	4250 ± 430	4455 ± 430
Su	One	250	2320 ± 245	2745 ± 240	3170 ± 340	3425 ± 310	3620 ± 310	3875 ±410	4410 ± 430
	Five	283	2115 ± 255	2610 ± 240	2965 ± 285	3425 ± 300	3985 ± 293	4290 ± 272	4505 ± 550
	0	120				3060 ± 316		3443 ± 351 *	
Zhe	One	114				3049 ± 201		3309 ± 266 *	
	Five	258				3601 ± 353		3626 ± 299 *	4023
	0	122			3221 ± 116			3734 ± 109	3912 ± 113
Wan	One	78			3259 ± 274			3725 ± 263	3962 ± 244
III	Five	114			3380 ± 310			3906 ± 320	4117 ± 293

* indicates body weight at 8. 5 months.

Su Strain : The body weight of the fifth generation at 4, 5, 6, 7, 8 and 11 months is respectively 0.71%, 11.54 %, 3.67 %, 2.24 %, 2.44 % and 0.94 % higher than that of the zero generation, and is about 4505g at 11 months.

Zhe Strain : The average body weight of the fifth generation group breeding rabbits at 6 and 8.5 months is respectively 3601g and 3626g, 18.10 % and 9.58 % higher than the first generation and 17.68% and 5.32 % higher than the zero generation, all with showing great differences ($P< 0.01$).

Wan III Strain : The body weight at 5,8 and 11 months is respectively 3380g, 3906g and 4117g, respectively 4.30 %, 4.62 % and 5.25 % higher than that of the zero generation.

(3) Bristle rate and wool yield

Table 5 : Wool Quality Analysis and Wool

Strain	Generation	No. of rabbits	Bristle rate	Annual wool yield	Down fibre size	bristle size	Down fibre strengh	Down fibre elongation
	0	248	15.87 ± 8.29	744	13.66	46.09	...	...
Su	One	222	13.84 ± 7.14	799	12.84	39.21	2.67	45.04
	Five	41	15.71 ± 3.39	898	14.20	41.16	...	...
	0	120	17.09 ± 9.08	733	...	...	...	...
Zhe	One	114	15.33 ± 5.40	702	...	...	...	...
	Five	258	15.94 ± 4.74	959	...	...	...	...
	0	122	13.69 ± 1.18	826	14.91	44.16	4.23	45.67
Wan	One	78	12.52 ± 1.79	904	14.98	41.25	4.03	44.18
III	Five	114	15.14 ± 1.66	1012	14.86	45.12	4.23	44.97

Su Strain: The bristle rate is lowered by 12.79% from the zero generation to the first generation ($P>0.05$), and that of the fifth generation at 11 months is 15.71%, 1.01% lower than that of the zero and first generation respectively ($P>0.05$). The wool yield of the fifth generation is 898g, 20.70 % higher than that of the zero generation ($P< 0.01$), showing extremely great difference.

The average bristle rate of the fifth generation bristle rabbits at 11 months is 15.71%, and the bristle rate of the female rabbits after 1-2 litters is 17.72 %. The adult rabbits have a body weight of 4505g and an annual wool yield of 898g.

Zhe Strain : After successive generation of selection breeding, the wool yield of bristle rabbits has been increasing year by year, and is 959g with the bred new strain, 30.83% higher than that of the zero generation which is 733g ($P<0.01$). The bristle rate is 15.94 % by average, 6.73 % lower than that of the zero generation which is 17.09 %.

Wan III Strain: After selection breeding for five generations, the bristle rate at 11 months is 15.14%, increased by 10. 59% over the zero generation, the annual wool yield is 1012g, increased by 22. 52% over the zero generation, the body weight of adult rabbits at 11 months is 4117.41g, increased by 5.25% over the zero generation, and the bristle rate of female rabbits after 1-2 litters is 17.58%.

(4) Wool quality analysis

In order to select and breed new strains of bristle type long wool rabbits with high wool yield, high bristle rate and good wool quality, determination of wool quality was carried out in all three provinces during different selection breeding period, i.e. at 2, 5, 8, 11 months and for the reproducing rabbits at one year old. From the fifth month, the bristle content and wool yield increase along with the age. Although at 2 months the bristle rate is higher than that at 5 months, it features high awns content of 41.28%, while this awns content is only 10.27 %, 25 %, 25.31% and 16.63 % at 5, 8, 11 and 12 months.

The three new strains of bristle type long wool rabbits respectively selected and bred by Jiangsu, Zhejiang and Anhui Provinces have an average bristle rate of 15.60 %, annual wool yield of 950g, down fibre size 14.35μ and bristle size 42.43μ, with strength and elongation both satisfying the spinning technical requirements.

(5) Estimation of main character heritability for bristle rabbits

After 8 years of selection breeding, the heritable characters of the new strains of bristle long wool rabbits have become basically stable. The estimation is done with half-sib group correlation coefficient method and the t examination method is used for the test of significance. The bristle rate and wool yield heritability is respectively 0.134 and 0.295, 0.1312 and 0.2648, and 0.2124 and 0.3296 for Su, Zhe and Wan Strains. The heritability of bristle rate is low while that of wool yield is

medium. Reproduction performance : the heritability of initial individual weight, litter weight at 21 days and individual weaning weight for Su Strain is respectively 0.117, 0.233 and 0.161, and the heritability of litter size, milkability and weaning litter size is respectively 0.1564, 0.1343 and 0.1447, all being low heritability, and complying with the law of low character heritability for domestic animals. No significant difference is detected by the t examination. The correlation coefficient between bristle rate and wool yield is 0.131, being direct correlation.

Popularization and application

In recent years, experiment bases have been established by carrying out selection breeding while popularizing at the same time to expand the groups of bristle long wool rabbits. Artificial insemination and semen refrigeration technique are also adopted to speed up the reproduction and improvement of the bristle rabbits. Training sessions on rabbit breeding have been held to popularize the technique of raising bristle rabbits. At present the new strains bristle rabbits have been spread to over 100 cities and counties in 10 provinces and municipalities over the country, with a total of 116 000 breed rabbits and 4 279 000 improved bristle rabbits, and 2276.8 tons of bristle rabbit wool has been exported.

Conclusions

(1) There are now 1817 rabbits as the core group with an average bristle rate of 15.60%, annual wool yield 956g and adult (11 months) body weight 4215g, over 6000 rabbits as the reproduction group and over 100 000 rabbits as the production group.

(2) While the production performance of the bristle rabbits bred by the three provinces are basically identical, the different strains have their respective own features. For example, the Su Strain has a large body size, the Zhe Strain has higher wool yield and the Wan III Strain features identical body form and appearance with little difference.

(3) After successive selection breeding, the various characters of the bristle long wool rabbits of the three strains, including the reproduction performance, growing power, wool yield and bristle rate, have become basically stabilized.