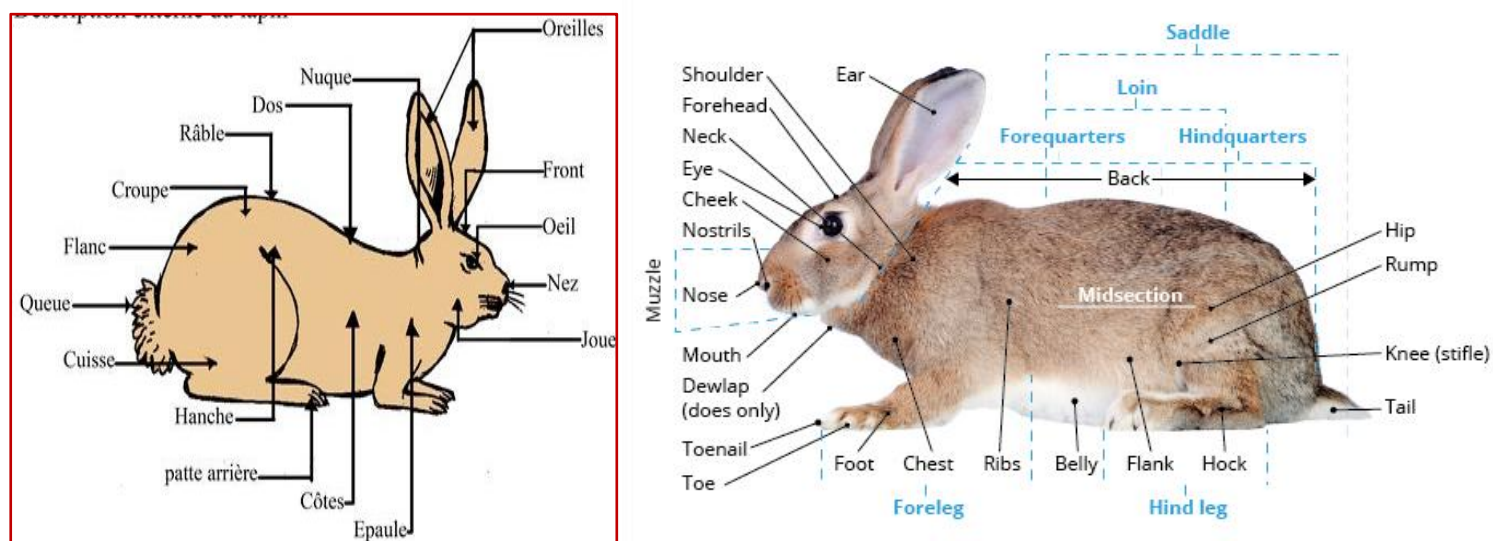


CHAPTER 6- EHNOLGY OF RABBIT

Rabbit (*Oryctolagus cuniculus* ; 2n= 44 Chromosomes)

The rabbit is a mammal with crepuscular and nocturnal habits. In the wild, before giving birth, it builds burrows and makes its nest with its fur. It is a calm and docile animal that likes to be treated very gently. The characteristics of the domestic rabbit are presented as shown in Figure 1.



Translation: Oreilles :Ears; Front :Forehead; Œil: Eye; Nez:Nouse ; Joue:Jaw ; Epaule:Shoulder; Côtes:Rips; Patte arrière: Hind leg; Hanche:Hip; Cuisse:Thigh; Queue: Tail; Flanc: Flank; Croupe: Rump;Râble: Saddle ; Dos: Back; Nuque: Neck

Figure 1 : Description of the exterior of the rabbit (Wirecrafted.com : on the right; FAO, 2018; © ADADJA Constantin on the left)

1. ORIGIN, DOMESTICATION AND EVOLUTION

Rabbit (*Oryctolagus cuniculus*), one of the 29 species of long-eared mammals belonging to the family Leporidae, excluding hares (genus *Lepus*) (Andrew Smith, 2024), is the only domesticated mammal whose paleontological origin is in Western Europe. The oldest fossil remains of the genus are dated to about 6 million years ago and were found in Andalusia (Labes, 2024). Spain means "land of rabbits" in Phoenician, tamed and spread throughout Europe first by the Romans, then domesticated in the Middle Ages by monks in order to eat its meat during fast .was brought to Africa by missionaries and colonists in the 19th or 20th century depending on the country (Meyer, 2024).

2. CLASSIFICATION

Table number 1 represents the classification of the rabbit in the animal world

Table 1: Taxonomy of the rabbit (Linnaeus, 1758)

Kingdom	Animalia
Phylum	Chordata
Sub-Phylum	Vertebrata
Class	Mammalia
Sub- class	Placentalia
Order	Lagomorpha
family	Leopiridae
Genus	<i>Oryctolagus</i>
Soecies	<i>cuniculus</i>
<p><u>Physiological Parameters</u></p> <p>2n=44 CHROMOSOMES Rectal Temperature TR : 39,5°C Heart Rate HR : 120-150= Beats/Mn. Respiratory Frequency FR :50-60 Mvmt/Mn</p> <p>Type of ovulation: Induced ovulation; Type of estrous cycle: Continuous estrous cycle; Gestation duration: Gestation: 1 month (Villemin, 1984)</p>	

Here are the different genera of the order Lagomorpha:



Oryctolagus (*Oryctolagus cuniculus*)

Sylvilagus (*Sylvilagus floridanus*)



Lepus (*Lepus europaeus*)

Ochotona (*Ochotona princeps*)

Figure 2 : Order of Lagomorpha (Lebas, 2008)

3. EXTERIOR AND PHANEROPTIC VARIATIONS

3.1. COAT AND COLOR OF THE FUR

3.1.1. According to the variation in the nature of the hair, three categories are distinguished:

- **Ordinary breeds** are characterized by the presence of **down hairs** (about 2 cm) and **jar hairs**, which are significantly less numerous but thicker and longer (3-4 cm). Jar hairs are also sometimes called "guard hairs".

Examples: The Russian, Burgundy Fawn, New Zealand, The Flemish Giant



Figure 3 : Russian rabbit breed (Anonymel, Meyer, 2024 cirad)

Short-haired breeds are breeds where undercoat and guard hairs are the same length (2 cm), giving the fur a velvety appearance.

Examples: Rex breed

"Wool" breeds

These are rabbits that provide hair **5 to 6 cm** long. Due to the thickness of this coat at the end of growth (before molting), rabbits of this type tolerate heat very poorly.

Example: Angora Rabbit

3.1.2. According to the variation in fur color

There is a very wide range of rabbit fur colors and distribution of colors

Agouti sauvage	Agouti bicolore	Agouti harlequin	Pigment extrêmes	Unicolore	argenté	Panaché plaqué	Panaché tacheté
							
Lapin de garenne	Feu noir	Japonais	Chamois de Thuringe	Alaska	Argenté de Champagne	Hollandais noir	Petit Papillon Rhénan
							
Normand	Nain Noir et Blanc	Rhoen	Russe (ou Petit Russe)	Bleu de Vienne	Petit Argenté Noir	Hollandais Madagascar	Géant Papillon



Black



Castor



Blue



Chinchilla



Opal



Tortoise



Chocolate



Lynx



Seal



White



Lilac



Red



Himalayan



Broken



Blue Eyed White



Otter



Sable Point

Ring Colors



Castor



Chinchilla



Lynx



Opal

Figure 4 : Different types of color distribution in the Rabbit (Below: nmrrc.com; Above: FAO, 2018).

3.2. EARS

Depending on the size and shape of their ears, rabbits are classified as follows:

3.2.1. Lop-eared (with drooping ears) breeds

Examples: Lop rabbits



Figure 5 : (Planèteanimal.com on the left; FAO, 2018 on the right)

3.2.2. Upright-ear breeds

Examples: New Zealand Rabbit breed, Colored Dwarf Rabbits



Figure 6 : New Zealand Rabbit breed (FAO,2018)

3.3. SHAPE AND SIZE

3.3.1. Hypermorphic, Heavy Breeds

The adult weight **exceeds 5 kg**, rapid growth.

Examples: the French Lop, the White Giant of Bouscat, the French Butterfly Giant, the Spanish Giant, and the largest of all, the Flemish Giant (7 to 8 kg).

3.3.2. Medium breeds, Eumetric

Adult weight varies from **3.5 to 4.5 kg**.

Examples: Champagne Silver, Burgundy Fawn (characteristics of its fur) Burgundy Fawn (France), Californian (3.6 to 4 kg), New Zealand White (4 kg), Large Chinchilla (4.5 kg).

3.3.3. Hypometric breeds (light and dwarf)

- **Light breeds** are breeds whose adult weight is between **2.5 and 3 kg**.

Examples: Russian, Small Chinchilla, Dutch, English Butterfly...

- **Dwarf breeds** have adult weights around 1 kg.

Example: Polish rabbit

3.4. ENERGETIC

3.4.1. PROLIFICACY

By definition; Prolificacy at birth is the number of kits from each parturition (live-born and stillborn). This parameter is essential for determining profitability of a breeding or a female rabbit. Prolificacy results from a balance between the following components: the number of eggs released and the viability of blastocysts and embryos until birth, which evolve independently.

The female rabbit produces between **3 and 14 baby rabbit (kittens) per litter** with extremes ranging from **1 to 20 baby rabbit (kittens)** depending on the size of the female rabbit; small and light breeds are generally less prolific than medium or large breeds. Prolificacy reaches a plateau during the female's third and fourth litter and only decreases later. This parameter is calculated at birth and at weaning. Weaning prolificacy is useful to evaluate the numerical productivity of the female (number of weaned kittens per reproductive female and per unit of time).

The prolificacy of the local Algerian population at birth is **6.37 baby rabbit (kittens) per litter** (Kindling); despite this, it only weans **4.66 kittens per litter** (Kindling) due to mortalities that occurred under the mother ((Hulot and Matheron, 1982; Gianinetti, 1984; Roustan, 1992; Fortun-Lamothe and Bolet, 1995; Lakabi, 1999 cited by Bouguerra, 2012).

Table 2: Prolificacy at birth and weaning of improved breed does and local populations (cited by Bouguerra, 2012)).

Authors	Strain,	post-natal Prolificacy			
		Number of Litters	Total born	Live born	Weaned
Hulot and Matheron (1981)	Californian	127	8,76	8,05	6,95
	Neo-Zealand	115	7,35	6,95	5,99
Kennou and Lebas (1990)	Local Population(Tunisia)	92	6,17	-	-
Berchiche v Zerrouki (2000)	local Population (Algerai)	176	7,64	5,59	4,00
Remas (2001)	local Population (Algeria)	64	7,40	6,40	3,92
Gacem et al. (2009)	local Population (Algeria)	980	6,75	6,23	5,40
	Synthetic Strain (SS) Itelv		9,50	8,74	7,08
	White Population		7,42	6,84	6,09

3.4.2. MEAT

Rabbits marketed for meat belong to a breed, but most often to populations of animals that resemble this or that breed without meeting the origin or breed standard criteria, or do not resemble any breed. These are the so-called "common" rabbits: Gray, Spotted, or White, resulting from unplanned crossings (farm breeding) or belonging to local populations.

Examples: New Zealand White breed, Baladi breed (indigenous or local to Egypt, Maltese of Tunisia, the Creole rabbit of Guadeloupe, (Lebas, 2008). The rabbit is characterized by very moderate energy contributions (about 170 kcal/100 g). It provides 20.5% protein per 100 g of meat, of good nutritional quality: an important animal protein source in human nutrition (FAO, 2007 cited by Zerrouki, 2014).

3. / STANDARD CRITERIA

4.1. GEOGRAPHICAL DISTRIBUTION

For the distribution of the rabbit population around the world, Table 3 represents the latter

Table 03: Evolution of the rabbit population in the world (2011-2017) (FAO2017 cited by Bezaou, 2019).

	2011	2012	2013	2014	2015	2016	2017
Africa	15553	15076	15684	14559	18181	17511	17124
Asia	252901	255024	255813	256107	249276	250378	263082
America	5624	5664	5721	5638	5769	5590	5699
Europe	22921	23469	23414	23256	23361	23199	23039

4.2. PERFORMANCE AND USE

The rabbit can be raised for 3 main types of production: meat, fur or hair, as a pet (Lakabi – Ioualitene, 2007), in addition to the benefit of their droppings (FAO, 2018).

4.2.1. MEAT

The rabbit produces a valued meat, which is sold at the age of **3 to 4 months**, that is 35 days from birth to weaning with an average weight of **500g**, then **60 to 90** days of fattening.

The weight at sale: **1.8 to 2.5 kg** live on average. The number of rabbits sold per female per year: 25 to 35. (FAO, 2018).

In Algeria, the adult weight of the local population is estimated on average at **2.8 kg**, which is reached around the age of **18 weeks (4,5 months)**. The growth rate of these animals is modest: **ADG** (average daily gain) about **28 g/day** compared to that of the hybrid animals used in European farms (**ADG up to 50 g/day**).

Today, animals are generally slaughtered at the age of **11 or 12 weeks** while the live weight of the animals is modest (< **1.8 kg**) (Lakabi –Ioualitene, 2007).

Another study (Bouguerra, 2012) mentions these parameters: Average Daily Consumption (ADC), growth rate (ADG), and average final live weight are respectively **77.61 g/day**, **24.38 g/day**, and 1675.66 g. At slaughter, the commercial carcass weight is average (1029.56 g).

4.2.2. FUR AND HAIR

Some rabbit breeds are marketed for the quality of their skin, whether for their hair or for their fur:

- **Hair.** What characterizes these breeds the most is their abundant coat.

Example: Angora Breed (Turkish origin)

- **Fur.**

Example: Rex Breed. The white color is sought after, and the fur must be very uniform, with a velvet-like appearance. Many varieties are distinguished: Rex-brown or Castorrex (intense brown), Rex-chinchilla (bright ash-gray), Rex-otter (jet black), Rex-chamois (ochre yellow), Rex-gold (orange-yellow), Rex-lynx (strong pink-beige), Rex-sable (brown with darker extremities), Rex-blue sable (blue with dark brown-black extremities), Rex-Dalmatian (white with many spots), Rex-white with pink eyes or blue eyes, Rex-blue (Beveren shade), Rex-blue (Vienna shade), Rex-black (intense black), Rex-Havana (color of a dark Havana cigar), Rex-pearl gray (uniform pearl gray) (Meyer, 2024; cirad)



Figure 7 : Rex breed from the left o the right : Blue zibeline, mini Castorrex, tricolor Rex (Meyer, 2024; CIRAD)

4.2.3. PET BREEDS

Certain rabbit species, given certain criteria and physiognomic characteristics (colors, fur, size...) occupy a place as human companions.

Examples: Chinchilla breed, Polish rabbit breed, Colored dwarf rabbit, etc.

4.2.4. DROPPINGS (EXCREMENTS)

They are used as fertilizer or to feed fish. (Meyer, 2024). The production of droppings, consisting of hard feces and urine, must be periodically removed but can be used as fertilizer: on average **10 kg per rabbit produced per year** (FAO, 2018).

5. BREEDS IN THE

5.1. LARGE FORMAT RABBITS (GIANTS SIZE)

5.1.1. Flemish giant rabbit

- **Origin**

Originating from Flanders, belgian province.

- **Characteristics**

Large animal, long and wide. The weight varies from **5 to 7 kg** for males and from **6 to 9 kg** for females. The short and smooth coat is hare gray (Anonymous1; Meyer, 2024). They are also gray, black, blue, fawn, or white on top. Ears are wide and erect (Meyer, 2024; Cirad).

- **Performance (Abilities)**

Used in **crossbreeding**, the Flemish Giant improves the growth of breeds with finer meat (Anonymous1). The **meat is not highly valued**. It is mainly used in crossbreeding to increase the weight of other breeds (Meyer, 2024; Cirad).



Figure 8. Flemish giant rabbit(FAO,2018 ; à gauche ; Anonyme 1 à droite)

5.1.2. French lop rabbit

- **Origin**

From France

- **Characteristics**

Giant breed with **lop ears** and **short fur**, very hardy, having a big appetite but slow to mature and not very prolific. Ideal weight: **5.5 kg**. The **ears**, which can reach **45 cm**, are **drooping**. All colors are allowed.



Figure 9 : French Lop rabbit (Meyer, 2024 ; cirad)

5.2. Medium Format (Size)

5.2.1. NEW ZEALAND RABBIT

- **Origin**

Breed originating from the united states, commonly raised there. It is the ideal type of meat rabbit.



Figure10 : Neozealand breed (Meyer, 2024 ; cirad on teh left & in the middle ; Anonyme on the right)

- **Characteristics**

Weight 4.5-5.5 kg. With a good butcher's conformation, it is an ideal meat producer. It is prolific but fragile. Breed of domestic rabbits with short white hair (albinos). The ears are erect. (Meyer, 2024). The neck is strong and short, the ears short, the legs short. The New Zealand has white skin and white hair, but there are varieties with black or red skin (Anonymous).

- **Performance (Abilities)**

Growth is rapid. Its feed conversion ratio is **3 to 3.5**. At less than **10 weeks**, a New Zealand rabbit yields a carcass of **1,200 to 1,500 g**. Its yield is advantageous: **62 to 64%**. The mothers are prolific with about 8 to 10 kits per litter (Anonymous1).

Table 4 Weight of New Zealand rabbits according to age (Anonymous1)

Average weight in kilgrammes depending on age		
Age	Males	Females
2 months	2.1	1.8 – 2.1
3 months	2.5	2.2 – 2.5
4 months	3.2	2.7 – 3.2
5 months	3.8	3.6 – 3.8
6 months	4.1	4.5
7 months	4.5	5.5

5.2.2. Californian rabbit

- **Origin**

This breed of rabbit is created in California (USA) (Meyer, 2024 ; cirad)

- **Charactéristiques**

Medium-sized rabbit, white coat with black extremities (ears, paws, nose, tail). Its weight ranges between **4 and 5 kg**. (Anonymous1). The fur is quite dense. It is white and black. The muzzle, ears, tail, and ends of the paws are black. (Meyer, 2024; CIRAD).

- **Performance (Abilities)**

Highly valued in industrial breeding due to its hardiness, prolificacy, and meat quality. (Anonymous1).



Figure 11 : Californian breed rabbit (Meyer, 2024 on the left ; FAO, 2018 in middle ; Anonyme1 on the right)

5.2.3. Burgundy Fawn breed (Fauve de bourgogne rabbit)

- **Origin**

Originating from Bourgogne, province in the east of France (Myer,2024 ; cirad)

- **Caractéristiques**

The body has **regular proportions**, harmonious shapes, broad, strong, and compact. With rounded and rather compact shapes, the saddle is short and thick. The tail is medium, straight, pressed against the croup. The average weight of the male is about **3.5 to 4 kg**, that of the female reaches **4.5 kg**. The head is strong and broad in the male, fine and more elongated in the female. The eye is well open, but of average size, iris grey, brown, pupil dark blue in both sexes. **The ear** is strong, well-opened, **straight** but slightly curved on the inside, touching at their base, average length **13 cm**. The neck is short and thick in both sexes. The dewlap is absent in males, it is accepted in adult females but remains simple and without exaggerated extension. The legs are short and strong. The **overall color** is **fawn yellow**, the eye is circled with pale white, blending with the fawn, the eyelashes are rather dark. The underside of the head pale white which tapers off down to behind the jaws and thus forms the sides of the neck, a dividing line between the head and the shoulders. The ears, tawny on their outer part, are internally furnished with very short and sparse white hairs, the edge is lined with the same color. The underside of the legs, belly, and tail is white or cream, except for the inner part of the thighs, which is slightly tawny. In principle, the tawny should dominate and the white part be less apparent. The hair is fairly dense and the color distinct. The hairs are tawny along almost their entire length, ending white at their very base.

- **Performance (Abilities)**

La croissance est rapide. Le fauve de bourgogne est réputé pour la finesse de sa chair ; le rendement en viande est élevé (Anonymel). Cette race est appréciée pour la fourrure également (Meyer, 2024 ; cirad).

Table 5 : Weight of Burgundy Fawn breed depending on age (Anonymel)

Average Weight in grams depending on age.	
Kit (young rabbit) at birth	70
15 days old rabbit (Kit or young rabbit)	350
A 1-month-old rabbit	700
A 8 weeks old rabbit	1 700
A 10 weeks old rabbit	2 000
A 12 weeks old rabbit	2 500 à 2 700
Adults	3 500 à 4 500



Figure 12 : Burgundy Fawn breed (Meyer, 2024 on the left & FAO,2018 in the middle ; Anonyme on the right)

5.2.4. Angora rabbit. wooly type

- **Origin**

Angora comes from Angora comes from Ankara, a province and city in Turkey, in Anatolia.

- **Caractéristiques**

Minimum weight **3.5 kg**. It is albino (pink eye irises, white coat). This breed is characterized by the **length of its hair**, due to the prolongation of the activity of the hair follicles. The following are distinguished: the Angora (Angora rabbit), the Coloured Angora (Coloured Angora rabbit), the Dwarf Angora (Angora dwarf rabbit).

- **Performance (Abilities)**

Angora hair is a fiber of excellent quality. It is used to make fancy or high-end clothing. This hair is lighter, softer, and insulates better than sheep's wool. Adult females produce more than males: about **1 kg/year** instead of **0.7-0.8 kg/year**. The hair is harvested

(sheared) approximately every 100 days. Mixed production of hair and meat is more advantageous in tropical countries than narrow specialization in hair production. At the global level, there is a division of labor:

- selection: Germany, France,
- production: China, Chile, Argentina,
- processing: Japan, Italy, Germany,
- use: Japan, Germany, United States.

Angora rabbits have much longer fur than other rabbits; it is wavy and curly like wool; during the molting period, it clumps together, and sometimes makes the animal very misshapen. The colors vary like those of other domestic rabbits.



Figure 13 : Angora breed (Meyer, 2024 ; cirad)

5.2.5. Chinchilla rabbit

- **Origin**

This domestic rabbit is originated from **Germany**

- **Characteristics**

This breed of domestic rabbits, having a very dense silver fur, resembles that of the chinchilla and the meat is tasty. The following can be distinguished:

- the Grand Chinchilla rabbit (Chinchilla Giganta rabbit) which has an average weight of **4.5 kg**;
- the Small Chinchilla rabbit (Small Chinchilla rabbit) which was created in **France**. Average weight **2.5 kg**. (Meyer, 2024; cirad)

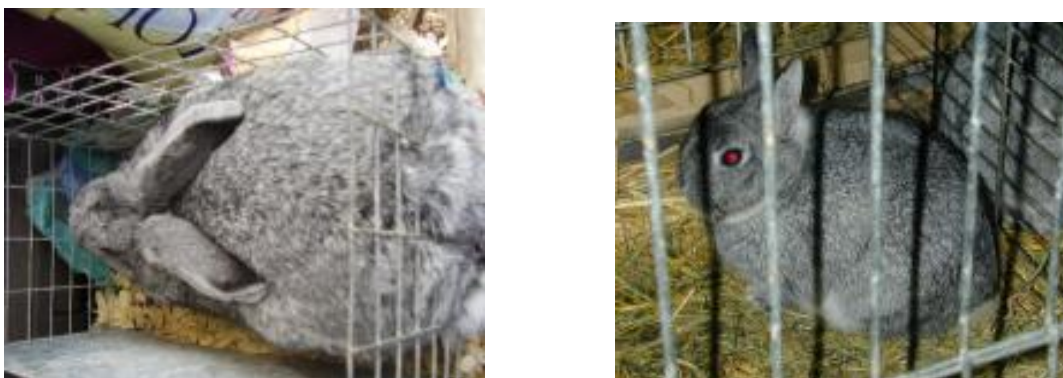


Figure 14 : Grand Chinchilla on the left & small Chinchilla on the right (Meyer, 2024 ; cirad)

6.2. SMALL SIZE (FORMAT) : PET RABBITS

There are currently about ten breeds of dwarf rabbits around the world:

Dwarf lop rabbit, Polish rabbit, Dwarf colored rabbit, Pygmy rabbit, Angora rabbit, Jersey Wooly, Holland Lop, Britannia Petite, Lionhead rabbit, Cashmere Lop, Blanc de Hotot, Satin, American Fuzzy Lop.

6.2.1. Polish rabbit

- **Origin**

As its name indicates, it is originally from Poland (but some reference report that its origin is Englang)

- **Caractéristiques**

This breed of rabbit is very light and of **English origin**. Average weight **1 to 1.25 kg**. The body is compact and short. The fur is dense, short, and completely **white**.



Figure 15 : Polish breed (Meyer, 2024 ; cirad).

6.2.2. Dwarf rabbit

- **Origin**

Very light breed originating from holland.

- **Characteristics**

Weight 1 to 1.25 kg. The body is compact and short. The fur is dense, short, in an accepted color. It is also a pet.



Figure16 : Dwarf colored breed(Meyer, 2024 ; cirad)

7. BREEDS IN ALGERIA (Bezaou, 2019)

The rabbit species in Algeria are represented by the taxonomic family of leporids, which includes domestic rabbits (*Oryctolagus cuniculus domesticus*) and the hare (*lupus capensis*). Three genetic types characterize the rabbit population in Algeria:

6.1. LOCAL POPULATION

6.1.1. THE KABYLIE RABBIT (Bezaou, 2019)

Origin and expansion

Belonging to the local population of Kabylie (Tizi Ouzou region),

- **Characteristics**

This population is characterized by an average weight of **2.8 kg** in the group of **light breeds**, such as Dutch and Himalayan rabbits. It is characterized by a medium-length body (arched type), descending in a progressive curve from the base of the ears to the base of the tail, of good height, carried on medium-length limbs. Its hindquarters are well developed with well-filled loins; the tail is straight. The head is convex with erect ears. Its coat is soft, showing several color phenotypes, a result of the contribution of imported breeds: Burgundy Fawn, New Zealand White, Californian. It is mainly used for meat production, but its

prolificacy and adult weight are too low to be used as such in meat-producing farms. The numerical productivity recorded in females of this population is around **25 to 30 weaned rabbits per female per year**.



Figure 17 : Kabyle Local Population (middle & on the left Farsi, 2016 cited by Bezaou, 2019 ; on the right Lakabi, 2007)

6.1.2. In another study on the Local Population at the ITELV center in central Algeria; Bouguerra (2012) reports that rabbits of the local population exhibit phenotypic diversity (black, gray, brown, black and white, brown and white, ...) as well as the following parameters: (**ADC = 77 g/day; ADG = 24.3 g/day; average weight: 2131.25 ± 243.09 g**). The litter size at birth is reasonable (7.40 total born TB and 6.60 live born LB, 5.48 weaned BW). **Fertility was 68.18%**.

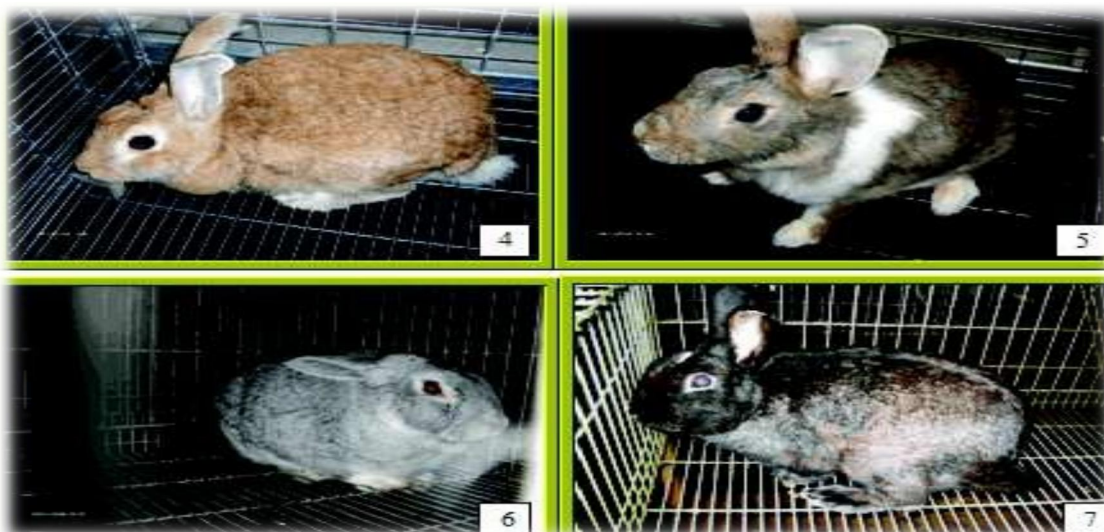


Figure18 : Some phenotyps of the Local Population ((Bouguerra,2012).

6.1.3. Thirth study at the center ITLEV (Gacem et al., 2009)

These authors report rates of: total births (TB), live births (LB), and weaned (BW): 6.75 TB, 6.23 LB, 5.40 W, **fertility of 51%. ADG 23g/day.**

6.2. WHITE POPULATION WP or POPULATION BLANCHE PB (UMMTO 2007)

- **Origin**

Dominant albino phenotype, produced by a state cooperative. Baba Ali & Lamtar. (Zerrouki et al, 2014)

- **Characteristics**

This population is a **heavier** and more prolific strain than the local population. Fertility, total number born (TB), live born (LB), and weaned (BW) are as follows: (60.5%, 7.1 ± 2.5 NT, 5.8 ± 3.1 NV, and 4.6 ± 2.9 NS). (Sid et al., 2018). Gacem et al., 2009 report rates of: total number born (TB), live born (LB), and weaned (BW): 7.42 TB, 6.84 LB, 6.09 BW. **Fertility: 52%. ADG: 24g/day.**



Figure 19 : white Population WP or Population blanche PB (Zerrouki et al., 2014)

6.3. synthetic Strain (SS ITLEV 2006)

- **Origin (called ITLELV 2006)**

It was created in 2003 to improve the genetic potential of rabbits intended for meat production in Algeria. It was obtained through an initial cross between the local population and the INRA2666 strain (Bezaou, 2019).

- **Characteristics**

It is **heavier** and more productive compared to the local population and the White population WP strain. The SS (66.4%, 8.9 ± 2.6 NT, 8.0 ± 3.2 NV, and 6.1 ± 3.3 NS) is higher compared to the White P opulation (60.5% , 7.1 ± 2.5 TB, 5.8 ± 3.1 LB, and 4.6 ± 2.9 BW) (Sid et al., 2018). Gacem et al., 2009 report rates of: total born (TB), live born (LB), and weaned (NS): 9.5 NT, 8.7 LB, 7.08 BW. **Fertility: 51%. ADG: 24 g/day.**



Figure 20 : Phenotyp of the Starin ITELV 2006 (Zerrouki et al., 2014)

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