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Evaluation of some reproduction performances of the exotic *Hyplus* rabbit *(Oryctolagus cuniculus domesticus,* Linnaeus, 1758) at the SAP Mé farm (Ivory Coast)

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Abstract

The objective of the study was to evaluate the reproductive performance and estimate the genetic parameters, in a real environment, of the rabbit of the exotic *Hyplus* breed. The study will allow appreciating the parameters that could be the object of genetic improvement in view of a selection to produce a more efficient rabbit. The work took place at the SAP Mé d'Adzopé farm from January 2013 to June 2015. One hundred and twenty breeding does were followed for five successive generations of five parities each, with an interval of 11 days between the parturition and the next mating with weaning at 30 days. These females produced 5283 total born rabbits with 5164 born alive and 4732 weaned. The genetic parameters including heritability, genetic, phenotypic and non-genetic correlations (environmental effects) did analyzed using the Derivative Free Restricted Maximum Likelihood program. The results obtained showed that the receptivity and fertility rates did significantly influenced by the order of parity and the season of kindling. The pre-weaning mortality rate was 8.37%. Females had the best prolificacies' between the second and fourth parity, with an average of 9.9, 10.19 and 9.79 kits respectively. The heritability values of young rabbits total born alive, born alive, weaned and old rabbits were 0.22; 0.20; 0.16 and 0.12 respectively. These results showed that selection is possible for these studied traits.

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Introduction

Rabbit meat production in Ivory Coast is still low. It did ensured mainly by small farms of local populations of rabbits in the autonomous district of Abidjan and a few cities of the country (Bleyere *et al.,* 2013; Kimsé *et al.,* 2013). This production comes mainly from local populations including the performances show a low profitability Breeders and young rabbits show a high mortality (Soro *et al.,* 2014, Samy *et al.,* 2018).

Unfortunately, very few rabbit crossing and selection experiments did so far carried out in Ivory Coast. Only a few recent studies (Bleyere *et al.,* 2013; Kimsé *et al.,* 2017a; Kimsé *et al.,* 2017b) provide results on the growth performance of rabbits in a few localities of the country. There is therefore a pronounced lack of data on genetic parameters of production and reproduction for rabbits in Ivory Coast.

To remedy this situation, a research program has been set up to create new strains by genetic means. The selection and creation of specialized lines including prolificacy and growth is certainly possible under local conditions, but genetic progress remains limited (Mefti-Korteby *et al.,* 2013).

The study is part of a project for genetic improvement of rabbits by selection carried out in the hutches of the "Agro-Piscicole la Mé" society (SAP Mé) in Adzopé. It aims better to appreciate the genetic variability of reproductive characters and offers the first opportunity to evaluate the performance of some reproductive characters and the genetic parameters on these characters in the exotic rabbit race *Hyplus* (*Oryctolagus cuniculus domesticus,* Linnaeus, 1758) introduced in Ivory Coast at the SAP Mé farm. These performances of economic interest are the number of live births, the number of young rabbits weaned per farrowing and the number of rabbits for sale.

The specific objectives of this study are:

To evaluate the reproductive performance of the female *Hyplus.*

To study the genetic determinism of some reproductive characters in the female *Hyplus.*

Materials and methods

Breeding conditions

The study was be conducted at the SAP Mé farm, located 12km from the town of Adzopé, and the capital of the administrative region of Mé, in the southeast of the country. This area did characterized by abundant vegetation with a humid climate. The hutch with a total area of 1200m² was composed of six rooms, three of which are reserved for maternity and the other three for fattening. The rabbits were be housed in individual metal wire mesh cages with a flat-deck type arrangement.

These rooms did built with terracotta bricks, a tiled roof and cemented floors. Screens on the lengths provide ventilation. The maternity wards have two pairs of batteries of metal cages arranged in a flat-deck (not superimposed) on a plane inclined by 25% towards two drainage channels for wastewater and droppings. Each battery consists of 29 cages. This makes 116 cages per building. Each pair of batteries measures 14.40m by 1.90m. The two pairs are spaced 1.90m apart. Each cage is 50cm long, 35cm wide and 65cm high, standing on four 70cm legs. The mesh size of the wire mesh cages is 12.50cm² for the sides and 4cm² for the base. Each cage has a 15cm x 15cm x 10cm volume feeder. The feeder is fitted with a vertical pipette serving as an automatic drinker connected to the water distribution circuit coming from the barrel placed upstream. Ventilation was be provided by trellises with screens on the sides at 1.20 m from the ground and 1.4m high. The fattening rooms also have four batteries of metal cages in the same layout as those of the maternity buildings. However, the dimensions are different. Indeed, the dimensions of the cages of the fattening rooms are 80cm x 50cm x 35cm. These cages are each equipped with a 50cm x 10cm x 10cm feeder with an automatic water distribution system. The female's cage is equipped with a nest box carrying a female plug for recording data.

The feeds came from the factories of the Ivorian Society of Animal Production (SIPRA) and / or the Manufacture of Ivorian Composite Foods (FACI). The animals did fed two types of granulated feed

specially made for rabbits (Table 1). The first did intended for lactating females and contained an average of 14.2% Crude Cellulose (CB) and 16.4% Crude Protein (CP). The second called containing 14.7% CB and 15.4% PB did intended for breeding males and fattening kits.

Table 1. Daily feed ration of animals.

Breeders
Male breeder: 100g / lap / day
Non-pregnant breeder: 120g / lap / d
Pregnant breeder: 150g / lap / day
Breastfeeding breeder up to 18 days of age of the young rabbits: 300g / lap / day
Breastfeeding breeder less than 6 young rabbits from 18 to 28 days old: 300g / lap / day
Lactating breeder 6 rabbits and over 18 to 28 days old: 450g / lap / day
Breeder breastfeeding less than 6 young rabbits 28 days old until weaning: 450g / lap / day
Breeder breastfeeding 6 rabbits and over 28 days old until weaning: 600g / lap / d
Weaned bunnies
1st week: 50g / lap / d
2nd week: 60g / lap / d
3rd week: 80g / lap / d
4th week: 100g / lap / d
5th week until the sale or slaughter: 120g / lap / d.
g / lap / d: gram per rabbit per day
(Source: Fabrique d'Aliments pour bétail de Côte-d'Ivoire (FACI); Ivorian Livestock Food Production Society (SIPRA), 2015

Animals and breeding management

Six PS Hyplus 59 (PS59) males weighing 3.3 to 3.5kg, 22 weeks old and 24 females PS *Hyplus 19* (PS19) did initially mated. Breeding females are nulliparous, 17 weeks old with a weight of 2.2-2.4kg.

Breeder selection criteria

The characters studied are the reproductive performance of females. These are fertility, litter size at birth, size and body live weight of the young rabbits at weaning, at two months, three months and four months of age (age of sexual maturity). Thus, the males and females involved in the mating plans did selected according to well-defined criteria. The first step is the preselection of the young rabbits based on their weaning weight. All rabbits with an individual weight greater than the average weight of the litter from which they came have been preselected.

The first phase of selection did carried out at two months of age of the females. The selected females have a weight greater than or equal to 2kg. They come from the second or third base bet. Their mothers are females who have a fertility of at least 80%, with an average number of live births per litter greater than 8.5 young rabbits.

The second phase of selection of breeding females did carried out at 4 months. PS Hyplus19 nulliparous females weighing between 2.2 and 2.4kg did selected.

Breeding groups and mating plan

Six breeding groups were formed for the mating's. They are each composed of a male and four females. Thus, 24 families of full brothers and full sisters formed in the first generation. A replacement male and female did provided for each group. After forming the groups, the rabbits were identified by breeding numbers. The male, whose weight is greater than the average weight of the males in the group, did selected to be the father of the next generation. The daughters from dams with the best litters, having the best final weight did distributed in the other groups keeping their number from the previous group. The

animals were followed over five generations of five cycles each over 30 months (January 2014 to June 2016). After farrowing, the rabbits did placed in the box under the shavings. During this operation, gloves did worn for hygienic reasons. Fresh leaves of lemongrass (*Cymbopagon citratus)* did applied to the hand before touching any kit. This precaution did taken to prevent the mother from losing interest in the pups due to the odor of the handler after weighing. The young rabbits did weaned at 30 days of age. The next service d carried out 25 days after the previous farrowing.

Data collection and traits evaluated

The data collected at the maternity ward related to mating, kindling and weaning dates; the litter number; the number of total new-borns; the number of baby rabbits born dead; the number of kits born alive; the number of young rabbits stillborn and dead after weaning. The formulas used for the calculation of the studied performances are the following:

Receptivity rate (%) = (Number of receptive females X100) / Number of females presented to males

Pregnancy rate (%) = (Number of positive palpated females X100) / Number of females mated

The gestation of a rabbit did diagnosed from the 11^{th} day after mating by abdominal palpation. When a rabbit is pregnant, palpation did considered positive.

Fertility rate (%) = Total number of females having given birth X100 / Number of females mated

Prolificity at birth = Number of total kits born / Total number of females having given birth

Prolificity of born alive = Total number of kits born alive / Total number of females having given birth

Prolificity at weaning = Total number of rabbits weaned / Total number of females having given birth

TS (%) = (Number of females present-Number of culled or dead females) X100) / Number of females present at the beginning of the period considered

TS = Survival Rate

Mortality rate (%) = Number of animals dead in a given period X100 / Number of animals present at the start of the period

Stillbirth rate (%) = Total number of stillborn rabbits X100 / Total number of kits

TM presev (%) = Number of kits born alive but dead before weaning X100 / Number of kits born alive

TM presev = Pre-weaning Mortality Rate

Statistical analysis of data

The quantitative variables were the subject of a multivariate analysis of variances (ANOVA) by the GLM (General Linear Model) procedure of the STATISTICA 7.1 software. The DUNCAN test did performed to compare the averages. The calculation of heritability values (h^2) did based on the half-sibling scheme. The variance components for heritability (additive variance or inter-family variance) did calculated using the DFREML (Derivative Free Restricted Maximum Likelihood) procedure (Meyer, 1998).

Results

Evaluation of reproductive performance in the Hyplus breed

Hyplus females recorded receptivity and gestation rates of 99%. The observed performances were 9.55; 9.34; 8.56; 8.04 respectively for the average number of total born young rabbits; the average number of live births, the average number of weaned and the average number of alive at 60 days of age.

Evaluation of reproduction performance according to the order of parity

Maternal aptitudes, particularly receptivity and gestation did not significantly influenced by the order of parity ($P > 0.05$). However, the influence of the order of parity over fertility was highly significant ($P < 0.001$). After the first birth, the fertility rate fell significantly ($P < 0.007$) for the other parities. The effect of the order of parity was highly significant over the number of young rabbits total born (stillborn and

born alive), the number born alive, the number of weaned and the number alive at 60 days. After the first kindling, the number of total bunnies born varied significantly from one parity to the other: 9.99 bunnies at the second parity and 9.79 bunnies at the 4th parity; 10.19 bunnies at third parity and 9.35 bunnies at 5th parity. The number of kits born alive has followed the same trend. The number of rabbits born alive was greater at the third parity (9.94 against 8.48 bunnies to the first parity. As for the number of rabbits weaned, it was high at the third parity with an average of 9.03 (Table 2).

Evaluation of reproductive performance according to generation

Generation order did not have a significant effect on receptivity and gestation rates (P> 0.05). The second generation presented the lowest fertility rate, which was 86.67%. The reproductive performance of females was significantly influenced by the order of generation (P <0.001).

Females of the first generation produced more rabbits (10.65 average litter size of total born).These averages fell over the other four generations respectively by 9.9; 10.06; 8.90; 8.32 average litter size.

The average number of born alive, weaned and alive at two months per litter has also decreased significantly over generations. Thus, the average number of young rabbits born alive decreased from 10.48 in the first generation to 9.65; 9.86; 8.65 and 8.10 in the four other respective generations (Table 3).

Table 2. Reproduction performance as a function of the order of parity.

Variables	Parity 1	Parity 2	Parity 3	Parity 4	Parity 5	P
Receptivity	100%	100%	99.17% *(± 0.01)*	98.33% *(± 0.01)*	97.50% *(± 0.01)*	0.223^{ns}
Gestation	100%	100%	99.17% *(± 0.01)*	98.33% *(± 0.01)*	97.50% *(± 0.01)*	0.223^{ns}
Fertility	$100\%^{b}$	$90.83\%^{a}$ *(± 0.02)*	$88.33\%^{a}$ *(± 0.02)*	$90.83\%^{a}$ *(± 0.03)*	$90.83\%^{a}$ *(± 0.03)*	0.007^{*}
Total born	8.57^{c} *(± 0.12)*	9.99^{a} *(± 0.21)*	10.19^{ab} *(± 0.20)*	9.79^{a} *(± 0.19)*	9.35^{b} *(± 0.16)*	$<0.001^{***}$
Born alive	8.48^{c} *(± 0.12)*	9.72^{a} *(± 0.22)*	9.94^{ab} *(± 0.19)*	9.52^{a} *(± 0.19)*	9.13^{b} *(± 0.15)*	$<0.001^{***}$
Weaned	7.78^{c} *(± 0.01)*	8.85^{ab} *(± 0.02)*	9.03^{b} *(± 0.02)*	8.83^{ab} *(± 0.02)*	8.37^{a} *(± 0.02)*	$<0.001^{***}$
Alive at 60 days	7.48^{b} *(± 0.02)*	8.37^{a} *(± 0.02)*	8.50^{a} *(± 0.02)*	8.27^{a} *(± 0.02)*	7.66^{b} *(± 0.02)*	$<0.001^{***}$

ns: effect not significant at P> 0.05;*** highly significant effect at P <0.001;* significant effect at P <0.05. a, b, c, d: the means of the same row assigned the same letter do not differ at threshold P = 0.05.

Table 3. Reproductive performance according to the order of generation.

Variables	Generation 1	Generation 2	Generation 3	Generation 4	Generation 5	P
Receptivity	99.17% *(± 0.01)*	99.17% *(± 0.01)*	97.50% *(± 0.01)*	100%	99.17% *(± 0.01)*	0.402^{ns}
Gestation	99.17% *(± 0.01)*	99.17% *(± 0.01)*	97.50% *(± 0.01)*	100%	99.17% *(± 0.01)*	0.402^{ns}
Fertility	$94.17\%^{bc}$ *(± 0.02)*	$86.67\%^{a}$ *(± 0.03)*	$90\%^{ab}$ *(± 0.03)*	$97.5\%^{c}$ *(± 0.01)*	$92.5\%^{abc}$ *(± 0.02)*	0.021^{*}
Total born	10.65^{d} *(± 0.19)*	09.90^{a} *(± 0.17)*	10.06^{a} *(± 0.17)*	08.90^{c} *(± 0.15)*	08.32^{b} *(± 0.15)*	$<0.001^{***}$
Born alive	10.48^{d} *(± 0.19)*	09.65^{a} *(± 0.17)*	09.86^{a} *(± 0.17)*	08.65^{c} *(± 0.15)*	08.10^{b} *(± 0.15)*	$<0.001^{***}$
Weaned	09.58^{d} *(± 0.21)*	08.53^{bc} *(± 0.19)*	08.98^{c} *(± 0.19)*	08.07^{ab} *(± 0.15)*	07.64^{a} *(± 0.14)*	$<0.001^{***}$
Alive at 60 days	08.96^{d} *(± 0.21)*	08.07^{bc} *(± 0.18)*	08.46^{cd} *(± 0.19)*	07.58^{ab} *(± 0.15)*	07.17^{a} *(± 0.15)*	$<0.001^{***}$

ns: effect not significant at P> 0.05; *** very significant effect at P <0.001; * significant effect at P <0.05

a, b, c, d: the means of the same row assigned the same letter do not differ at threshold P = 0.05

Analysis of some genetic parameters

Genetic and phenotypic correlations

Prolificacy traits showed positive and moderate genetic correlations ranging from 0.34 to 0.49 for total born kits, born alive, weaned kits and kits alive at 60 days. Reproductive traits related to litter size did very strongly correlated with one another by positive phenotypic correlations ranging from 0.75 to 0.97 for total born, born alive, weaned kits and kits alive at 60 days per litter (Table 4).

Table 4. Genetic and phenotypic correlations.

Variables	Total Born	Born Alive	Weaned	Alive at 60 days
Total Born		0.49	0.40	0.37
Born Alive	0.97		0.37	0.34
Weaned	0.81	0.83		0.36
Alive at 60 days	0.75	0.77	0.91	

Heritability of reproductive traits of the Hyplus rabbit

The heritability values of the reproductive traits of the breed *Hyplus* were relatively low, at 0.22 respectively; 0.20; 0.16 and 0.12 for the total born bunnies; the born alive; the weaned and the kits alive at 60 days.

Survival of rabbits

The survival rate of breeding females was 99%. The mortality of the young rabbits before weaning was 8.37% and 6% after weaning (Table 5).

Table 5. Frequencies of modalities related to rabbit health.

Variables	Female survival rate (%)	Stillbirth rate (%)	Pre-weaning mortality rate (%)	Post-weaning mortality rate (%)
	(N = 600)	N = 5283	N = 5164	N = 4732
Frequencies	99	2.25	8.37	6
	-594	-119	-432	-284

N: Total number of rabbits. The numbers in brackets (...) are the number of dead rabbits

Discussion

The work showed that the receptivity rate was 99.00% to the Hyplus breed. These results obtained are similar to those of Cherfaoui (2015) who obtained 78.8% in a strain from Algeria. On the other hand, Lebas *et al.* (2010) recorded lower rates than that obtained in this study. Indeed, the rates obtained by these authors are 64%, 69% and 64.5% respectively for a local population of Algeria, the White rabbit population and an Algerian synthetic strain. The work of Théau-Clément *et al.* (2008) also showed high individual variability in the receptivity of females. This supposes that receptivity did linked to one or more genes. The high value observed did attributed to the extensive reproduction rhythm used and the natural mating practiced with breeders kept in the same hutch. The gestation rate obtained is also high (90%). It is higher than the 70% value observed by Goudjo (2010) in Benin. This difference did linked to the method of reproduction, which is extensive or intensive rhythms, artificial insemination or natural mating. Indeed, the more extensive conduct of reproduction improves the body condition of females (Feugier and Fortun-Lamothe, 2006).

The observed fertility rate of 92.17% was also high. Cherfaoui (2015) obtained the value of 78.6% at the local population of Algeria. Hassamien and Boiomy (2011) obtained results similar to those of this study. These authors obtained respective fertility rates of 92 and 88% in Californian females and Red Baladi females. On the other hand, the rates observed in this study do not agree with those of Lebas *et al.* (2010), Goudjo (2010) and Bolet *et al.* (2012) who obtained respective rates 64%, 66% and 51% in Argenté de champagne, Fauve de Bourgogne in France and local females from Benin. The difference would be due to the genetic type. Indeed, small animals have a high fertility (Goudjo, 2010).

Differences in fertility did also related to genetic types. Bolet *et al.* (2004) show that fertility did related to the genetic type, in particular with the size of the strain. Khedidja *et al.* (2020) reported a significantly lower fertility rate in rabbits of the Algerian synthetic strain carried out by artificial insemination (69.7%). Sid *et al.* (2018b) obtain a rate of 60.4% in females of the white population. Moula and Yakhlef (2007) recorded a higher fertility rate (87%) in rabbits from the local Algerian population. According to Goudjo (2010), small animals have high fertility.

The average size of the total born of the Hyplus strain was 9.55 young rabbits per litter. This value is lower than the standard value, which is 11 rabbits according to Boucher (2012). This difference did explained by the change of climate, in particular temperate or tropical, and feeding. The average size of total born was 9.34 rabbits per litter. In a synthetic strain, Gacem *et al.* (2008) recorded a litter of 7.9 born alive. This high prolificacy obtained did attributed to a low embryonic mortality. According to Zerrouki *et al.* (2014), the number of rabbits observed in a litter depends on the number of eggs laid by the female and on the viability of the fertilized eggs. Indeed, certain factors, in particular high temperature and lighting, would have a negative effect on the viability of young rabbits at birth (Cherfaoui *et al.,* 2013). The size at weaning at 35 days of the young rabbits is much lower (8.56) than that obtained at the Hypharm farm, which is 10.5 young rabbits per litter (Boucher, 2012). This result would been linked to the high mortality rate to the birth at the weaning due to farming conditions, such as climate, environment and feeding.

Litter size at weaning did also linked to the mortality of low weight young rabbits during the pre-weaning phase, particularly in the first week, as well as wicked nest designed by some females (Cherfaoui, 2015). Receptivity and gestation at the female did not influenced by the order of parity. This observed result could been explained by the extensive rhythm used, which allows females to recover on the one hand and on the other hand the restricted use of males. Indeed, the excessive use of males contributes to the deterioration of fertility in second gestation (Kennou and Bettaib, 1990). On the other hand, Zerrouki *et al.* (2012) reported that the effects of female lactation status at the time of mating as well as kindling rank had a significant effect on female reproductive performance. While receptivity and gestation are not influenced by the order of parity, fertility was be significantly influenced by this factor. Receptivity is higher in nulliparous females of the present study. This result is consistent with that of Fellous *et al.* (2012) who obtained the best fertility rate (85.9%) at first parity. Théau-Clément (2008) revealed that nulliparous were be characterized by a fertility greater than 85%.Perrier *et al.* (2003) noted that multiparous females have a high fertility level (78.6%). Zerrouki (2006) observed that multiparous females are significantly more receptive and more fertile than nulliparous females. The difference between these results did explained by the breeding management method, in particular the rate of reproduction, feeding, health monitoring and the age of breeding or culling of the breeders.

The study on reproductive performance revealed that they did significantly influenced by the order of parity, in particular, the average number of young rabbits total born, rabbits born alive, rabbits weaned and rabbits alive at 60 days. In addition, primiparous females (first litter) have the lowest performance. Between the second and the fourth litter, the size at typical age increases and decreases at the fifth parity. These results are similar to those of Goudjo (2010) and Sid *et al.* (2018a). Prolificacy at weaning in this study is high between the second and the fourth parity. Fellous *et al.* (2012) made similar observations in the local population of Algeria.

In general, Parity has an effect on the performance of mothers. Prolificacy at birth increases steadily with parity. Parity had an important role in reproduction: primiparous females always record the worst performance (Theau-Clément, 2005). Indeed, the energy balance of does is more deficient during the first lactation than for the following ones (Fortun-Lamothe and Gidenne, 2003). This phenomenon was be attributed mainly to the competition between the needs for body growth, gestation and lactation (Szendro *et al.,* 2008). This situation explains largely the lower reproductive performance, particularly the size, litter weight and milk production observed in primiparous females compared to multiparous females (Sid, 2010 and Mazouzi-Hafid *et al.,* 2014). Previous work (Hulot and Matheron, 1981 and Belhadi, 2004) carried out on careers of more than three kindling had confirmed a significant difference for prolificacy, in favour of multiparous females compared to primiparous. On the other hand, Chineke (2006) and Ouyed *et al.* (2007) did not find an effect of the order of litter.

Except the receptivity and the pregnancy rates, which did not influenced by the order of generation, the other variables did significantly influenced by the generation. This influence would be due to genetic effects, in particular heritability. In addition, any improvements observed at third generation did linked to good breeding management (Gacem and Bolet, 2005).

The phenotypic correlations observed were strong and positive between total born, born alive and weaned. Similar results were be obtained by Mefti-Korteby (2016). Sid (2010) observed values from 0.74 to 0.86 between total born and born alive of three different genetic types. The number of weaned was positively correlated very significantly (0.43 to 0.61) with the number of total born. Selection on litter size results in an indirect choice of an interesting live litter and weaned litter. Moreover, Mantovani *et al.* (2008) reported values of r-values > 0.82 between total born and born alive.

Total born increase the productivity at weaning because the correlation values are 0.61 to 0.98 (Gomez *et al.,* 2002; Orunmuy *et al.,* 2006). Thus, the high number of born alive results in a high number of weaned due to a large correlation value of 0.47 (Hanaa *et al.,* 2014).

The stillbirth observed in this work was 2.89%. This rate falls within the margin indicated by the provider Hypharm (<5%) (Boucher, 2012). It is lower than those who recorded by other authors in the local Algerian population, in particular 21% (Moulla and Yakhlef, 2007) and 7.3% (Zerrouki *et al.*, 2008). These authors considered that these variations would be due to various factors such as the number of total born and the order of parity. Kpodékon *et al.* (2006) found that stillbirths tended to increase with the number of total born and order of parity with high stillbirth rate obtained at the sixth parity (11%).

The mother before and after weaning influenced the mortality of kits. The mortality rate of young rabbits is linked to the poor conception of the nest by the mothers and embryonic survival on the one hand and on the other hand to the fact that some killed their kits which they consumed by cannibalism due to a lack of food (Cherfaoui, 2015). The rabbit mortality rate was 8.37% before weaning. Like stillbirth, pre-weaning and post-weaning mortality would depend on several factors including litter size, season and alimentation (Rashwan and Marai, 2000). According to Combes *et al.* (2018), the robustness of the young rabbits at the birth depends on their development during the fetal period and the milk production of the females. Thus, the lightest kits die before weaning while the larger ones have better survival.

All the heritability showed that there is significant genetic variability for the different characters. It is therefore possible to improve these characters by selection in the population studied. The heritability of the number of born alive observed by Lenoir and Garreau (2011) in the C Hycole line was 0.04. This number is lower than that obtained in the present study. This difference would be due to the environmental conditions of study. The heritability depends on the environment in which the animals live. Indeed, the higher the environmental variance, the lower the heritability (Bolet *et al.,* 2012).

Conclusion

The objective of the study was to evaluate the zoo technical performance of reproduction in the *Hyplus* breed. It emerges from the work that the order of parity and the order of generation significantly influence reproduction performance. The future breeders for the next generation did selected between the second and the fourth parity. In addition, the study found that these reproductive traits are heritable. However, the morality rate remains high. The exotic *Hyplus* breed appears to be a competitive genotype that can aid in the diversification of meat production through the utilization of performing rabbits. However, the dissemination of such genetic material requires a development program that takes into account accompanying and support measures for all operators in the local rabbit industry. The reinforcement of technical support did also searched in terms of control of the technical itinerary and the supply of production factors such as quality feed and appropriate breeding conditions.

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