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PROLIFICACY AND FECUNDITY STUDIES AMONG SELECTED BREEDS OF RABBITS (*ORYCTOLAGUS CUNNICULUS* LINNAEUS)

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ABSTRACT: *Research work on selected breeds of rabbits was staged at Rabbitary Unit of Forestry Research Institute of Nigeria, Ibadan, Nigeria to examine the differences on prolificacy and fecundity among the breeds. Twelve matured female rabbits of four different breeds were allocated into four replicates laid in completely randomized design. ANOVA at 95% level showed that there was significant difference across all breeds in Weight before mating (WTBM), Weight at two week of pregnancy (WT2P), Weight at four week of pregnancy (WT4P), Weight at birth (WTAB), Weight of Kittens at three week old (WTK3) except LITTER SIZE. New Zealand White (NZW) was the most prolific among the breeds with average kittens of 6 over Flemish Giant of 5. All breeds selected were of high fecundity with ability of 6 parturitions. Flemish Giant and New Zealand White are therefore recommended to farmers and prospective farmers to use as farm stocks for economic turnover in term of prolificacy and size.*

KEYWORDS: prolificacy, fecundity, litter size, parturition, breeds

INTRODUCTION

Rabbits are raised for many different uses, and they can play an important role in a small sustainable farming operation. While the most common use in agricultural industries is for meat, rabbits also are raised for pelts, manure, show, and laboratory use. Rabbit meat is high in protein and low in fat, calories, and cholesterol when compared to most of the meats eaten in the United States (Samkol and Lukefahr, 2008).

Rabbit is a prolific animal, that is, it produces offspring abundantly. It denotes it is highly fruitful. Also, rabbit is being reared for its high fecundity. It refers to the ability to produce an abundance of offspring or new growth. The real amazing factor of rabbit reproduction is how fast they get around to breeding, and how often they can do it. The average rabbit reaches sexual maturity at 3-8 months old, and they have the rest of their 9-to-12+ years to get it on (though egg/sperm production drops off at around 3 years). Their breeding season lasts three-quarters of the year, and the does don't have an estrous or "heat" cycle. They're more or less ready to mate all the time. They don't have a menstrual cycle, either, so there's no special window during which pregnancy can happen. Does are actually *induced ovulators*, which means that intercourse stimulates ovulation. After 40 seconds of magic, the egg is emitted for fertilization.

Rabbits gestate for only 30 days, and usually have litters of between 4 and 12 babies (kits), depending on the breed. Once the babies are born, the doe can mate and get pregnant again as soon as the following day. If they maintain a pace like that and all the kits survive, the large-litter breeds are looking at about 100 babies per season. Dana, (2016) reported that rabbit gestation lasts 28-31 days, and because they are induced ovulators, mother rabbits can be impregnated again within minutes of giving birth. This means that doe could, hypothetically, have one litter per month if she is constantly with a male rabbit.

On the international market, European countries account for the majority of rabbit production, while China ranks second (Samkol and Lukefahr, 2008); however, rabbit production has recently gained attention as an effective means of alleviating poverty in developing countries (Lukefahr, 2008).

While raising rabbits is a labor-intensive endeavor, there are many reasons to consider doing so on a small farm: rabbits are quiet and small, their meat is nutritious, litters are large with short generation intervals (meaning a quick economic return), rabbits can eat waste materials, and they are efficient at extracting protein from forage (Samkol and Lukefahr, 2008).

Breeds Two medium-size breeds, the New Zealand White (NZW) and the Californian, are the most important for meat production. They have white fur that is difficult to see if a few pieces are stuck to the carcass, and they have higher meatto-bone ratios (Spencer, 2011). The NZW is considered the best breed overall, considering mothering ability and carcass characteristics. However, crossing male Californians to female NZWs and then breeding the female from this cross back to male Californians results in larger litter sizes and heavier fryers than using straight NZWs. Other meat breeds include Californian, Champagne d' Argent, English Spot, and Flemish Giant, but these may not receive a premium price because of the colored fur. A relatively new hybrid breed developed from crosses of Flemish Giant, Champagne d'Argent, and Californian named the Altex (a combination of Alabama and Texas, as the breed was developed between Alabama and Texas A&M), has been bred for commercial viability. Th is breed is more heat-tolerant and gains more weight quicker than other breeds—reaching up to 10 to 20 pounds. For more information, visit http://users.tamuk.edu/kfsdl00/rabb.html. Breeds developed for fur include American Chinchilla, Checkered Giant, Silver Marten, and Rex. The Angora was developed for wool and meat. Laboratory breeds include Dutch, English Spot, Himalayan, and Polish (Shaeffer et al., 2008). Pet breeds include Holland Lop, Polish, Dutch, and Mini Lop.

Record Keeping for Rabbit Farm Itemized

An ideal rabbitary always progresses with good record for all the aspects.

A. Breeding Records

1. Rabbit's number
2. Number of rabbit to which this rabbit was bred
3. Date bred
4. Date kindled

5. Number of bunnies born
7. Number of bunnies weaned
8. Weight of bunnies at weaning time
B. Feed Records
Concentrate as well as greens consumption
C. Medication records
Drug used, dosage, period of treatment

Breeding Management in Rabbit Farm

TamilnaduFarms Group (n.d) itemized breeding management in rabbit as follow;
* The average age at first mating is about 5-7 months and it varies with the physical maturity of individual rabbit and also breed.
* Mating should be done either early in the morning or in the evening.
* The doe is to be taken to the buck cage and never vice-versa
* The breeding should be planned in such a way that about 3 to 4 litters per doe are obtained per year during multiplicative stage.
* The nest box is kept in the cage around 25th day of pregnancy with loosened jute wool or wood shavings.
* Male rabbits can be used for mating until they are about three years.
* In order to prevent inbreeding depression rabbits from the same family should not be bred. Therefore, replace male rabbit about once every year.
* After three years, the full grown female rabbits should be replaced either by new purchases or females of own farm.
Care of young ones:
* The nest box should be removed after 5 weeks of kindling.
* Kits should be examined and dead ones should be removed daily.
* If the bedding becomes wet it should be replaced by a fresh and clean one.
* Weaning should be done at 5th or 6th week after kindling.
* No sudden change in feed is advisable.

Breeding of Rabbit

TamilnaduFarms Group (n.d) reported that the ideal age of Buck and Doe to start breeding is 10-12 months and 4-6 months respectively. Rabbits do not ovulate on a regular cycle; as a result they do not actually go into heat. The mating of the rabbit will cause the doe to produce the eggs necessary for fertilization, usually 10-13 hours after breeding has occurred. This phenomenon is called as Induced Ovulation.

Although the does has no actual heat cycle, she will only accept the buck in about 12 out of every 14 days. When a successful connection happens, the buck will literally fall to its side, and will usually let out a grunt. When she is ready to breed her vent area will be a dark pink, red or purple. Gill, (2004) in his own remark explained that an important part of reproductive management is taking the female (doe) to the male's (buck's) cage. Otherwise, the buck would spend his time

marking new territory in the doe's cage instead of breeding. Breeding should occur within about one minute. If it does not occur, the doe should be removed and the process should be tried again in a few days. The doe should not be left in with the buck for long periods of time because they may fight. Rabbits do not have a heat cycle like many animals do—rabbits ovulate after mating. The doe's abdomen may be palpated 10 to 14 days after breeding to see if she is pregnant. The embryos are round and feel like grapes. Birth of the kits (kindling) occurs in 31 days with NZWs. A nest box with wood shavings or other bedding material is placed in the doe's cage at 29 days so she can pull fur and build a nest.

The best way to determine if the doe is pregnant is to palpatate the doe. Palpating the doe correctly to determine pregnancy takes practice and should be done after 12 days from mating.The average pregnancy period is 30 days. With the nearing delivery the doe will start making nest by pulling her fur and placing in nest box. The average fecundity rate is 6-8 pups. The pups are 'Altricial' i.e. deaf, dumb and blind at the time of birth. Care should be taken that adlibitum feed and water is available in the cages before during delivery period. Water deficiency at the time of delivery can lead to Cannibalism. In broiler rabbits the survival rate of young ones till maturity or slaughter age is 85-90%.

The Doe can be rebred after 15 days from delivery even though the pups from previous litter are with her. Care should be taken that Bucks and Does are always housed separately. Housing does together leads to 'Pseudopregnancy', bucks and does together leads to castration of bucks by does and only bucks together leads to fight and injuries.
In its remark, TNAU, (2015) stated in tabular form the reproductive descriptions of rabbits as follow;

Breeding males required	1 male for 10 females
Age at which first bred	Small breeds - 4 months age (Polish, Dutch) Medium breed - 5 to 6 months (Newzealand White, Chinchilla)
Characteristics of reproduction	Polyoestrous. A female rabbit appears to have no definite oestrus cycle although a certain rhythm exists in their sexual receptivity. Cycle lasts for about 12 days of which 4 are infertile.
Signs of heat	Congested, purple and moist vulva, restlessness, rubbing the chin on the sides of the cage, lying in mating posture and lifting the tail
Mating behaviour	The doe is always taken to the buck's cage for mating, and if the doe is in full sexual receptivity it will lift the tail and within a minute the buck will be mating the doe. Mating is successful when the buck falls to one side or backwards after mating
Ovulation	Ovulation occurs 10 - 13 hours after copulation – reflex ovulation
Pseudo pregnancy/	Pseudo pregnancy in rabbit may result from sterile copulation and lasts for 16 to 17 days. At the end of this period she may pull hair

	from her body and attempt to make nest and shows development of uterus and mammary gland.
Gestation period	28 -34 days (average 31 days)
Pregnancy diagnosis	The methods adopted to determine the state of pregnancy are test mating, weight gain method and the 'palpation technique'. The palpation technique is the most reliable method if done by an experienced person.
Palpation technique	A completely relaxed doe should be placed on a table which has been covered in sacking to prevent her from slipping. The doe should be restrained by gently holding the fold of skin behind ears and over the shoulders. The left hand is placed under the body between the hind legs and in front of the pelvis. The uterine horns are felt gently using fingers and thumb. The thumb is placed to right of horns. Embryos can be located and felt like small marble shaped bodies slipping backwards between thumb and fingers when moved gently in a sideways direction. An experienced person can deter-mine pregnancy by 8th to 10th day of mating using this technique. During last week of pregnancy a nest box lined with wood shaving or hay or coir fibre should be placed inside the cage.
Litter size	6-8 kits
Weaning	4-6 weeks
Kindling interval	2 months (it may be as short as one month if bred immediately following kindling)

As economical and profitable the rabbit farming is, the rate of parturition in a given time and litter size need to be studied to identify the particular outstanding breed among the selected in term of prolificacy and fecundity for economic choice to be made.

MATERIALS AND METHODS

Research Site: The research was conducted in Rabbitary Unit of Forestry Research Institute of Nigeria, Ibadan.
The area lies on Latitude 7º 23¹ N and Longitude 3º 51¹E. The climate condition of the area is tropically dominated by rainfall pattern from 1200mm-1250mm. The average temperature is about 32ºC, average relative humidity of 80 -85% and the climate of the area experience rainfall with two distinct seasons, dry season usually from November-March and raining season usually from April – October.

Source of Research Animals:
Rabbits used for the research were sourced from Rabbitary Unit of Forestry Research Institute of Nigeria, Ibadan.
12 healthy matured adult rabbits were used; 3 Chinchilla, 3 Dutch, 3 New Zealand White and 3 Flemish Giant

Experimental Design:
The four breeds of rabbits were arranged in Completely Randomized Design with three replications.

Management of Research Animals:
The animals were intensively managed. They were fed with the same feeds such as forages and concentrates. Feeds of the same quantity were always given before and during the research. Water was given to the animals at ad-libitum. Each one of the animals was kept in a cell of the battery cage provided in the pen with water and feeding troughs.

Materials for the Research:
Materials used for the research work were:

Table 1: Materials and Uses

	Materials	Uses
(1)	Electronic Weighing Scale	It was used to take the weights of the animals
(2)	Animals (Rabbits)	They were used to carry out research goals
(3)	Feeding trough	It was used to provide concentrates to the animals
(4)	Watering trough	It was used to provide water to the animals
(5)	Nest box	It was used to house kittens at kindling
(6)	Pen	It was used to house the research animals
(7)	Forages	Plant materials used to feed the animals
(8)	Concentrates	Compounded feed used for the animals
(9)	Cotton wool	This was used to provide bedding materials for kittens at kindling in replacement of fur
(10)	Hand glove	It was worn to prevent infection
(11)	Face mask	It was worn to prevent infection
(12)	Broom	It was used to sweep the pen and its surroundings
(13)	Disinfectant	It was used to disinfect the rabbits' pen
(14)	Wheel barrow	It was used to pack away feed remnants and litters from the pen
(15)	Buckets and bowls	They were used to fetch and store water

Source: Field work, 2020

Methods used in Analyzing Parameters:
Twelve matured healthy female rabbits (does) were purposively selected for the research. 4 breeds were involved in the research; Chinchilla (CCA), New Zealand White (NZW), Dutch (DUC) and Flemish giant (FLG). 3 each of the animals were selected for the research work.
The weight of each animal was taken immediately after selection before mating. Each breed of animals was mated by buck of the same breed, that is, CCA was mated by CCA buck, NZW by NZW buck, DUC by DUC buck and FLG with FLG buck to maintain breed genetic heritability.
Each animal is put in a single cell of the cage provided with feeding and water troughs. Feed (forages and concentrate) of appreciable same quantity was given to the experimental animals throughout the research period. Water was given ad-libitum. Remnants of the feed were packed and discarded daily. Fresh water was given to the animals daily.

Table 2: Parameters and Mode of Measurement

Parameters		Mode of Measurement
(1)	WTBM	This is the weight of the animal measured with digital weighing machine in kg
(2)	WT2P	This is the weight of the animal at two week of pregnancy measured with digital weighing machine in kg
(3)	WT4P	This is the weight of the animal at four week of pregnancy measured with digital weighing machine in kg
(4)	WTAB	This is the weight of the doe immediately after parturition measured with weighing machine
(5)	LITTER SIZE (Prolificacy)	This is the number of kittens produced at a parturition. By counting
(6)	WTK3	This is the weight of the kittens at three week old measured with digital weighing machine
(7)	FECUNDITY	This is the number of parturition an animal undergo in a year. By counting

Source: Field work, (2020)

Data Collection:
Data was collected on each of the animals used for the research work. The data was collected on each parameter set for the research. Those parameters are; weight of the animal before mating (WBM), weight of the animal during pregnancy (WDP), weight of the animal after kindling (WAK), number of kittens per animal per kindling (prolificacy) (NKt/K), number of kindling per animal per year (fecundity) (NK/Y) and weight of kitten at birth (WKB).

Data Analysis:
Data collected were analyzed using SPSS analytic package.

The mean square was drawn for the parameter to identify the significant relationship among the breeds of rabbits.
Statistical tools used to draw inference were tables, graphs, pie chart and bar charts.

RESULT AND DISCUSSION

TABLE 3: Anova Showing Significant Difference among Selected Breeds of Rabbits in Relation To Parameters Studied

		Sum of Squares	df	Mean Square	F	Sig.
WTBM	Between Groups	.516	3	.172	33.876	.000
	Within Groups	.041	8	.005		
	Total	.556	11			
WT2P	Between Groups	.462	3	.154	18.653	.001
	Within Groups	.066	8	.008		
	Total	.528	11			
WT4P	Between Groups	.420	3	.140	13.969	.002
	Within Groups	.080	8	.010		
	Total	.500	11			
WTAB	Between Groups	.174	3	.058	4.683	.036
	Within Groups	.099	8	.012		
	Total	.273	11			
LITTER SIZE	Between Groups	7.000	3	2.333	1.273	.348
	Within Groups	14.667	8	1.833		
	Total	21.667	11			
WTK3	Between Groups	.053	3	.018	3.462	.071
	Within Groups	.041	8	.005		
	Total	.095	11			

WTBM-Weight before Mating, WT2P-Weight at 2 Week old Pregnancy, WT4P-Weight at 4 Week old Pregnancy, WTAB-Weight at Birth, LITTER SIZE-Number of Offsprings, WTK3-Weight of Kittens at 3 Week old

Table 3 showed the significant differences among the breeds of rabbits used in relation to the studied parameters. The ANOVA showed that all breeds of rabbits were significantly different in WTBM, WT2P, WT4P, WTAB and WTK3 within the same breed and among the selected breeds except in Litter Size. This may be due to genetic difference in breeds that majorly determines the size while non-significant difference in Litter size may be due to the same environment of research work all rabbits were exposed to in term of feeds and general management practices. This was supported by Glenna (2013) that when the doe's egg is fertilized by the buck's sperm, the chromosome from the sperm unites with the same chromosome type in the egg and the chromosome pairing is once again restored. Whatever genes that came from the buck are now

matched up with the genes of the doe. The expression of these genes in the resulting offspring depends on their dominance and how the other genes relate to each other.

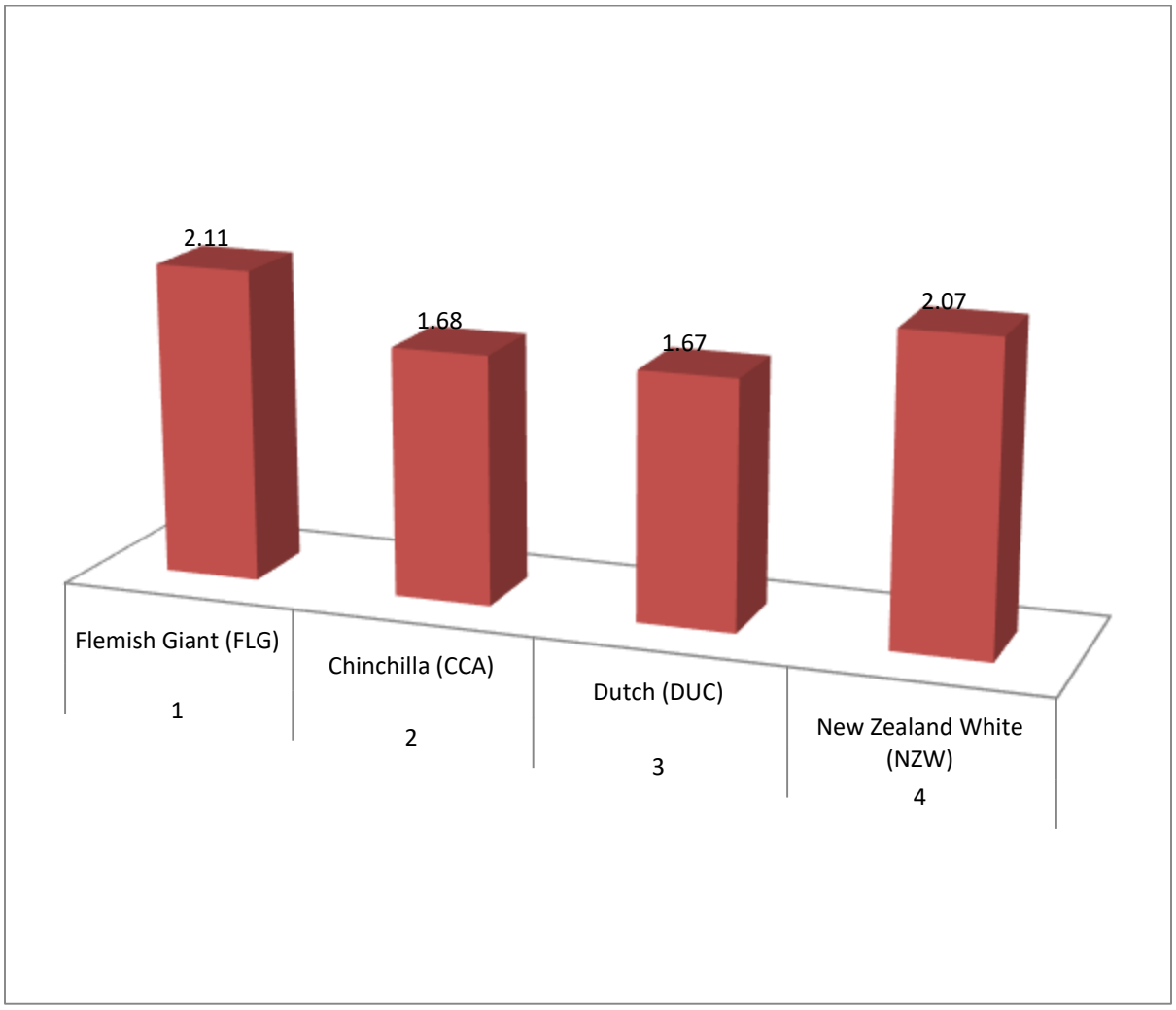

Figure 1: Average Weight of Breeds of Rabbit before Mating (Kg)
Flemish Giant (FLG), Chinchilla (CCA), Dutch (DUC), New Zealand White (NZW)

Figure 1 showed the average weight of breeds of rabbits before mating. Flemish giant weighed 2.11kg followed by New Zealand White, 2.07kg while Dutch had the least weight of 1.67kg. The difference in weight may be related to the difference in breed that determines size of the animals irrespective of age. This was in line with the remark of Pippa (2019) that Flemish giant rabbits are the largest breed of rabbits. Also supported the work of University of Florida (2019) on breed types, "due to the great variations between rabbit breeds (including variations in size and weight at adulthood), there are also variations between the times at which certain breeds reach sexual maturity. On average the smaller breeds will mature faster than larger breeds. In addition, within certain rabbit breeds there is also variation between the varieties of that breed"

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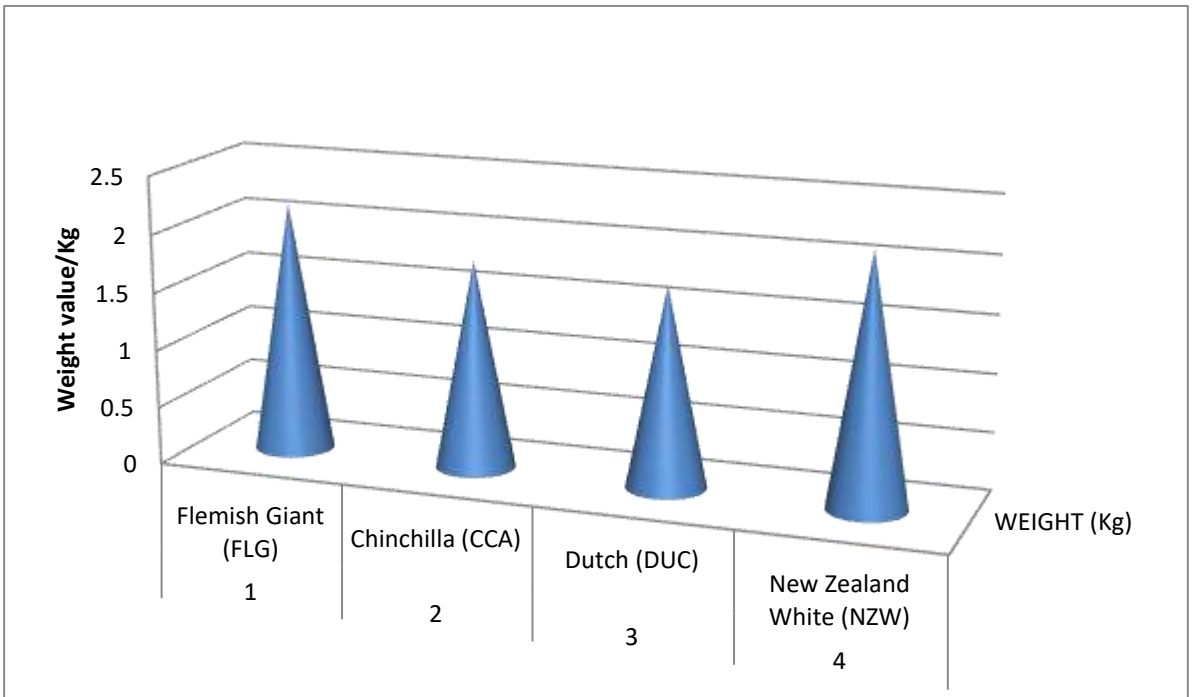


	1	2	3	4
	Flemish Giant (FLG)	Chinchilla (CCA)	Dutch (DUC)	New Zealand White (NZW)
WEIGHT (Kg)	2.17	1.8	1.73	2.16

Figure 2: Average Weight of Breeds of Rabbits at 2 Week of Pregnancy (Kg)
Flemish Giant (FLG), Chinchilla (CCA), Dutch (DUC), New Zealand White (NZW)

Figure 2 showed the average weight of rabbits' breeds at 2 week old pregnancy. FLG had 2.17kg with the increment of 0.06kg followed by NZW, 2.16kg with the increment of 0.09kg while DUC had the least weight of 1.73 but with increment of 0.06kg. This may be due to breed of the animal that genetically determines the wellbeing and size of zygotes.

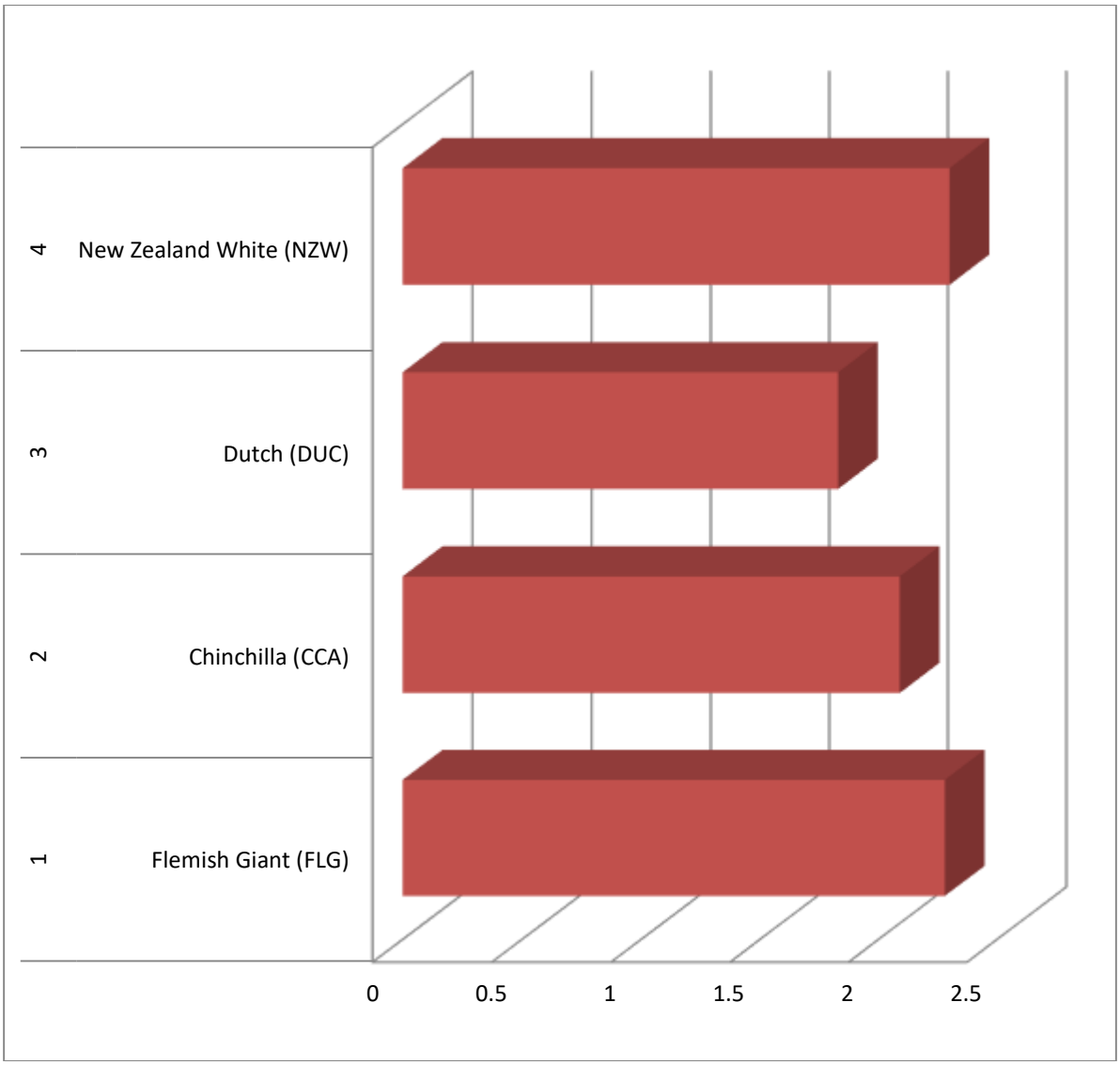


Figure 3: Average Weight of Breeds of Rabbits at 4 Week of Pregnancy (Kg)
Flemish Giant (FLG), Chinchilla (CCA), Dutch (DUC), New Zealand White (NZW)

Figure 3 showed the average weight of rabbits at 4 week of pregnancy. NZW had the highest weight of 2.30kg closely followed by FLG with 2.28kg while DUC had the lowest value of 1.83kg. This may be due to genetic composition of the breeds complemented by the environment in term of feeds and management practices. This supported the work of TNAU (2015) that adequate measures should be taken concerning feeding and management during pregnancy period. Quantity of feed should be increased for 10 to 15 days of pregnancy. Plenty of fresh water should be provided. Environmental stresses should be avoided as far as possible**.**

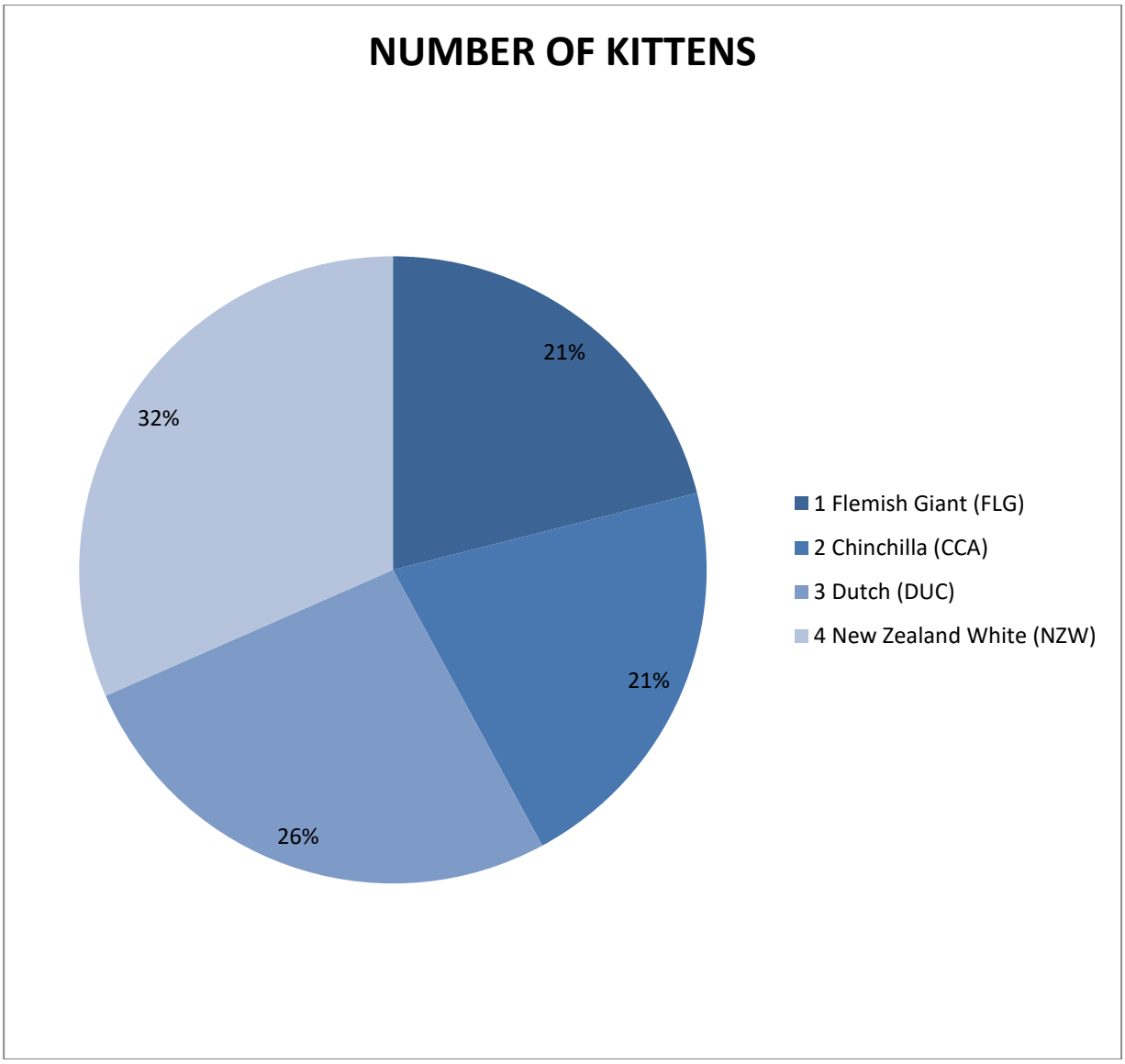


Figure 4: Average Litter Size of Rabbits per Kindling
Flemish Giant (FLG), Chinchilla (CCA), Dutch (DUC), New Zealand White (NZW)

Figure 4 showed the average litter size of selected breeds of rabbits per kindling. NZW had 6 kittens per kindling which was equivalent to 36% followed by DUC, 5 kittens (26%) while FLG and CCA had 4 kittens appease equivalent to 21% of the litter size per kindling of the selected breeds of rabbits. This may be due to genetic make-up of the animals, differences in parental care and feed management. This is in conformity with the work of Dana, (2016) that a single female rabbit can have 1-14 babies per litter, but to be conservative the average litter size is six. This is in support of the work of Diane (2016) that young does may kill and eat their young for a number of reasons, including nervousness, neglect (failure to nurse), and severe cold. Dogs or predators

entering a rabbitary often cause nervous does to kill and eat the young. Cannibalism of the dead young occurs as a natural, nest-cleaning instinct. If all management practices are proper and the doe kills 2 litters in a row, she should not be used for breeding.

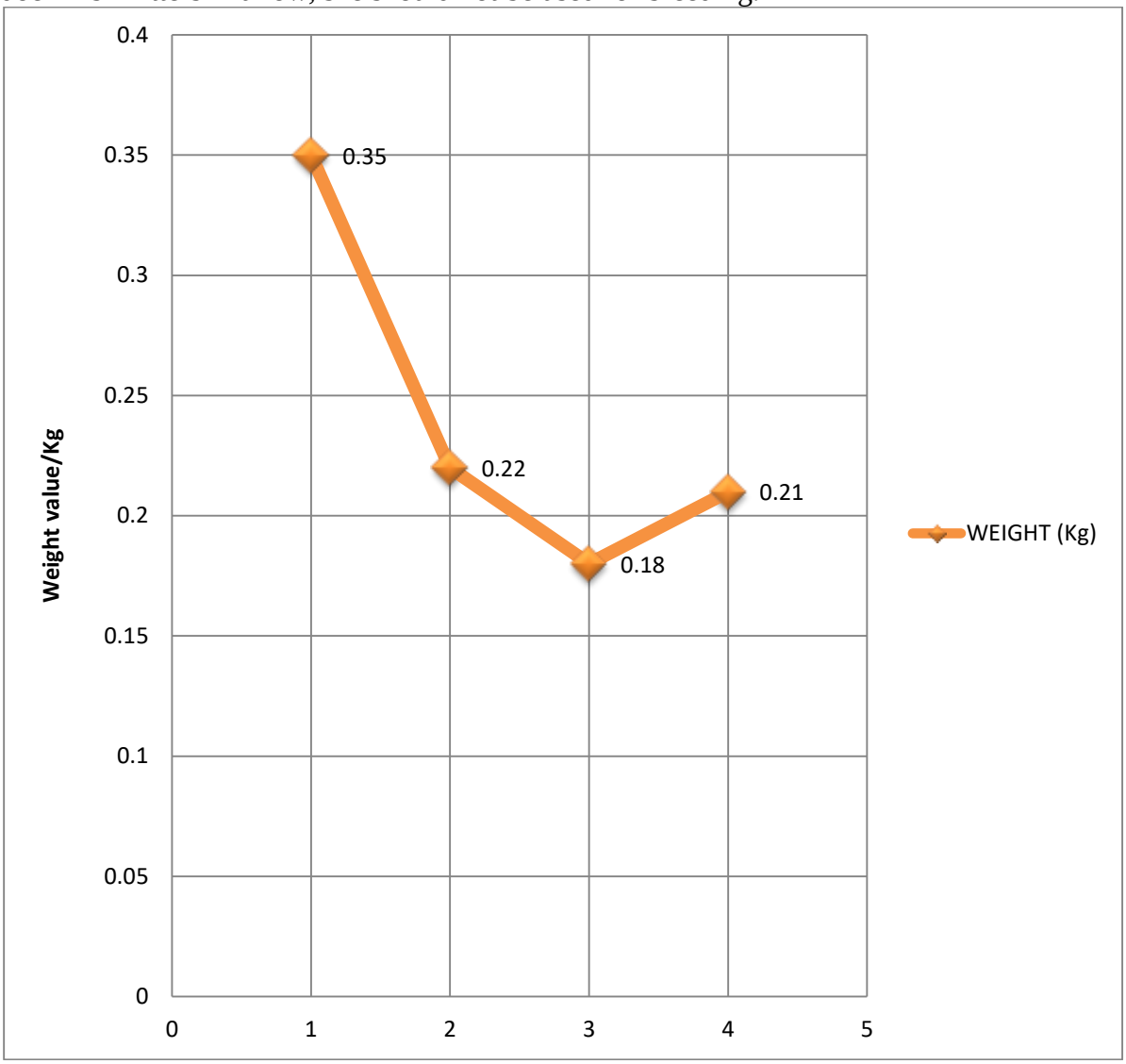
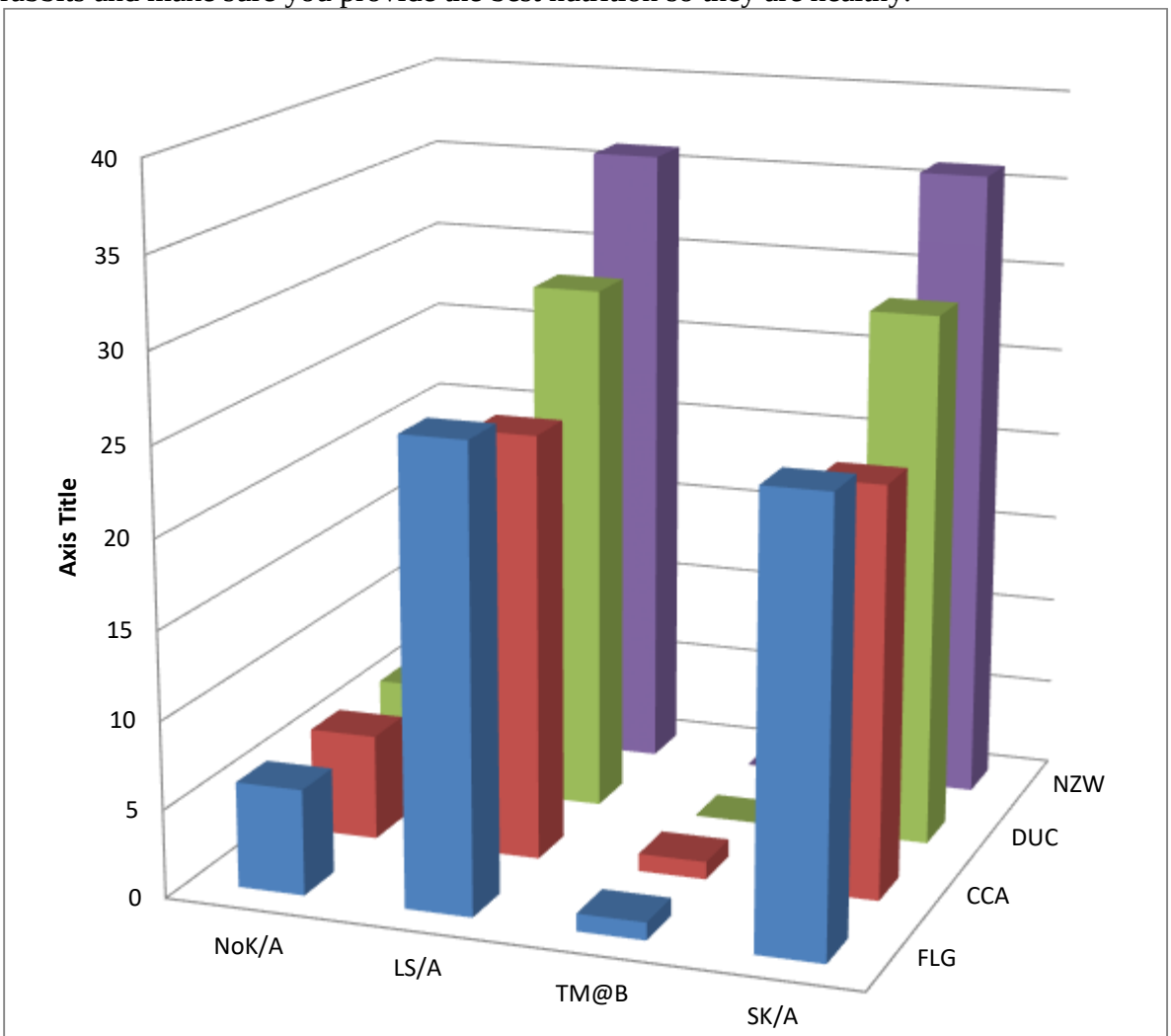


Figure 5: Average Weight of Kittens at 3 Week-old (Kg)

In figure 5, average weight of kittens at 3 week old in kg was shown. The kittens were left for 3 weeks after bath before weighing to avoid mortality due to mother's rejection due to touching. FLG kittens had 0.35kg as the highest weight followed by CCA, 0.22kg while the least weight of 0.18kg was recorded against DUC. This may be due to genetic constituents of the breeds, feed in pregnancy and after pregnancy. This is in conformity with the work of Hannah and Kitten (2020) on average weight of kittens at three week old, **"average three week old kitten weight:** 350-450 grams". This also supported the work of Pippa (2019) that rabbits should not be underweight or

overweight because this affects the success of the breeding. You should monitor what you feed the rabbits and make sure you provide the best nutrition so they are healthy.



	NoK/A	LS/A	TM@B	SK/A
FLG	6	26	1	25
CCA	6	24	1	23
DUC	6	30	0	30
NZW	6	36	0	36

Figure 6: Fecundity Analysis among Selected Breeds of Rabbits
NoK/A-Number of Kindling per Annum, LS/A-Litter Size per Annum, TM@B-Total Mortality@Birth, SK/A-Surviving Kittens/Annum, Flemish Giant (FLG), Chinchilla (CCA), Dutch (DUC), New Zealand White (NZW)

Figure 6 x-rayed the ability of breeds of rabbits to give birth per annum. All selected breeds of rabbits were successfully mated 6 times in a year to give resting period for the does. NZW had the highest litter size per annum at the value, 36 followed by DUC of 30 bunnies per annum while CCA had the lowest number of bunnies per annum, 24. This may be due to genetic constituents and management practices. This conforms to the work of Dana, (2016) reported that rabbit gestation lasts 28-31 days, and because they are induced ovulators, mother rabbits can be impregnated again within minutes of giving birth. This means that doe could, hypothetically, have one litter per month if she is constantly with a male rabbit.

Total Mortality at Birth occurred with FLG and CCA with one mortality appease while DUC and NZW recorded no mortality. NZW had the highest surviving kittens per annum with 36 bunnies followed by DUC with 30 while the least value of 23 kittens was recorded against CCA breed.

CONCLUSION

The result of the research work concluded that there was significant difference in prolificacy and fecundity among the selected breeds of rabbits put under study. The studies showed that all rabbits' breeds used were significantly different in all parameters; weight before mating, weight at two week of pregnancy, weight at four week of pregnancy, weight at kindling (birth) and weight of kittens at three weeks of age except the litter size.Flemish Giant breed proved to be outstanding in term of size while New Zealand White had largest litter size.Flemish Giant and New Zealand White are therefore recommended for farmers as breeding stock and to be crossed together for hybrid vigour

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