The Journal of Animal & Plant Sciences, 27(1): 2017, Page: 75-81
ISSN: 1018-7081

PRODUCTION PERFORMANCE OF INDIGENOUS RABBITS UNDER TRADITIONAL AND INTENSIVE PRODUCTION SYSTEMS IN NORTHERN PAKISTAN

K. Khan[1], S. Khan[2], N. A. Khan[2*] and N. Ahmad[2]

[1]Department of Animal Sciences, Shaheed Benazir Bhutto University Sheringal, Khyber Pakhtunkhwa, Pakistan
[2]Faculty of Animal Husbandry and Veterinary Sciences, The University of Agriculture Peshawar, 25130, Khyber Pakhtunkhwa, Pakistan
[*]Corresponding Author: Email: nazir.khan@aup.edu.pk

ABSTRACT

The present study was conducted to evaluate the effect of rabbit phenotypes and production systems (traditional *vs.* intensive) on the production performance of indigenous rabbits in Northern Pakistan. A total of 128 rabbits from four distinct phenotypes, denoted as white, black and white, brown and black, were allotted to a traditional (household subsistence) and intensive (modern husbandry and balanced feeding) production systems for a period of 12 months. Compared to the traditional production system, mean litter size was large ($P < 0.05$) at birth (6.47 *vs*. 5.13) and weaning (5.84 *vs*. 4.41), while the pre-weaning mortality was lower ($P \leq 0.05$; 9.41 *vs*. 13.6%) under the intensive production system. Inter-kindling interval was lower ($P \leq 0.05$; 53.3 *vs.* 84.7 days) and the rate of annual kindling was higher ($P \leq 0.05$; 6.58 *vs.* 4.29) under the traditional system. However, the mean weight of doe at first kindling (1329 *vs.* 1199 g) and the mean weight of kit at weaning (348 *vs*. 308 g) was higher ($P \leq 0.05$) under the intensive production system. This study develops the first dataset on the production performance of rabbits raised in Northern Pakistan under traditional and intensive production systems, and shows that the production performance of indigenous rabbits can be improved under the intensive production systems, and brown phenotypes are more efficient in terms of weight gain at weaning and first kindling.

Keywords: Indigenous rabbits, Production performance, Traditional system, Intensive system.

INTRODUCTION

Globally, the demand of meat is projected to be 73% higher in 2050, and a major part of this increase will arise from the developing countries (FAO, 2011), because of the increasing incomes and fast population growth (Makkar *et al.*, 2014). The consumption of animal products has increased, and this shift is likely to continue in the coming decades. As a consequence, in many developing countries, such as Pakistan, the animal production systems are facing enormous challenge to meet the growing demand for quality meat products. As a result, the pressure on feed resources has been increased. A quest for both alternate feed resources and an affordable and more efficient animal production system is a must for meeting the increasing demand for quality meat on sustainable basis.

Domestic rabbit (*Oryctolagus cuniculus*) is a potential, unexploited, micro-livestock species that possess a number of features such as high reproductive efficiency, early sexual maturity (Hulot *et al.*, 1988; Rommers *et al*., 2010), short (30.2-30.4 days) gestation length (Ghosh *et al.*, 2008), and short (81-87 days) generation interval (Effiong and Wogar, 2007; Hassan *et al*., 2012). Rabbits can extract energy and nutrients from feedstuffs that are rich in fiber (Finzi, 2008), and as such they can extract nutrients and energy for low-cost roughages and other organic wastes (Irlbeck, 2001). Therefore, rabbits have less competition with human for cereal grains compared to other monogastric micro livestock species (Iyeghe-Erakpotobor *et al*., 2006). Moreover, the available literature shows that white meat of rabbit is highly valued for its nutritional and dietetic properties (Hernandez *et al.*, 2008), such as for lower fat, cholesterol and sodium contents and a higher protein content (Arino *et al.*, 2007; Khan *et al*., 2016). This background provides an impetus to fully exploit the potential of rabbit for meat production, particularly in the resource scarce developing countries.

In Northern Pakistan, several types of rabbits are reared under small-scale, backyard production systems. Recently, rabbit production has gained considerable interest in the region, due to a marked increase in the prices of conventional sources of meat. Moreover, the agro-climatic condition and feed resources of the region is conducive for the production of rabbits. Rabbit is relatively a new introduction as a farm animal in Pakistan and more particularly in Khyber Pakhtunkhwa province, and so far, there is no commercial rabbit production in the Province. In the remote areas rabbits are mostly reared in traditional house-hold system (Khan *et al.*, 2016). However, to the author's knowledge, information on the production performance of rabbits under the current small scale production system is scarce.

Moreover, no systematic research has been conducted to evaluate the production competence of the indigenous rabbits under the modern intensive production system. Therefore, the present research study was designed to provide a comprehensive insight on the production potential of the indigenous rabbits of Khyber Pakhtunkhwa under the traditional subsistence production system and the scientific feeding and husbandry based intensive production system.

MATERIALS AND METHODS

Ethical considerations and study area: This research study was pre-approved in the Departmental Board of Studies meeting for procedures involving live rabbits handling, welfare and standard laboratory protocols. The study was conducted at the Rabbit Research Center of the University of Agriculture Peshawar (34°00′ N latitude, 71°30′ E longitude, and 350 m altitude) from March 2013 to February 2014. The summer mean maximum atmospheric temperature was 37.4 °C and mean minimum temperature was 24.5°C, while in winter mean maximum temperature was 24.4°C and mean minimum temperature was 9.9°C with annual rain fall of 380 mm.

Rabbit selection and experimental design: Four types of commonly reared rabbits, denoted as white, black and white, brown and black were selected or this study. Twelve breeding does and four breeding bucks of each rabbit type were selected from the herd at the Rabbit Research Center, and assigned into the traditional (household subsistence) and intensive (modern husbandry and balanced feeding) production systems according to randomized complete block design. The blocks were balanced for sex ratio, age and body weight.

Housing and feeding in intensive production system: In the intensive farming condition, all the experimental rabbits were kept in individual concrete metabolic cages (60 cm length, 60 cm width and 40 cm height) having wire flour, with a movable trays fixed below the wire flour for collection of urine and feces. Each cage was equipped with a feeder and drinker. Berseem hay was fed *ad-libitum* as a basal diet. The basal diet was supplemented with a calculated amount of pelleted concentrate supplying calculated 60% of the total metabolizable energy and protein requirements of the rabbits. The ingredients and proximate composition of the concentrate pellet feed is presented in Table 1. Fresh hay was provided in the feeder twice daily, and the daily concentrate allowance was fed in three equal proportions every day. The feeding and management practices were uniform throughout the experimental period. All rabbits had 24 h/d free access to clean drinking water. For breeding, the does of each phenotype were individually taken into the respective buck cages early in the morning (5:00 to 8:00 am) and late afternoon (5:00 to 8:00 pm) for 5 to 10 minutes and visually observed for mating. In case of failure the procedure was repeated till successful mating. Pregnancy diagnosis was performed during 15-17 days post conception through abdominal palpation. On day 25 (post-conception), the pregnant does were shifted to maternity cages constructed from galvanized welded wire in a well-ventilated concrete house. The pregnant does were carefully managed and fed according to nutrients requirements. The rabbits remained in the maternity cages till weaning (35 days post parturition). After successful weaning, the kids were shifted to the floor and does were allowed to rebred in afore mentioned breeding cages.

Housing and feeding in traditional production system: In the traditional production system, the four rabbit types were maintained in isolated tunnels/natural burrows. Twelve breeding does and four breeding bucks from each rabbit types were housed in separate facility guarded by "mud shelter" and wire fencing. All experimental rabbits were offered green fodder *ad-libitum* and were allowed separate grazing at day time. Rabbits had free access to clean drinking water all the times. Free mating was allowed to all experimental animals within the tunnel. Births took place inside the tunnels and the kits were counted on day 14 to 16 post kindling when they come out from the burrows. All the experimental rabbits and kits were properly tagged and were carefully observed for data collection.

Statistical analysis: The effects of rabbit types and production systems on litter size at birth and weaning, pre-weaning mortality, inter-kindling interval, annual kindling, kit weight at weaning, age at first kindling and weight at first kindling was analyzed using PROC MIXED procedure (Littell *et al*., 2006) of the Statistical Analysis System (SAS version 9.2, SAS Inst. Inc., Cary, NC). The model used for the analysis was,

$$Y_{ijk} = \mu + RG_i + PS_j + \epsilon_{ijk}$$

Where, Y_{ijk} is the observation on dependent variable; μ the overall population mean; RG_i is the fixed effect of rabbit types (i = white, black and white, brown and black); PSj is the fixed effect production systems (j = intensive production system and traditional production system); ϵ_{ijk} is the residual effect. When significant ($P \leq 0.05$) differences were observed, post-hoc analyses were carried out using Tukey-Kramer test to compute pair-wise differences in the means. Results are presented as least square means with their standard deviation and model estimated standard error of the mean (SEM).

RESULTS

Data on gestation length, litter size at birth, litter size at weaning, pre-weaning mortality, inter-kindling interval and annual kindling, as affected by the production systems and rabbit phenotypes, are presented in Table 2. Gestation length did not differ (P > 0.05) due to rabbit types and production system. The litter size at birth (6.47 *vs*. 5.13) and weaning (5.84 *vs*. 4.41) was higher (P ≤ 0.05) under the intensive production system. Moreover, the pre-weaning mortality of kits was lower (9.41 *vs*. 13.6%; P ≤ 0.05) under the intensive production system. However, litter size at birth and weaning and pre-weaning mortality did not differ (P > 0.05) among the rabbit types. Inter-kindling interval was lower (53.3 *vs.* 84.7 days; P ≤ 0.05) and the rate of annual kindling was higher (6.58 *vs.* 4.29; P ≤ 0.05) under traditional production system. Among the rabbit types, inter-kindling interval and the rate of annual kindling did not differ (P > 0.05).

Data on effect of the production systems and rabbit phenotypes on weaning weight, age at first kindling and weight at first kindling are summarized in Table 3. Kit weight at weaning was higher (348 *vs.* 308 g; P ≤ 0.001) under the intensive production system. Kit weight at weaning differed (P ≤ 0.001) due to rabbit types, and the highest (330 g) weight (P ≤ 0.001) was recorded for the brown rabbits. Age at first kindling was lower (211 *vs.* 224 days; P ≤ 0.05), whereas the weight at first kindling was higher (1329 *vs.* 1199 g; P ≤ 0.05) under intensive production system. Among the rabbit types, age at first kindling did not differ (P > 0.05) among the rabbit types. On the other hand, weight at first kindling was higher (P ≤ 0.05) for Brown (1266 g) and Black and white (1263 g).

Table 1. Ingredients and chemical composition of the experimental diet

Ingredients	**(%)**
Maize	47.5
Cotton seed cake	10.0
Soybean meal	8.00
Wheat bran	31.0
Palm oil	3.00
Salt	0.25
Vitamin/mineral premix	0.25
Chemical composition (%)	
Dry matter	89.4
Crude protein	17.3
Crude fiber	15.3
Ether extract	4.58
Digestible energy (MJ/kg)	9.68

Table 2. Production performances of rabbits under traditional and intensive production system in Northern Pakistan

Traits	Rabbit types				SEM[1]	Production system		SEM	Significance[2]	
	White	Black and white	Brown	Black		Traditional	Intensive		Rabbit types	Production system
Gestation length	29.8±0.31	30.0±0.37	30.1±0.36	30.5 ±0.42	2.345	29.3±0.36	30.1±0.36	0.142	NS	NS
Litter size at birth	5.69±0.69	5.88±0.78	5.94±0.96	5.69±0.71	0.206	5.13±0.65^{b}	6.47±0.91^{a}	0.146	NS	***
Litter size at weaning	4.94 ±0.55	5.19±0.60	5.31±0.89	5.06±0.98	0.216	4.41±0.85^{b}	5.84±0.66^{a}	0.153	NS	***
Pre-weaning mortality (%)	12.9±12.9	11.9±9.96	10.3±11.6	10.8±11.9	3.263	13.6±9.29^{a}	9.41±13.9^{b}	2.307	NS	***
Inter-kindling period (d)	79.9±4.24	70.2±3.50	69.6±3.29	70.1±6.21	3.568	55.3±5.09^{b}	84.7±3.53^{a}	2.488	NS	***
Annual kindling	5.25±0.51	5.43±0.33	5.44±0.46	5.43±0.30	0.219	6.58±0.49^{a}	4.29±0.31^{b}	0.155	NS	***

Values are expressed as means with their standard deviation
$^{a-b}$Means within a row, within production system, with different superscript letters differ significantly at P < 0.05 level
[1]SEM = Standard error of the mean
[2]NS, not significant; ***, P ≤ 0.001

Table 3. Weaning weight, age and weight at first kindling of the rabbits under traditional and intensive production system

Traits	Rabbit types				SEM[1]	Production system		SEM	Significance[2]	
	White	Black and white	Brown	Black		Traditional	Intensive		Rabbit types	Production system
Weaning weight (g)	326±1.29^{b}	328±3.86^{b}	330±0.78^{a}	327±1.77^{b}	0.484	308±1.58^{b}	348±2.27^{a}	0.342	***	***
1st kindling age (days)	217±1.39	216±3.67	218±3.17	220±2.03	0.771	224±3.61^{a}	211±1.52^{b}	0.545	NS	***
1st kindling Weight (g)	1261±2.29^{c}	1263±2.42^{b}	1266±3.12^{a}	1262±2.59^{bc}	0.613	1199±2.54^{b}	1329±2.67^{a}	0.433	***	***

Values are expressed as means with their standard deviation
$^{a-c}$Means within a row, within rabbit types or production system, with different superscript letters differ significantly at P < 0.05 level
[1]SEM = Standard error of the mean
[2]NS, not significant; ***, P ≤ 0.001

DISCUSSION

A rapid increase in the demand for meat due to a rapid rise in human population in the resources-limited developing countries has triggered a growing research to exploit the potential of low-inputs animal production systems (Mermelstein, 2002; Habib *et al*., 2016). Although rabbit has many production advantages such as high prolificacy, rapid growth and short generation interval (Effiong and Wogar, 2007; Hassan *et al*., 2012), and can extract energy and nutrients from low-cost fiber-rich forages (Khan *et al*., 2017) and organic wastes with less competition for feed with human and mono-gastric animals. Limited work has been done on local rabbits to exploit their poteintal for meat produciton. The present study reports the first comprehensive dataset on the production performance of indigenous rabbits under traditional and intensive production systems. The database can be used to device management and feeding strategies for the local rabbits. The results showed that the production performance of indigenous rabbit was improved under the intensive system, demonstrating an opportunity for improvement in the meat quality traits and large-scale production for the local rabbits.

The litter size at birth and at weaning is the most critical economical traits in rabbit production. The large litter size at birth in the intensive production system could be, in part, related to the effect of balanced ration (concentrates and forage combination); proper housing and management. Various authors have reported that balanced ration improve ovulation rate, number of fertilized ova and pre-implantation viability (Rashwan *et al*., 1995; Argente *et al*., 2003; Ahmed *et al*., 2005). Our results are consistent with the findings of Ndor *et al*. (2010). The current study reported a gestation length of 29.3 to 30.5 days in the indigenous rabbits, and the rabbit types and the production systems did not alter the gestation length. In agreement with our findings, a gestation length of 30.2 to 30.4 days was recorded by Ghosh *et al*. (2008) with non-significant effect of breed on gestation length (Addass *et al.*, 2010).

The kit mortality at the weaning phase is the most critical factor determining the litter crop at weaning. The net financial return of the farm is also dependent on pre-weaning kit mortality (Rashwan and Marai, 2000). The dams milk production (Ayyat *et al*., 2010); climatic condition, management and skills are the major contributory factors towards pre-weaning kit mortality. The lower pre-weaning kit mortality recorded under the intensive production system may be the response of balance ration and improved managemental practices. The concentrate and forage intake by the rabbit does may have resulted to higher availability of nutrients leading to better embryonic development pre-partum, and a higher availability of does milk causing lower mortality during the pre-weaning phase (Effiong and Wogar, 2007).

Milk is usually the sole source of nourishment for rabbit kits in early days, therefore kit growth and development depends on doe milk production. Rabbit milk yield may be affected by breed-type (Lukefahr *et al*. 1983), nutrition (Chrastinova *et al*., 1997), number of kits suckling, their age of weaning (Taranto *et al*., 2003) and pregnancy during lactation (Lukafahr *et al*., 1983). In the present study, highest weaning weight of kit was noted in the intensive production system. Higher weaning weight in the intensive production system may be due to the role of balance ration, rabbit in this production system effectively utilized minerals and other nutrients in the feed to increase the quality and quantity of milk for proper nursing of the kitten which thereby resulted in the higher kit weaning weight. Our results are supported by earlier findings of Ndor *et al*. (2010).

Annual kindling (number of crops per year) is dependent on the inter-kindling interval. In the present study, least inter-kindling period and more number of crops per year were noted under traditional production system as compared to intensive system. It might be due to the fact that in this system the does remained within closed contact with the bucks and has more chances of mating. Inter-kindling interval of 98.7 days in New Zealand White and 86.6 days in Soviet Chinchilla breed was reported by Ghosh *et al*. (2008), which is within the range of values (84.7±3.53 days) observed for the intensive production system in our study. Kits of brown rabbits had the highest (330 g) weaning weight, whereas the does of brown and black and white rabbit had higher weight at first kindling. Similarly, Ghosh *et al*. (2008) reported a weaning weight of 695 g for New Zealand White and 710 g for Soviet Chinchilla. Discrepancy in the findings of the two studies might be due to the differences in breed, environment as well as that of feeding and husbandry practices.

Conclusions: This study develops the first dataset on the production performance of rabbits raised in Northern Pakistan under traditional and intensive production systems. The results showed that mean litter size was improved at birth (20.7%) and weaning (24.5%), while the pre-weaning mortality were reduced (44.5%) under intensive production system. Similarly, 11.5% improvement in weaning weight and 9.80% at first kindling weight was noted. Most of the production performance variables did not vary due to rabbit types. The study demonstrates that the production performance of indigenous rabbits was improved under the intensive production system, highlighting an opportunity for improvement in the meat quality traits and large-scale production for the local rabbits.

Acknowledgements: The Agriculture linkages program of Pakistan Agriculture Research Council Islamabad is acknowledged for financial support in this study.

REFERENCES

Addass, P., A. Midau, and M. Tizhe (2010). Variation Pattern for Some Reproductive Characters among Selected Breeds of Rabbits in Bauchi, Nigeria. World J Agric Sci. 6(2): 127-131.

Ahmed, N.A., A. Elfar, and O. Sakr (2005). Evaluation of sexual and maternal behaviour, hormonal pattern and reproductive performance of doe rabbits as affected by seasonal variation. Paper presented at the Proceeding 4th International Conference Rabbit Production Hot Climates, 2005.

Argente, M., M. Santacreu, A. Client, and A. Blasco (2003). Relationships between uterine and fetal traits in rabbits selected on uterine capacity. J Anim Sci. 81(5): 1265-1273.

Arino, B., P. Hernandez, M. Pla, and A. Blasco (2007). Comparison between rabbit lines for sensory meat quality. Meat Sci.75(3): 494-498.

Ayyat, M., I. Marai, and G.A. El-Sayiad (2010). Genetic and non-genetic factors affecting milk production and preweaning litter traits of New Zealand White does under Egyptian conditions. World Rabbit Sci. 3(3): 119-124.

Chrastinova, L., A. Sommer, J. Rafay, and M. Svetlanska (1997). Avotan exploitation in rabbit nutrition. II. Nutrient digestibility and lactation performance of does rabbit. J Farm Anim Sci. 30: 80-86.

Effiong, O. and G. Wogar (2007). Litter performance traits of rabbits under mixed feeding regime. Paper presented at the Proceeding 32th Annual Conference of the Nigerian Society of Animal Production. Calabar, Maret, 2007.

FAO, (2011). World Census of Agriculture: analysis and international comparison of the results (1996-2005). FAO Statistical Development Series No. 13. Rome, 2011.

Finzi, A. (2008). Rabbit production development, new strategies to avoid conflict between use of natural resources for food and feed. Paper presented at the Proceedings of the International Workshop on Organic Rabbit Farming based on Forages. Cantho University, Vietnam, 2008; pp. 1-6.

Ghosh, S.K., A. Das, K.M. Bujarbaruah, D. Asit, K.R. Dhiman, and N.P. Singh (2008). Effect of breed and season on rabbit production under subtropical climate. World Rabbit Sci. 16(1): 29-33.

Habib, G., N.A. Khan, A. Sultan, and M. Ali (2016). Nutritive value of common tree leaves for live stock in the semi-arid and arid range lands of Northern Pakistan. Livest Sci. 184, 64-70.

Hassan, H.E., K.M. Elamin, I.A.S. Yousif, A.M. Musa, and M.A. Elkhairey (2012). Evaluation of body weight and some morphometric traits at various ages in local rabbits of Sudan. J Anim Sci Advan. 2(4): 407-415.

Hernandez, P., V. Cesari, and A. Blasco (2008). Effect of genetic rabbit lines on lipid content, lipolytic activities and fatty acid composition of hind leg meat and perirenal fat. Meat Sci. 78(4): 485-491.

Hulot, F., J. Mariana, and G. Cattiau (1988). HCG-induced ovulation in two rabbit breeds: effects of dose, season and sexual behaviour. Livest Prod Sci. 20(3): 257-267.

Irlbeck, N. (2001). How to feed the rabbit gastrointestinal tract. J Anim Sci. 79: 343-346.

Iyeghe-Erakpotobor, G., R. Aliyu, and J. Uguru (2006). Evaluation of concentrate, grass and legume combinations on performance and nutrient digestibility of grower rabbits under tropical conditions. African J Biotechnol. 5(20).

Khan, K., S. Khan, R. Khan, A. Sulatan, N.A. Khan, and N. Ahmad (2016). Growth performane and meat quality of rabbits under different feeding regimes. Trop Anim Health Prod. 48 (8): 1661-1666.

Khan, K., S. Khan, S. Ullah, N.A. Khan, I. Khan, and N. Ahmad (2017). Nutritive value, fiber digestibility and methane production potential of tropical forages in rabbits: effect of species and harvest maturity. The J Anim Plant Sci. 27(4):(In press)

Littell, R.C., G.A. Milliken, W.W. Stroup, R.D. Wolfinger, and O. Schabenberger (2006). SAS® System for Mixed Models (2nd eds). SAS institute Cary, NC (2006).

Lukefahr, S., W. Hohenboken, P. Cheeke, and N. Patton (1983). Characterization of straightbred and crossbred rabbits for milk production and associative traits. J Anim Sci. 57(5): 1100-1107.

Makkar, H.P., G. Tran, V. Heuzeand, and P. Ankers (2014). State-of-the-art on use of insects as animal feed. Anim. Feed Sci Technol. 197, 1-33.

Mermelstein, N.H. (2002). A look into the future of food science & technology. Food Technol. 56(1): 46-55.

Ndor, L., O.J. Owen, and V.N. Nyeche (2010). Influence of housing systems on the performance and reproductive characteristics of wearnerrabbits reared in Port Harcourt, Rivers state, Nigeria. Int. J Agric Biol. 12: 947–949.

Rashwan, A., S. Ahmed, and M. Tawfeek (1995). Doe reproduction and preweaning and postweaning litter performance of straitbred and crossbred rabbits. J Agric Sci. 20 (6): 2839-2851.

Rashwan, A. and I. Marai (2000). Mortality in young rabbits. A review: World Rabbit Sci. 8:111 – 124.

Rommers, J., R. Meijerhof, J. Noordhuizen, and B. Kemp (2010). Effect of different feeding levels during rearing and age at first insemination on body development, body composition, and puberty characteristics of rabbit does. World Rabbit Sci. 9(3): 101-108.

Taranto, S., C. Di Meo, G. Stanco, G. Piccolo, M. Gazaneo, and A. Nizza (2003). Influence of age at weaning on caecal content characteristics and post-weaning performance and health of rabbits. Asian-Aust. J Anim Sci. 16 (10): 1540-1544.