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Characterization of rabbits production systems in Egypt

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Abstract

This study aimed to characterize rabbit (*Oryctolagus cuniculus*) production systems during two periods of the year: almost hot weather (from April to September 2021) and almost cold weather (from October 2021 to March 2022). A survey was conducted in two governorates, El-Minya and Al-Qalubia, through semi-structured interviews with a questionnaire. Three types of production systems were identified: family (66%), semi-commercial (22%), and commercial (12%). The commercial rabbit production system had the highest significant average number (153.13) compared to the semi-commercial system (18.90) and family system (2.29). Although the average doe number was slightly higher in the almost cold period (63.64) than in the almost hot period (52.77), no significant differences were observed. The majority of householders in the family system (52.38%) and semi-commercial system (80.95%) housed their rabbits in rooms inside their homes, while 86.96% of householders in the commercial system used separate rabbit houses for their rabbits. Most farmers (87.30%) reared their rabbits on the floor under a family system. Battery cages was the most predominant form of rearing being 83.33% and 95.65% for the semi-commercial and commercial system; respectively. In conclusion, rabbit production is typically a family system with a tendency to become semi-commercial. Rabbit housing systems vary according to the available resources and the applied production system. Different rearing systems and seasonal variations can affect the rabbit flock structure.

Keywords: rabbits, production system, housing system, flock structure.

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1. Introduction

In developing countries where malnutrition is prevailing, rabbits can play an important role in nutritional security as a mean to alleviate food shortages of poor villagers. Poultry production has a vital role in addressing deficiency of food in several countries (Khalil *et al*., 2016). As rabbit meat is a good source of protein, vitamins and minerals (Cullere and Zotte, 2018; Kunnath, 2017) and has low fat, sodium and cholesterol contents compared to other livestock (Bodnár and Skobrak, 2014; Dalle Zotte and Szendro, 2011) which is of major concern to consumer health. The fat contains high proportions of essential polyunsaturated linolenic and linoleic acids, less stearic and oleic acids (Kunnath, 2017). Rabbit's meat contains selenium which acts as an antioxidant to remove free radicals. However, despite its health benefits, the consumption of meat is considered quite low when compared to other countries, this is due to many reasons such as the low income of the villagers, hence rabbits which produced at low cost could be an opportunity to meet the villagers demand at an affordable price and bridge the wide gap in dietary protein intake. El-Raffa (2004) indicated that rabbits are considered as an alternative source of protein in developing countries, where there is a deficiency in animal protein. Rabbit production system has many advantages such as the capability to effectively utilize less competitive fibrous feedstuffs and digest leaf protein, high rate of reproduction, short gestation length, early sexual maturity, short generation interval, high growth rate, efficient feed and land space use. In addition, they do not compete with humans for grains (Elamin, *et al*., 2012; Effiong and Wogar 2007; Musa 2003). Moreover, Rabbits are the most effective converters of feedstuff into meat (Taiwo *et al*., 2004). The existence of caecal microbes allows rabbits to digest fibrous feeds (Lebas *et al*., 1997). Rabbit is producing about 47 kg meat/doe/year, which is sufficient to meet the requirements of animal protein for a medium sized family in a traditional rural farming system (Adedeji *et al*., 201١). Egypt is a lower middle income, overpopulated country, and with the rapid increase in the Egyptian population, demand for animal protein will increase. Around 33% of the population lives below the poverty line. Most of hungry people in the world (80%) live in the rural areas (De Haen, 2003). Therefore, involving rural families in income generating activities is a prerequisite to alleviate poverty. Rabbits farming is considered one of the methods through which rural villagers can increase their income. Rabbits farming considered one of the main strategies used to reduce poverty and nutritional deficiency (Cherwon *et al*., 2020; Mutwedu *et al*., 2015). Rabbit production is also important to the economy of some developing countries like Nigeria, Egypt, Ghana, Morocco, and Cape Verde

(Zwingelstein and Lebas, 1996). Rabbits have a big role in the socio-economic development of the farmers in rural areas (Odinwa *et al*., 2016). In Egypt, Kamel and Lukefahr (1990) indicated that village rabbit projects that directly involved young people, reduced the rate of youth migration to urban areas. Rabbit commercialization generates income to villagers (Gono *et al*., 2013; Mutsami and Karl, 2020; Tembachako and Mrema, 2016). According to Kale, *et al*. (2016) rabbit manure is a natural source of soil nutrition, used as organic fertilizer as it is the case with cattle manure (Cishesa *et al*., 2022; Upenji *et al*., 2020). In the meantime, researchers focused on mono-disciplinary approach to solve problems relating to rabbits, instead of research based on system approach. Given the importance of linking research to development, it becomes necessary to move from a mono-disciplinary to a multi-disciplinary approach (based on system approach) (Conroy, *et al*., 2002). Also, most of the research on rabbit production has focused on rabbit nutrition and were conducted under on-station conditions (Oseni, 2008). To the best of the authors' knowledge, there is very limited research on rabbit production systems in Egypt. Therefore, the aim of this research is to provide a better understanding of rabbit farming, explored the status of rabbit farming systems in the rural areas under two periods of the year (almost hot and almost cold).

2. Materials and methods

2.1 Study site

The geographical coordinates of Al-Minya are 28.11° North and 30.11°East and its weather is dry throughout the year. The average precipitation 14.59 mm /year, and its human population is around 5.8 million, which is about 5.1% the whole population of Egypt. The total area is 32,279 km^2, which represent 3.2% of the total area of Egypt. Human development index was 0.657 in 2017. The climatic conditions in the study areas are of the subtropical type. June is the warmest month with an average of 37°C, while the coldest month is January with an average of 20°C. The month with the highest relative humidity is December (67%), and the month with the lowest relative humidity is May (37%). Al Qalyubiya coordinates are 30°18'0" North and 31°18'0" East The total population reached 5,703,000. It has an average of precipitation rate of 39 mm/year. The total area is 1,001 $km^2$and the human development index was 0.698 in 2017.

2.2 Data collection

The study was carried out in two governorates (Al-Minya and Al Qalyubiya). A cross-sectional and longitudinal survey was performed during two periods of the year: almost hot from April to September 2021 and almost cold from October 2021 to March 2022.

The Egyptian climate is characterized by warm days and cold nights. There are two main seasons: a mild winter (November–April) and a hot summer from May to October (Goma and Phillips, 2021). The data was collected through a structured questionnaire by interviewing 200 farmers face to face. The questionnaires had both open and closed ended questions which were clear and easy to understand. The questionnaire was piloted with 10 rabbit keepers in each governorate. The questionnaire covers information about flock structure, types of hutches and housing system.

2.3 Data analysis

To measure the association between categorical variables, we used Chi-Square tests, while the General Linear Model (GLM) of SAS program (SAS, 2010) was used to analyze the variation of continuous data (two-way factorial arrangement, 3×2), F-test was applied to test look into differences between relevant parameters. Statistically significant differences ($P < 0.05$) were indicated by different superscripts. The following linear model was used as follows:

$$Yijk = \mu + Si + Pj + (SP)ij + eijk$$

Where Yijk is the observed flock structure, μ is the general mean, Si is the effect of production system, i = 1, 2, 3 (1=family, 2=semi-commercial and 3=commercial), Pj is the effect of period of the year, j =1, 2 (1= almost cold, 2= almost hot), (SP)ij is the interaction between production system and period of the year, eijk = is the random error.

3. Results and Discussion

3.1 Characterization of rabbits farming in Egypt

Characterization of rabbit production systems will allow the application of fruitful improvement and development plans. Rabbits may be reared under a wide range of production systems (extensive or family, semi-commercial and commercial). In the extensive production system rabbits are kept under varying conditions in a primitive housing, usually fed on farm made feed and kitchen waste, with different stocking density and operated by family labor. The semi-commercial and commercial production systems are technically advanced, rabbits kept under controlled conditions in a relatively good housing in large flock sizes, fed on complete pelleted diets, and may be operated by hired labor. Rabbit's production systems composed of a mixture of several aspects such as different housing systems with different equipment (ventilation, lighting, feeding and drinking) and subjected to different management practices (Cerolini *et al*., 2008). Based on the number of does in the current study, the contribution of the family members in the farm activities,

the breeding objective, the use of equipment, and technological component, rabbit's production systems classified into three production systems: (1) The family (extensive), (2) Semi-commercial, and (3) Commercial system.

3.2 Brief description of the systems

3.2.1 The family rabbit's production system

Most householders live under limited-resource conditions of, feed supplies, equipment and capital. Therefore, the promotion of intensive rabbit production system may not be appropriate for them because they may be subjected to considerable economic risk. Consequently, the family rabbit production system considered the most prevailing system, represented about 66% of the studied sample. Farmers have the lowest number of breeding does (varying from 1 to 7), as the amount of rabbit meat produced depends upon the number of breeding does, also reflected on the average of weaned rabbits. This system is a low input farming system mainly based on family labor, especially women can easily do the managerial practices in little time she can spare from the routine household work. The householders try to maximize the use of on-farm inputs. Gacem and Lebas (2000) indicated that rabbit production systems are mainly extensive (8.0 does /unit and 20.1 rabbits produced per doe per year). Zwingelstein and Lebas (1996) noted that small rabbit farming system with 8 to 10 does, constitute 64% of farms in Sub-Saharan Africa and 58% in North Africa. The small-scale production is the most widespread one in many developing countries, with poor husbandry knowledge and funds for expansion (Lukefahr, 2007; Oseni and Ajayi 2008; Zwingelstein and Lebas, 1996). According to Finzi (2000), family production system characterized by the following: (1) small number of breeding rabbit does, (2) labor is family based, (3) feeding on fresh kitchen waste and green forages, (4) integration of rabbits with other poultry, (5) use of the available local materials for hutches and equipment, (6) home consumption of rabbits and the surplus is sold in the local market.

3.2.2 The semi-commercial rabbit production system

Under the semi-commercial rabbit production system householders use a little bit higher level of input than the extensive system, such as better housing and cages, and using commercial pelleted feed, this supplemental feed helps to boost rabbits' productivity hence improve sustainability. This system represented about 22% of the surveyed sample. The breeding does number is larger than that in the extensive system ranging from 8 to 45 Doe. This system is market-oriented since the householders have to some extent better skills in management and marketing than their counterparts in the family production

system. Householders can invest their available capital in order to intensify their farming system as a means to abandon poverty. In order to achieve this, market accessibility and creating a high demand for rabbit meat must be established and advanced. It seems that inadequate financial resources and limited information are the main factors hindering transformation of this system to commercial system. Priyanti and Raharjo (2013) indicated that medium scale rabbit farming increases income and improves the nutritional status of householders and enhances their livelihoods.

3.2.3 The commercial rabbit production system

The commercial rabbit production system is a high-input and technically advanced rearing system that relies more on off-farm bought inputs. It is based mainly on a group of wire battery cages and almost all labor force is hired. Feeding is provided by commercial pellets and water is supplied by pipelines and nipple system. In addition, disinfection procedures are adopted. This system represented nearly 12% of the total surveyed sample. Householders have the highest number of breeding does (varying from 50 to 400) compared to the aforementioned systems. The European commercial rabbitries have a does number ranging from 300–500 doe or more. The intensive rabbit production system rely on wire cages, which are located inside buildings (Hernández and Gondret, 2006). Rabbits reared under this system are more likely to display aggressive behavior, especially at puberty. Unlike the family system under which rabbits have more space and free to move everywhere. So, it permits them a broad range of natural behavior patterns (Morisse *et al*., 1999). Commercial rabbit production system is a closed cycle performed on a farm with does and bucks reared separately in individual wire cages, while the growing kids reared in collective cages (Szendrő *et al.,* 2012).

3.3 Rabbits flock structure

The largest average does number were detected under the commercial rabbits production system being 153.13 with high significant differences comparable with the other two systems as shown in Table (1). The respondents under the family production system had the smallest significant growing rabbits (5.50) as compared to the semi-commercial (59.13) and commercial (536.09) rabbits production system. The same trend was observed for kits number being 10.9 vs 77.42 and 730.87 kit for the aforementioned production systems (Table 1). As indicated in Table (2) the number of does, bucks, growing rabbits and kits was a little pit larger in the almost cold period (from October to March) than in the almost hot period (from April to September) with no significant differences. Regarding the interaction effect between production system and the period of the year in

Table (3). There were statistically significant differences ($p \leq 0.01$) in the average does number between the production system and period of the year. Farmers under the commercial system during the cold period of the year had the highest average number of does being 169.09±7.23 followed by those during almost hot period being 137.17±7.23 as shown in Table (3). The same trend was observed in bucks' number, growing rabbits, and kits number.

Table (1): Rabbits flock structure (LSM ± SE) under the different production systems.

Items	Family system	Semi-commercial system	commercial system
Does number	2.29±2.22C	18.90±3.78 b	153.13±5.11 a
Bucks number	0.98±0.37 C	4.27±0.64 b	21.72±0.86 a
Growing rabbits	5.50±9.78 C	59.13±16.70 b	536.09±22.56 a
Kits number	10.90±13.22 C	77.42 ±22.57 b	730.87±30.50 a

Means with different superscripts within the same row are significantly different (P<0.001).

Table (2): Rabbits flock structure (LSM ± SE) under the two periods of the year.

Items	Almost cold weather	Almost hot weather
Does number	63.64±3.17	52.77±3.17
Bucks number	10.04±0.54	7.93±0.54
Growing rabbits	215.73±14.01	184.75±14.01
Kits number	312.22±18.94	233.90±18.95

Table (3): Rabbits flock structure (LSM ± SE) as affected by the interaction between production system and the period of the year.

Production system	Period of the year	Does number	Bucks number	Growing rabbits	Kits number
Family production system	Almost cold weather	2.59±3.13 ^{d}	0.99±.53 ^{d}	7.61±13.80 ^{c}	15.46±18.65 ^{c}
	Almost hot weather	2.59±3.14 ^{d}	0.97±.53 ^{d}	3.39±13.85 ^{c}	6.33±18.73 ^{c}
Semi-commercial production system	Almost cold weather	19.26±5.35 ^{c}	4.31±.90 ^{c}	59.57±23.61 ^{c}	86.43±31.92 ^{c}
	Almost hot weather	18.55±5.35 ^{c}	4.23±.90 ^{c}	58.69±23.61 ^{c}	68.40±31.90 ^{c}
Commercial production system	Almost cold weather	169.09±7.23 ^{a}	24.83±1.22 ^{a}	580±31.91 ^{a}	834.78±43.14 ^{a}
	Almost hot weather	137.17±7.23 ^{b}	18.61±1.22 ^{b}	492.17±13.91 ^{b}	626.96±43.14 ^{b}

$^{a-d}$Means in the same column with different superscripts are significantly different (p<0.01).

3.4 Housing systems

Good housing is very important for rabbit to protect them against unfavorable circumstances and improve productivity, where poor housing may be led to spread of diseases. It seems that housing is linked to behavioral, hygienic, and health aspects. Mailafia *et al*. (2010) indicated that housing is indispensable for a successful rabbits farming. As indicated in Table (4) householders in this study provide different sort of housing as a separate house, room, coop, backyard (underground hole). The majority of the householders in the family (52.38%) and semi-commercial (80.95%) system housed their rabbits in room inside their home while almost most of the respondents (86.96%) uses separate rabbit house for their rabbits under the commercial system. The backyard housing system (10.32) was found only under the family system,

where rabbits in the backyard make for themselves houses in holes. The location of rabbits houses were mostly in the farmer's home being 50.79 % and 52.38% for the family and semi-commercial systems; respectively whereas the majority of the householders (86.96%) in the commercial system have a separate rabbit house as shown in Table (4). The majority of farmers (87.30) reared their rabbits on the floor under the family system, this may be due to the limited financial and technical information. This rearing system is the most simple because it gives the rabbits all the freedom to run around and move anywhere, so rabbits have its natural living conditions. The bucks and does are not reared separately and consequently keeping record about them is difficult.

Table (4): A wide array of rabbit housing systems details under the different production systems.

Items	Family		Semi-commercial		Commercial	
	Number	%	Number	%	Number	%
Type of housing						
Rabbits House	0	0	7	16.67	20	86.96
Room	66	52.38	34	80.95	3	13.04
Coop	47	37.30	1	2.38	0	0
Backyard (underground hole)	13	10.32	0	0	0	0
Location						
Outside the farmer home	4	3.17	8	19.05	20	86.96
In the farmer home	64	50.79	22	52.38	2	8.70
On the rooftop	58	46.03	12	28.57	1	4.35
Rearing system						
On the floor	110	87.30	5	11.90	0	0
In cages (wood & wire mesh)	13	10.32	2	4.77	1	4.35
In battery cages (fully galvanized)	3	2.38	35	83.33	22	95.65
Floor type						
Concrete	98	77.78	38	90.48	21	91.30
Ceramic	1	0.79	2	4.76	2	8.70
Soil	27	21.43	2	4.76	0	0
Roof type						
Concrete	47	37.30	25	59.52	15	65.22
Wood	58	46.03	15	35.71	4	17.39
Palm branches	21	16.67	2	4.76	4	17.39
Walls type						
Red bricks covered with cement	7	5.56	15	35.71	6	26.09
Red bricks and cement	62	49.21	21	50.0	4	17.39
Red bricks and clay	39	30.95	0	0	0	0
White bricks and cement	18	14.29	6	14.29	13	56.52
Electricity (available)						
Yes	75	59.52	42	100	23	100
No	51	40.48	0	0	0	0
Ventilation status						
Good	111	88.10	40	95.24	32	100
Moderate	14	11.11	2	4.76	0	0
Bad	1	0.79	0	0	0	0

Differences between systems for type of housing are significant ($\chi 2$ =145.7, P≤0.0001). Differences between systems for location are significant ($\chi 2$ =99.77, P≤0.0001). Differences between systems for rearing system are significant ($\chi 2$ =147.22, P≤0.0001). Differences between systems for floor type are significant ($\chi 2$ =16.20, P≤0.0028). Differences between systems for roof type are significant ($\chi 2$ =13.23, P≤0.0102). Differences between systems for walls type are significant ($\chi 2$ =65.18, P≤0.0001). Differences between systems for is their electricity are significant ($\chi 2$ =35.89, P≤0.0001). Differences between systems for ventilation status are not significant ($\chi 2$ =5.70, P≤0.2228).

Possibility that rabbits can eat infected feed as they pass out their faeces on the ground, this faeces is considered great risk to the health of the rabbits, because chances to get infected of diseases with coccidiosis is very high. Hungu *et al*. (2013) indicated that the limited access to technical information is the main reason for the poor construction of rabbit houses. Battery cages were the most predominant form of rearing being 83.33% and 95.65% for the semi-commercial and commercial system; respectively, these batteries were fully galvanized to protect from getting rusted. Chave (2003) recommended cages (equipped with a feeder and a nipple drinker) because of its benefits such as better disease control, close rabbit monitoring, ease of management. Given these benefits, the daily husbandry practices can easily carry out. However, Suc *et al*. (1996) mentioned the disadvantage of cages is that exposure of rabbits to high temperature during the hot season, negatively affect feed intake and live weight gain of rabbits. Only a minor percentage (about 10.32 %) of householders under the family system reared their rabbits in self-built cages constructed from locally available materials such as wood and wire mesh as indicated in Table (4). The use of the locally available materials such as wood to build rabbit house was also observed by Oseni and Ajayi (2008). It is worthy to mention that it is difficult to keep wood clean because it would soak up accumulated urine. Therefore, Schiere (2004) encouraged the use of wire mesh as opposed to wood for the floor so that the faeces and urine can fall down, decreasing disease occurrences. Appropriate hygiene and management of cages could inhibit the spread of certain epidemic diseases (Lukefahr and Cheeke, 1991). A varied variety of construction materials were used for building the rabbit house. The rabbit house ceiling was made of concrete (37.30, 59.52, and 65.22%), wood (46.03, 35.71, and 17.39%) and palm branches (16.67, 4.76 and 17.39%) under family, semi-commercial and commercial rabbit production systems, respectively (Table 4). Lukefahr *et al*. (2000) indicated that poor householders with limited resources use locally available materials to build rabbits houses and added that rabbits used to empower women and children. Walls were made of red bricks covered with cement, red bricks and cement, red bricks and clay, and white bricks and cement. Red bricks and cement (49.21 and 50%) were the main component of the house walls under the family and semi-commercial rabbit production system, respectively. White bricks and cement (56.52%) were the major component of the rabbit's house wall under the commercial production system. Most of the respondents (59.52, 100, and 100 %) under the family, semi-commercial and commercial production systems stated that there is a source of electricity in the rabbit's house. The results of the present study indicated that about 88.10, 95.24 and 100% of the

householders had houses with good ventilation for their rabbits under the aforementioned systems as indicated in Table (4).

4. Conclusion

The nutritional properties of rabbit meat suggest its regular consumption, especially by children and elderly people. The use of rabbits could be of great value as its potential to decrease malnutrition and poverty. Rabbit production is typically of family system, with a tendency to become semi-commercial. Rabbits housing systems vary according to the available resources and to the applied production system. Different rearing system and season variation can affect the rabbits flock structure. To rear rabbits on a commercial scale providing training, microcredit and other logistics support is important. For setting up good rabbit farming industry, further systematic research is needed to identify constraints to production and putting appropriate policies to promote the growth of rabbit industry.

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