

Pig behavior research and its application in breeding-landrace pigs as an example.

Guanghai Teng^{1*}, Qiudong Yu^{1,2}

¹College of Water Resources & Civil Engineering, China Agricultural University, Beijing, PR China

²Department of Computer and Information Engineering, Tianjin Agriculture University, Tianjin, PR China

Abstract

Social demand for Landrace pigs continues to grow, and the existing farming methods cannot meet the commercialization of Landrace pigs at present. Therefore, the existing methods of culture were observed by using behavioral characteristics of Landrace pigs, in this paper. And the circle as well as large-scale breeding was conducted. Pure Landrace pigs in selected farm were monitored for 24 h without interruption. The test results are as follows: most of the behavior of the Landrace pigs can be expressed but a small part of the nature and habits can't be expressed in the circle of feeding mode. It can keep the purity of the Landrace pigs intact in this kind of farming mode, which improved the survival rate of Landrace pigs production. In addition, pig breeding was optimized and re designed, which made the species more in line with the needs of their various stages of growth and development. The sows and piglets were high bed breeding area by optimizing design in order to make the structure more reasonable distribution and make more reasonable separation of breeding pigs. The optimization and re design can guarantee the Landrace pigs offspring survival rate and purity could be improved in the large-scale feeding. The number of Landrace pigs will be expanded to provide the first experimental data for large-scale pig breeding in the future.

Keywords: Landrace pigs, Behavioral characteristics, Survival rate.

Accepted on January 14, 2017

Introduction

Landrace, originated in Denmark, is a world famous lean type pig. Main advantages is the multiple calving, fast growth, province feed, carcass lean meat rate higher, but poor resistance, higher requirements for the feed nutrition [1]. At present, there is little research about the behavior of Landrace pigs and there are few studies on the behavior of the common pigs. Investigating the behavioral characteristics of Landrace pigs in order to improve the economic benefit of Landrace pigs breeding due to Landrace pigs affected by environmental conditions and long-term formation of feeding habits (year-round in the natural pasture grazing, free feed), which provided the basis for the healthy growth and reproduction of Landrace pigs and the preservation and utilization of the resources of Landrace pigs [2-4]. The existing methods of culture were observed by using behavioral characteristics of Landrace pigs in this paper. And the circle as well as large-scale breeding was conducted. Pure Landrace pigs in selected farm were monitored for 24 h without interruption. Finally, the optimization and design of the pig breeding were carried out.

Current Situation of the Study on the Behavior of Landrace Pigs

Living habits

For large-scale Landrace pigs, after eating they will choose a shady place to play slapstick, and use swine nasal arch. The activity of pigs decreased after 1-2 h. It will choose its way to adapt to the temperature of the lunch break. If the temperature is low, the pigs will bask in the central enclosures. If the temperature is too high, it will be in the shade or in the water or eating beside the mud in the shady and cold places. The scope of its activities is limited to the side of the sow in the first week of the birth. They often lie on the side to rest. And they will not be affected by external noise and other interference during rest [5]. The activity was significantly improved and its range of activities has become more extensive after a week. Some of the pigs ran out of the pigsty. But it is more sensitive to external stimuli and will run back to the pigsty when frightened promptly.

Rutting behavior

The piglets at the age of 45 days of birth, weighing about 3 kg have non-induction of intromission behavior, found in both

male and female, which presents abdominal contraction, and small boar penis inside wrapping a slight rotation in the prepuce. The boar at four months age was found that the penis extends, and at five months age penis secretes. There was obvious representation of the sows' estrus at the age of four months. At the onset of estrus sow vulva moist enlargement, restless, chasing climb across the other pigs; after 1-2 days, vulva further enlargement of damp and dark almost black, mucus outflow, near the boar sows, two forelimb hold sows the hindquarters, provided extensor muscle also bite sow back mane leveraging; about 2 ~ 3 minutes, keep quiet, ejaculation; after 5 ~ 8 minutes, the mating was end. After the distribution of the vulva moist sows, individual sows will be discharged milk white or yellow jelly like mucus. Later, sow burnout, joy away from pigs in a quiet corner of the rest, close to the human or porcine screams; stand in the behind, moving its tail, tail root tight, swelling of the vulva and becomes dry, gradually swelling was pale pink. The whole heat period lasts 4 - 6 days [6,7].

Sexual behaviors

The first sex of pigs occurred in 45 days after birth, which is reflected in the boar and sow body. Its weight is roughly equal. Sexual behavior is unconscious. Pigs will shrink by half ABS so that the body height increased. The reproductive organs were only creeping in its foreskin to small boars [8]. And the reproductive organs of the real mature secrete liquid at the same time after 4-5 months. This time will be a real sexual behavior. And this true sexual behavior occurs mostly in the early morning after eating. Pigs in specific pigs can chase play each other and occur climbing phenomenon at the same time to specific pig after eating [9]. And the sow's heat period is also in the 4 months or so. The genital will be followed by swelling and swelling with becoming more than 1.5 times before the heat and its color will become bright red in the process of breeding sows. Two forepaw of boar will hold the second half body boar sows and the abdominal crunch at the same time when the boar is closed. Teeth bites sow mane. The two pigs will remain stationary at the same time and after mating for 2-3 minutes the boar ejaculates. The whole mating process is complete in 5-8 minutes. The reproductive organs of the sow will remain moist for longer periods of time after mating. Sow removals of secretions of boar occasionally. The sow is usually alone with a quiet place and will be close to the outside world to show a strong vigilance at this time [10]. At the same time, genital swelling slowly and in a dry state. The whole period of the male sow is generally 6 days after the end of the season.

Delivery behavior

Pregnant sows will show obvious signs of fetal movement 4-5 days before delivery. Its genitals will also swell until the last 7 h before delivery. The sow will find open space for arch excavation in the field so that it appears a pit. And make hay and other items in the field put on the basis of the pit after crush and then lying in the pit until the last 3 h or so. They will be quiet to wait for production [11]. The delivery process of

the sow will take about half an hour to an hour. Pigs need to rest about 5 minutes between each output. The body of the pig afterbirth will fall off automatically after the production about an hour in the night because most of its production time is at night. For Landrace pigs, the average total litter of pigs is 13, and the number of live births of litter is about 11.9.

Breast feeding behavior

Landrace pigs breast feeding behavior is shown in Figure 1. Sows and piglets will echo each other during lactation. When parents need food preparation or sow lactation, they give each other to call to shout at each other in suckling. They will make hay and other items in the field of placed in the body and lying on the ground when the sows in lactation. If there is any competition between the surrounding any stimulus or piglets, the sow will stop feeding action and repeatedly adjust its action to rest when the sow begins to nurse. When the number of pigs is small and significantly less than the number of secrete breast nipple of sows, pigs will no longer fixed sucking a nipple, and conduct sucking by turns between the nipples. And when the piglet age became old, sow lactation time become relatively fixed and average daily feeding times is about 30 times. The number of breast-feeding reaches the maximum value when the pig was born 15 days or so. Piglets don't need help their suckling from sows at this time. Pigs will usually touch sow nipples by noses and then sucking the milk just like before. Most of the pigs will run around and only a few pigs still suckling sows milk at this time. With the natural growth of piglets, they weaned sows naturally when piglets born to 3 months later. The excretion of pigs is extremely regular in concentrated in captivity, which usually concentrated in 1-2 h after a meal and three times a day. Feces are excreted in the dark corner of the feeding field.



Figure 1. Landrace pigs breast feeding behavior.

Materials and Methods

Behavioral test methods

Behavioral test animals: Select a Landrace Pig breeding farm in Tianjin reservoir (Figure 2) to make sure that pigs' health and development are in good condition. Take a single circle of feeding to Male and sow with 6 pigs in the first round. Pig

breeding is a double row type, brick and cement floor with a total of 20 observations of a pigsty.

Test time and place: The test time is from February 2016 to August 2016. At the same time, the test venue is a Landrace Pig breeding farm in Tianjin.

Test equipment: Camera, a display, a standard than swatches, pH meter, wire, plastic bags, electronic balance, absorbent paper, surgical knife.



Figure 2. Landrace pigs in A Pig breeding farm of Tianjin.

Test method

The experiment method is concealed observation method. That does not have any effect on the daily life of Landrace pigs with observation about 24 h [12]. The sense of the Landrace pigs is much better than the other pig breeds [13]. So it cannot be observed by people but machine as well as people in entering different time. The monitor is used to monitor the performance of the monitor during the day and the method of artificial shooting at night is used for observation. The day time is 6:00-18:30 and the night time 18:30-6:00.

Feeding and management

All feeding locations are closed at the experimental site. The ground is a rough cement surface and uses a large area of the active space. Ensure that the selected location of the environmental unity and in line with all the requirements before the experiment. Conduct installation of monitoring equipment. The feeding time of the pig was fixed and that is at 6:30 in the morning and at 5:30 in the afternoon. So the choices of feed are common pig feed and is to be mixed into the liquid to feed due to environmental conditions and other reasons can't be used for special feed in this experiment. The composition and nutrition level of the specific diets are shown in Table 1.

Table 1. Dietary composition and nutrient levels (air dry basis).

Composition materials	of raw Mixture ratio %	Nutritional indicator	Nutrient level
-----------------------	------------------------	-----------------------	----------------

Corn	64	Digestible energy (MJ/kg)	14.24
Soybean meal	26	Crude protein	15.25
Premix	10	Lysine hydrochloride	1
Total	100	Methionine cysteine	+ 0.36
		Threonine	0.57
		Tryptophan tryptophan	0.12
		Calcium	0.74
		Available phosphorus	0.26

Results and Analysis

Behavioural activity

Activity and lying behavior: Statistical data in Table 2 showed that the activities of Landrace pigs were more than in the daytime, and the amount of activities in the night was decreased significantly. The proportion of the whole day was (37.78 ± 6.67), and the rest time was (62.22 ± 1.32%). The proportion of active time of lactating sows was (60.14 ± 10.22%), and the rest time was (31.86 ± 6.44%). The main conditions may appear as follows in this traditional mode of large-scale cultivation of Landrace pigs: (1) Enough time of activity and activity of the sows were given in the breeding mode. (2) Pigs will affect the sows when the piglet and sow together in captivity, which can lead to normal growth and development.

Table 2. The activities and resting time of the sows (%).

	Lactating sow	Sow
Sample number	6	6
Proportion of daytime activity time	84.2	58.7
Proportion of daytime lying time	15.8	41.3
Proportion of nighttime activity time	40.67	28.73
Proportion of nighttime lying time	59.33	71.27
Proportion of all day activities time	(60.14 ± 10.22)	(37.78 ± 6.67)
Proportion of all day lying time	(31.86 ± 6.44)%	(62.22 ± 1.32)

Foraging behavior: It can be adapted to the original stocking model due to the characteristics of Landrace pigs. And the impact of feed adjustment is minimal because of its ability to absorb and endure hunger. And the Landrace pigs also appeared in the phenomenon of common pig in the feeding process. That big head of Landrace pigs tends in most food slot for feeding and other pigs only in relatively few locations

eating. And Landrace pigs will be issued and grunting with pig nose arch in the eating process. The length of time to eat is seen Table 3 in the case of a fixed time of eating.

The whole day the total harvest time of sow is (49.58 ± 2.45) min. Total feeding time of the whole day is (40.42 ± 10.57) min. The total length of time required for feeding sows to piglets is less than that of sows without that. And in the statistical data, the need to feed the lactating sows per day is not fixed and not to take the time to eat pig relatively fixed. The reason for this phenomenon is that the presence of piglets will affect the feeding time of the sow. For example, the milk sucking pig behavior will make the sows eat shorter.

Table 3. Foraging time of sows.

	Lactating sow	Sow
Sample number	6	6
Morning feeding time (min)	28.42	26.53
Feeding time in the afternoon(min)	18.63	26.26
Total harvest time (min)	40.42 ± 10.57	49.58 ± 2.45

Excretion behavior: It can be seen that normal physiological excretion times of without taking piglets sow is more than sows taking piglets obviously when observe the pigs (Table 4).

Table 4. Defecating times of the sows.

	Lactating sow	Sow
Sample number	6	6
The times of defecation during the day	3.6	4.2
The times of defecation during the night	2.1	3.2
Total defecation time (min)	5.7 ± 0.52	7.4 ± 0.38

There is no fixed area to its excretion for the Landrace pigs. Therefore, there will still exist everywhere such as waste can't be changed habits in such a way in captivity, which will cause it to become filthy pig and make it easier to get sick.

Breast feeding behavior: The nipple of the selection of the Landrace pigs is usually 14 in this experiment. They are usually lying in a haystack sideways to suckle during lactation. Of course, they stand up to lactation occasionally. Sows and piglets will echo each other during lactation. They will shout to call each other at the person to the suckling when parents need food or to sow lactation. They will place hay and other items in the field under the body when the sows in lactation. At the same time, healthy piglets grab milk volume up to suck the nipple. The milk of sows is largest in the 3 days after production and time for milk is the longest and the shortest for waiting time. With the piglet age goes on, output milk quantity of sow is small and the interval time elongated constantly, which will be fixed in a certain period of time to breast feeding eventually. It will be very quiet when the pig sucks breast milk. Because the sow will be alert to get up and adjust the position

once the sound. And milk time is usually 30 seconds before and after.

Pig feeding time is not fixed, and breast-feeding is not the only position, which can stand or side. But the time of side was higher than that of standing significantly through the statistics. And there is a big difference in the time of lactation of sows, which has a relationship with the number required by suckling piglets, lactation time is longer with more pigs. Table 5 shows the nursing time of the sows.

Table 5. Nursing time of the sows.

Sample number	6
Time of standing lactation (min)	15.25
Time of Lying on the side lactation (min)	42.52
Total lactation time (min)	57.77 ± 8.24

Mating behavior: The time with the sex consciousness of boar is earlier than sows. We can see from Table 6 that the time of boar from climbing up to mixing time is (0.98 ± 0.05) min and the time from blending to climbing down is (6.03 ± 0.06) min.

Table 6. Boars mating time.

Observed number	Climb up to mating	Mating to climb down
7	(0.88 ± 0.06)	(7.12 ± 0.05)

Breeding behavior: The sow will find and open space for arch excavation in the field so that it appears a pit in the last 7 h before delivery. And they will place hay and other items in the field after crush bedding on the pit and then lying in the pit. It will be quiet waiting for production until the last 3 h or so. The production of Landrace pigs does not distinguish between day and night generally. But there will be a significant reduction in the amount of food intake and other phenomena in a few days before the production. And the sow also began to secrete milk at this time. Although Landrace pig has big amount and it very carefully take care of pigs. Therefore, the mortality rate is very low in Landrace pigs. Sows farrowing time and the number of farrowing as shown in Table 7.

Table 7. Sows farrowing time and the number of farrowing.

Observed number	16
Sows farrowing time(h)	4.29 ± 1.24
Placenta discharge time(h)	4.92 ± 1.00
The number of farrowing	5.46 ± 1.22
Gestation period (d)	115 ± 0.78

Fighting behavior: Landrace pigs' vigilance is very high, and very sensitive to the things around so that they easy to fight. It can be seen from the data in the Table 8 that the number of fights at night was significantly higher than the number of fights during the day. They were belonged to the stocking

model originally. It is more likely to be irritated and stimulated at night and produces more fights.

Table 8. Fighting times.

Sample number	6
Daytime fight time	9.2
Nighttime fight time	13.4
All day fight time	22.6 ± 1.6

Other act: Table 9 shows the other action times. Daily number of rub wall in the circle of Landrace pigs Raising condition is (12.3 ± 1.5). The number of scratching is (5.22 ± 0.31). The times of the scratching and rub wall indicate that the environmental health status in piggery in other actions. This behavior increasing obviously indicates that the health situation in piggery is not good, which need to be cleaned and clean up pig manure and other debris of Landrace pig in a timely manner. If you keep this environment for a long time, it will make the pig infected with bacteria and viruses. The number of Landrace pigs licking is (1.22 ± 0.03). Frequency is not high and this kind of behavior is also the predecessor of the disease. The number of male Landrace pigs daily climb is (0.44 ± 0.02). This is the performance of the pig in the heat of the pig.

Table 9. Other action times.

Sample number	6
Rub the wall	12.3 ± 1.5
Scratching	5.22 ± 0.31
Tim	30 ± 2.3
Lick	1.22 ± 0.03
Climb the cross	0.44 ± 0.02

Behavior analysis of landrace pigs in the breeding mode of circle

A theoretical analysis was carried out after observing the behavior of the Landrace pigs. This analysis includes the analysis of a series of life movements such as drinking water, eating, activity, excretion and so on. This analysis has a very important role in the design of farms. It can be concluded that this model is consistent with its original living habits from the analysis. It will promote its growth and so on so that it can be healthy and rapid growth. The Landrace pigs selected in this experiment provided the first experimental data and results on the scale of the pig breeding process design, which makes better development to the future industry Large-scale pig breeding will lead to it influenced in some behavior by different degree in the traditional mode of captive breeding. However, most of the behavioral habits can be satisfied. Thus, feeding patterns need to be carried out in some detail and in the direction of change and improvement [14-16].

It can be obtained through the observation of the data that lactating sows it will have a full time to carry out activities but the rest of the time to become shorter in the traditional farming mode. Therefore, it will affect the normal growth and tending of sows. And fixed time feed intake of lactating sows will lead to eating extremely irregular. In order to change the above shortcomings, the following ways are adopted to modify and improve: (1) The feeding of sows alters from large group to the composition of region culture. The sow and piglet were isolated and fed. Configure dedicated special beds to sows so as to ensure the rest and growth. It should meet the needs of various kinds of behavior at the same time. (2) The weaned time of piglets were controlled artificially. Its optimal weaning date is 50 days after production through the analysis of its living environment and living habits. (3) Feed for lactating sows should be better than the other stages significantly because it needs more nutrition. So it is necessary to increase the time and frequency of feeding.

There still is a habit that not excreted in the drain for Landrace pigs. The phenomenon will lead to the environment of their lives become bad with serious pollution and more garbage [17]. Therefore, clean the residential building in the circle of feeding mode timely to maintain a clean and hygienic environment and prevent the spread of disease among pigs caused by random waste. Feeding time of sows decreased with increasing number of piglets. Therefore, we believe that the number of pigs required lactation feeding divided in order to make each piglet have more adequate time to suck milk for their healthy growth. Conduct piglet quantity adjustment according to the actual situation of lactating to ensure each sow has 12-20 piglet lactation. Because the sow's milk is not enough to support its growth when piglet more than 16.

The wild nature of Landrace pigs like fighting. It can cause frequent brawl occurred in Landrace pigs when the same number of Landrace pigs excessive, which will cause the pig to be injured or even killed [18]. The number of Landrace pigs needs precise control to ensure the same pig in Landrace pigs can be maintained at around 10 in two feeding modes. It is necessary for Landrace to ensure its wild muscle and the compaction degree have sufficient space to exercise [19,20]. Ensure the development of the boars at the same time.

Process Design of Pig Breeding Scale

Landrace pig scale

We want to build the farm is a medium-sized farms. Herds of sows are in 300-350 head. The purpose is to give the surrounding farms to better breeding and the breeding Landrace pigs industry improves and develops rapidly.

Production process of pig scale breeding

The need for the equipment and site to the Landrace pigs is different in different growth development processes and for different genders. Such as the need for nutrition, etc., is higher in breast feeding sows than sows in lactation. The flow chart

(Figure 3) was established according to the different growth and reproduction process of Landrace pigs:

The design of the production flow chart needs to follow the following principles: (1) Ensure that all of them need to be formulated according to different Landrace pigs Breeds. (2)

Table 10. Sectional word raising process.

	Two stage type	Three stage type	Four stage type	Five stage type
Technological process	Not in pregnancy, lactation growth and fattening period	Not in pregnancy - Lactation period - Growth and fattening period	Pregnancy - Lactation period - Piglet nursery - Growth and fattening period	Not in pregnancy - Lactation period - Piglet nursery- Incubation period- Fattening period
Pig species	Sows, fattening	Pregnancy, late, fattening	Pregnancy, conservation, fattening	harness, conservation, breeding and fattening
Turn group times	-	1 times	2 times	3 times
Pig farm equipment utilization rate and rationality	Half a cycle, unreasonable	The utilization rate is general, the rationality is general	The utilization rate is high, the rationality is general	The utilization rate is the highest, and the rationality is good.
Operation management	Simple	commonly	commonly	complex
Advantage	-	Simple, low cost	High survival rate of piglets	High efficiency of pig

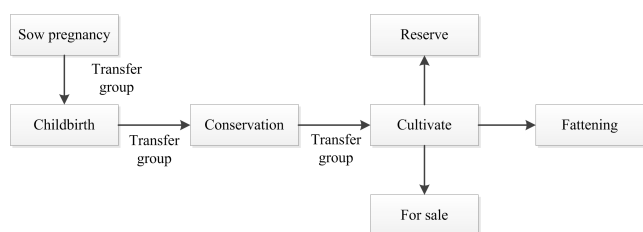


Figure 3. Production process flow chart.

Landrace pigs breeding process parameters

Pig breeding process design parameters are slightly different from the ordinary pig in view of there is a big difference of between living environment and production performance between the Landrace pigs and the common pig.

Table 11. Production parameters.

Production index	Parameter
Production rhythm (d)	30
Number of live births	6
Sow pregnancy rate (%)	90
Piglet survival rate (%)	90
Survival rate of piglets (%)	97
The growth of the fattening period of survival rate (%)	100
Weaning age (d)	50
Piglet nursery (d)	28

Design must be economical and environmental friendly, which is set for large scale pig farms. Ensure that the surrounding environment is not caused by pollution persecution and at the same time to meet the needs of Landrace pigs at the same time. Table 10 shows the sectional word raising process.

Male sow proportion	1:30
---------------------	------

Overview of pig breeding technology

The number of sows was 300 in the farm. It can provide for slaughter and sale of finished pig of about 5-6 head per year. Ordinary pigs use the circle of backyard style. Production of lactating sows use the way of high bed to scatter. The survival rate of Landrace pigs was the highest in this design. Table 11 shows the production parameters and table 12 shows the number of pigs at each stage.

Table 12. Number of pigs at each stage.

Stage	Number of Landrace pigs
Monthly number of sows	55
The monthly number of sows	46
Number of new piglets per month	242
Number of new piglets per month	220
The new monthly growth of fattening pigs number	210
The monthly number of slaughter pigs	203

Conclusion

The existing traditional farming methods have been unable to meet the needs of lactating sows. The training time of sow shortened because of the need to take care of the life time of pigs in this traditional way of captivity, which will allow the life of the sow to be affected with the number of eating to reduce. The resulting milk yield is not stable and the pig

growth is also affected. The captive is not only for sow considerable influence and also on piglet growth caused very serious impact. The growth cycle of pigs with variable elongated. So it is necessary to separate sow from pigs individually to make their respective regional zoning in their life so that it does not interfere with each other, which can prevent pigs disturb sows rest.

It also need to ensure that they have adequate space for the boar in captivity in the traditional way. Ensure that the activity space is about 1.5 times of its living space. Dig two defecation channel in the circle of foreign boar in order to prevent the winter temperature is low and the space of the frozen pig manure cannot be excluded.

It will lead to the pig manure lick arch probability becomes large in the traditional way of large-scale breeding boars. Boars are prone to viruses and bacteria may be infected each other. The soil arch should be provided special boar lick in the breeding process to avoid this kind of problem.

References

1. El Bouhssini M, Street K, Amri A. Sources of resistance in bread wheat to Russian wheat aphid (*Diuraphis noxia*) in Syria identified using the Focused Identification of Germplasm Strategy (FIGS). *Plant Breeding* 2011; 130: 96-97.
2. Riggi E, Avola G, Siracusa L, Ruberto G. Flavonol content and biometrical traits as a tool for the characterization of "Cipolla di Giarratana": a traditional Sicilian onion landrace. *Food Chem* 2013; 140: 810-816.
3. Tamiru A, Bruce TJ, Woodcock CM, Caulfield JC, Midega CA. Maize landraces recruit egg and larval parasitoids in response to egg deposition by a herbivore. *Ecol Lett* 2011; 14: 1075-1083.
4. Andersson A, Laikre L, Bergvall UA. Two shades of boldness: novel object and anti-predator behavior reflect different personality dimensions in domestic rabbits. *J Ethol* 2014; 32: 123-136.
5. Pérez-Torres S, Flores-Pérez F I, Orihuela A. Influence of tongue inspection during cysticercosis diagnosis on some behavioral and physiological stress measures in pigs (*Sus scrofa domestica*). *Tropical Animal Health Production* 2012; 44: 383-384.
6. McGlone JJ. Review: Updated scientific evidence on the welfare of gestating sows kept in different housing systems. *The Professional Animal Scientist* 2013; 29: 189-198.
7. Rutherford KMD, Donald RD, Lawrence AB. Qualitative Behavioural Assessment of emotionality in pigs. *Applied Animal Behav Sci* 2012; 139: 218-224.
8. Holl JW, Rohrer GA, Brown-Brandl TM. Estimates of genetic parameters among scale activity scores, growth, and fatness in pigs. *J Animal Sci* 2010; 88: 455-459.
9. Cui S, Chen D, Li J. A comparison of postural changes and maternal responsiveness during early lactation in Landrace and Minpig sows. *Appl Animal Behav Sci* 2011; 131: 40-47.
10. Valdez VA, Byrne PF, Lapitan NLV. Inheritance and genetic mapping of Russian wheat aphid resistance in Iranian wheat landrace accession PI 626580. *Crop Sci* 2012; 52: 676-682.
11. Tamiru A, Bruce TJA, Woodcock CM. Chemical cues modulating electrophysiological and behavioural responses in the parasitic wasp *Cotesia sesamiae*. *Canadian J Zoology* 2015; 93: 281-287.
12. Sadler LJ, Johnson AK, Lonergan SM. The effect of selection for residual feed intake on general behavioral activity and the occurrence of lesions in Yorkshire gilts. *J Animal Sci* 2011; 89: 258-266.
13. Landau AM, Doudet DJ, Jakobsen S. Amphetamine challenge decreases yohimbine binding to α_2 adrenoceptors in Landrace pig brain. *Psychopharmacology (Berl)* 2012; 222: 155-163.
14. Sonoda LT, Fels M, Oczak M. Tail Biting in Pigs-Causes and Management Intervention Strategies to Reduce the Behavioural Disorder. A Review. *Berliner und Münchener Tierärztliche Wochenschrift* 2013; 126: 104-112.
15. Nakamura K, Tanaka T, Nishida K. Behavioral indexes of piglet welfare: comparison of indoor and outdoor housing systems. *Animal Sci J* 2011; 82: 161-168.
16. Ursinus WW, Wijnen HJ, Bartels AC. Damaging biting behaviors in intensively kept rearing gilts: The effect of jute sacks and relations with production characteristics. *J Animal Sci* 2014; 92: 5193-5202.
17. Bovey KE, Widowski TM, Dewey CE, Devillers N, Farmer C. The effect of birth weight and age at tail docking and ear notching on the behavioral and physiological responses of piglets. *J Anim Sci* 2014; 92: 1718-1727.
18. Canario L, Mignon-Grasteau S, Dupont-Nivet M, Phocas F. Genetics of behavioural adaptation of livestock to farming conditions. *Animal* 2013; 7: 357-377.
19. Lonardi C, Brscic M, Normando S. Physiological and Behavioural Responses in Piglets Submitted to Castration: Preliminary Study. *Agriculturae Conspectus Scientificus (ACS)* 2011; 76: 341-344.
20. González-Valero L, Rodríguez-López J M, Lachica M. Contribution of portal-drained viscera to heat production in Iberian gilts fed a low-protein diet: comparison to Landrace. *J Sci Food Agric* 2016; 96: 1202-1208.

*Correspondence to

Guanghai Teng
College of Water Resources & Civil Engineering
China Agricultural University
PR China