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SMALL SCALE OUTDOOR PIG SYSTEMS IN THE TROPICS: IMPACTS ON THE SOIL, THE PHYSIOLOGICAL AND THE ZOOTECHNICAL RESPONSES OF FATTENING PIGS:

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With the collaboration of Georges Magdeleine (farmer in a mixed farming system).

Keywords: agroecology, pig, outdoor system, sweet potatoes

Abstract:

To our knowledge, there are few references on the pig production integrated into a mixed farming- system. In which farmers try to minimize inputs (in particular on feed purchase d). Feeding is one of the most important elements of the production cost. It is even more the case in tropical small countries, where the cost of the raw material included also the cost of transports. Farmers in these countries are looking for alternative solutions to reduce or replace the utilization of industrial concentrates, by the use of local resources (*e.g.* roots and tubers, sugar cane, banana). The main objective of this study was to compare fattening pigs' systems (outdoor *vs.* indoor, local *vs.* industrial feedings, local *vs.* exotic breeds). We performed two trials on a total of 54 fattening pigs, reared either in outdoor in a sweet potatoes field (n=18) or indoor with diet based on sweet potatoes (n=18) or indoor with industrial concentrates (n= 18). Our results show that the growth is significantly affected by the production system. The outdoor animals have a growth rate of 240 g/d, against 360 and 580 g/d for the indoor pigs fed with local or industrial feed, respectively (P < 0.001). Our findings on the physiological responses (blood profiles) highlighted the best adaptation of the local breed (Creole pig) when they passed from indoor to outdoor system. Indeed, adaptive hematologic response is faster in Creole pigs than in the exotic breed (Large White pigs). Unlike Creole pigs, the arrival of exotic pigs in outdoor conditions caused firstly a weakening of the hematologic status suggesting that Large White pigs are stressed by the change. Regarding the interaction between digging activities of pigs with macrofauna, in our experimental conditions (gradual discovery of plots and grazing period of 28 days), it seems that the presence of pigs on the plots (manure) is beneficial to soil macrofauna and thus the quality of the land from the farmer for future planting. The alternative systems (outdoor and/or diet based on local resources), although less powerful in a zootechnical point of view, should suit to mixed farmers who are looking for an economic gain on animal production by using crop residues and minimizing human interventions. These studies are the beginning of trials that aimed at meeting mixed farmers requirements in terms of techno-economic references on outdoor pig systems and alternatives to preserve and develop a niche market for the local pig breed.

Introduction

In tropical and subtropical regions, pork production is based on a variety of farming systems (Robinson et al., 2011). These farms are situated between two extremes. The first extreme is specialized industrial and landless farms with high pig density and a limited number of selected commercial breeds or lines with high genetic potential for high growth and reproduction. The second extreme is small family farms with indigenous and/or crossbreeds reared in low input conditions. In simplified terms, there are two opposing logics of production. In industrial systems: "Do to" maximize the pig output/input ratio *vs.* in non-conventional systems : "Do with" the available biomass from the farm or neighbouring farms to limit inputs (Gourdine et al., 2011). These two logics are clearly not mutually exclusive, and it can in some cases support each other. To our best knowledge, little is published on outdoor pig production in small scale farms in tropical humid conditions. As feed is the most costly element in the production, farmers are looking for alternative solutions to replace totally or partially industrial concentrate, via the use of local resources. Sweet potato (*Ipomea batatas*), by its appetite, nutritional qualities and its place in tropical agriculture could be an interesting alternative (Régnier C. 2011). Our first studies presented in this paper aimed at characterizing feeding behavior and activities, growth rate and physiological response of growing pigs and their impacts on the soil quality, when they are raised in an outdoor system with a sweet potato field.

Material and methods

Experimental design

We performed two trials on a total of 54 fattening pigs, reared either in outdoor in a sweet potatoes field (n=18) or indoor with diet based on sweet potatoes (n=18) or indoor with industrial concentrates (n= 18). In the first trial, 30 pigs, 15 exotic Large White pigs (LW) and 15 local Creole pigs (CR) were used. In the second trial, 24 pigs, 12 LW and 12 CR were used. The first experiment was conducted in the farm of Mr Georges Magdeleine. The second experiment was conducted at the experimental facilities of INRA in Guadeloupe. Experiments began when pigs were 87 days of age. Three groups with an average live body weight of 30 kg were defined. Each experiment period was about 28 days, with 4 days for adaptation to the new conditions. The 3 groups corresponded to 3 farming conditions. First, a conventional system with industrial concentrates as diet (**CSC**): pigs were reared in 2 pens in a semi-open building. Each pen was equipped with nipple drinkers and animals had free access to water and were fed *ad libitum* with commercial diet presented as pellets and formulated to meet the nutritional requirements of growing pigs according to the standard recommendations. Second, an outdoor system (**OSP**) on a sweet potatoes field (4.7m²/d/pig). OSP pigs had to feed themselves with the sweet potatoes leaves and tubers. Forty-seven tuber samples were

collected (0.5m²/19m²) in order to evaluate the available amount of sweet potatoes. According to these results, the estimated available amount of sweet potatoes was in average 6 kg per day per animal. Thus, animals were considered as having an ad libitum access to sweet potatoes, which means having an ad libitum energy feed intake. Nevertheless, the forty-seven leaves samples collected have shown a lack of protein in the feed ration: in average 1.2 kg of leaves were available per day per animal. Therefore, pigs were given soybean meal as supplementation, at the end of the afternoon (around 17:00 h). The provided amount was calculated in order to fulfill the nutritional requirements to achieve theoretically a growth rate of 500 g/day for CR and 800 g/day for LW. In order to study outdoor behavior of each breed, LW and CR were reared separately. Third, a CSP system in a semi-open building with similar feed allowance than in OSP conditions. CSP pigs had an ad libitum access to sweet potatoes tuber and the same average amount of sweet potatoes leaves that available on the OSP daily piece of field. Similarly to pigs in OSP, CSP pigs were given soybean meal as supplementation at the end of the afternoon (around 17:00 h). LW and CR were bred separately in order to evaluate feed intake and its effect on growth performances according to the breed.

Measurements

In OSP conditions, rainfall level was daily registered. Humidity and ambient temperature were recorded twice a day: in the morning (06:00h) and at the end of the afternoon (17:00h). In indoor conditions (CSC and CSP) ambient temperature and humidity have been recorded automatically every 15 minutes.

Pigs were weighed at the beginning (d-4) and the end (d-1) of the adaptation period as well as at the middle (d11) and end of the experiment (d25). At the end of the study, back fat thickness of all pigs was measured. Four values were recorded with an ultra-sonic device (Honda, HS 1500): on both sides at 6.5 cm of the spine at back- and shoulder-level. Average of these four values was calculated for statistical analysis. Body and skin temperatures (three measurements: back, side and skull) have been recorded for all pigs at the beginning (d-4) and the end (d-1) of the adaptation period as well as at the middle (d11) and end of the experiment (d25). Every three days the skin temperature of outdoor pigs (SEP) was registered twice a day in three points: back, side and skull. Measurements were performed in the morning (between 6:00 and 10:00) and at the end of the afternoon (around 17:00h).

Pigs' outdoor behavior was studied twice, at the middle and the end of the experiment (d7 and d19). During 24 continuous hours, every 5 minutes physical activity, feeding behavior and position of each pig in the field area was registered. Data collected were used to estimate the covered distance in 24h for each pig. In the second trial, blood samples were collected at the before adaptation (d-4), one day after adaptation (d1), at the middle of the experiment (d11) and at the end (d22). Blood samples were used to determine hematology characteristics of pigs. A total of 20 samples of macrofauna were collected (10 before the presence of pig and 10 after their departure) by detecting macrofauna in samples of 20 cm³ of soil.

Statistical analyses

Non-parametric Kruskal-Wallis tests were used for non-repeated data and variance analysis were performed for repeated data (body temperatures) using the R software. The effects of system (S) and breed (B) were tested. Differences in means of outdoor behavior parameters between LW and CR were tested for significance using a χ^2 test.

Results and discussion

Our results show that the growth is significantly affected by the production system. The outdoor animals had a growth rate of 240 g/d, against 360 and 580 g/d for the indoor pigs fed with local or industrial feed, respectively (Table 1; P < 0.001). The discrepancy between OSP and CSP pigs could be explained by a more important physical activity in outdoor conditions.

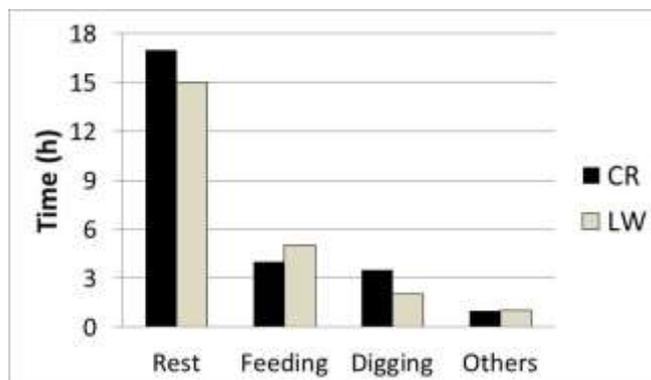


Figure 1–Effect of breed on outdoor physical activities.

Based on Noblet (2005) study, we estimated that around 6% of the metabolizable energy of the OSP diet was used to cover requirements for adding physical activity in outdoor conditions. At the end of the experiments, CR pigs had higher backfat thickness than LW pigs. These results were in agreement with those obtained in indoor pigs of 45 kg by Renaudeau et al. (2005).

Breed	Creole			Large White			Significance
	CSC	CSP	OSP	CSC	CSP	OSP	
System							
Daily growth rate g/day	480 ± 50 ^a	340 ± 90 ^b	220 ± 40 ^c	680 ± 250 ^a	380 ± 50 ^b	260 ± 70 ^c	S***
Backfat thickness, mm	14 ± 2 ^a	9 ± 2 ^{bc}	15 ± 4 ^a	10 ± 2 ^b	8 ± 1 ^c	10 ± 2 ^b	B***, S*
Skin temperature, °C	35.4 ^a	35.0 ^b	37.5 ^c	36.2 ^d	35.6 ^a	38.0 ^e	B***, S***
Rectal temperature, °C	39.7 ^a	39.2 ^b	39.9 ^c	39.7 ^a	39.9 ^c	40.0 ^c	S*, B x S*

Table 1. Effets of system (S) and breed (B) on zootechnical performance and thermoregulatory responses; *** P<0.001 ; * P<0.1

Outdoor pigs had greater body temperatures than indoor pigs. This is explained by an average difference in ambient temperature of + 1.5 °C between outdoor and semi-opened building. Skin temperatures were significantly affected by breed, with lowest values for CR animals. Our findings were in accordance with previous results on comparison between LW and CR growing pigs acclimation to hot environment (Renaudeau et al, 2007).

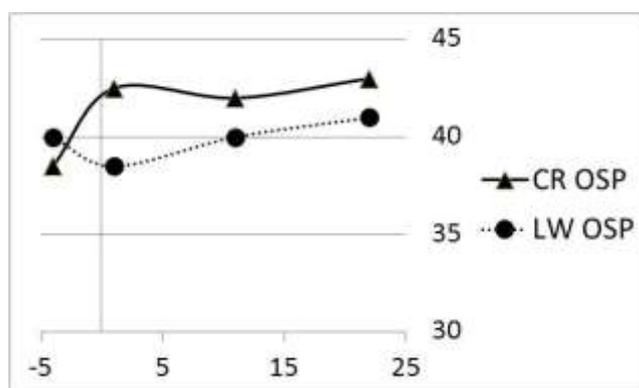


Figure 2 – Effect of breed (CR vs LW) on hematocrit (%) before (d-4) and after (d1, d11 and d22) the outdoor conditions.

After 4 days of adaptation to outdoor conditions, OSP pigs were able to feed themselves by eating sweet potatoes leaves and by searching the tubers. Physical activities were found different between breed (Figure 1). LW pigs were found to be more active (40% of the time dedicated to physical activities) than CR pigs (30 %). Outdoor feeding behavior were also affected by breed with much more time dedicated for eating leaves in LW pigs and more eating time for tubers in CR pigs. In agreement with the study of Renaudeau et al (2005), ingestion time of soybean meal was more important in CR than in LW pigs. The breed's difference in outdoor behavior suggests that some differences occur between CR and LW in adaptation's strategies in outdoor conditions.

Our findings on the physiological responses (blood profiles; Figure 2) highlighted the best adaptation of the local breed (CR pig) when they passed from indoor to outdoor system. Indeed, adaptive hematologic response is faster in CR pigs than in the exotic breed (LW pigs). Unlike CR pigs, the arrival of exotic pigs in outdoor conditions caused firstly a weakening of the hematologic status suggesting that LW pigs are stressed by the change

Regarding the interaction between digging activities of pigs with macrofauna, in our experimental conditions (gradual discovery of plots and grazing period of 28 days), it seems that the presence of pigs on the plots (manure) is beneficial to soil macrofauna and thus the quality of the land from the farmer for future planting (Figure 3).

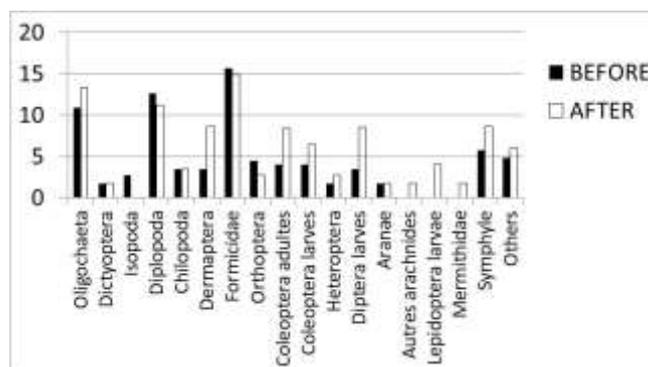


Figure 3–Effect of outdoor pigs activities on the density of the macrofauna (the density was expressed using the following formulae : ln(number of individuals +1)/surface in m²).

The alternative systems (outdoor and/or diet based on local resources), although less powerful in a zootechnical point of view, should suit to mixed farmers who are looking for an economic gain on animal production by using crop residues and minimizing human interventions. These studies are the beginning of trials that aimed at meeting mixed farmers requirements in terms of techno-economic references on outdoor pig systems and alternatives to preserve and develop a niche market for the local pig breed.

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