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"GREEN FEEDS" IN MEAT PRODUCTION: A PRELIMINARY STUDY

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Abstract— Aim of this research is to analyse some pig breeding systems in NW Italy to verify the sustainability of livestock production systems, in relation to different feeding resources availability. In an investigation on 55 pigs bred using semi-extensive and intensive methods and fed the same diet, the feed conversion index was 5.67 vs 4.50 to obtain a final weight of 168 kg. The diet included 68.6% food grain (corn 52.5% and barley 16.1%) and the semi-extensively bred pigs consumed 26% more. In conclusion the questions were “Is it ethically justifiable to use food grains as feed to assure animal welfare, when many humans are still far from having met their own needs? The unsustainability of feed grain production, as a result of over exploitation of natural resources, will affect the food availability for future generations? Replacing food grains in animal production could help to resolve conflicting ethical obligations. The animal nutrition progress is supporting breeders in producing ethical animal foods. By adopting an “Ethical Index”, branding animal food, consumers could induce producers to change their policies to an ethical animal food production.

I. INTRODUCTION

In recent decades the animal production sector has undergone an unprecedented development targeted to the research of scientific and technological tools able to exploit the environmental resources and the productive potential of animals (1). This sector has shown a remarkable dynamism to answer and to adapt to a fast growing market demand, which Delgado *et al.* (2) have defined as "livestock revolution". The consequences of the increased demand and evolution of consumption has undoubtedly led to huge benefits with improved nutritional quality and life expectancy of many people. But in a more careful and less sectorialized analysis, and broadening the vision in spatial and temporal sense, we realize that the issue is not so straightforward. In fact, livestock management is very complex, multifaceted and full of

contrasts and need of more attention, as confirmed recently by USA government which funded the project “Cow of the future project”. Intensive farming is based on massive use of concentrates, with diets consisting mainly of cereals – including wheat, corn, barley – not only for monogastric but also for ruminants.

This system is responsible for the growing competition between human and animal nutrition. It creates a questionable food chain not only in terms of ethical, social and environmental aspects but also, more concretely, in terms of production efficiency. Through these steps, the conversion of nutrients of plant origin to animal products generates a 60 to 90% loss of protein (3). According to these data, the animal sector consumes more than what it produces: the input/output ratio is 1.41 and, at the current trend, the dependence on grain will dramatically grow. The cereal crops for livestock use, which currently account for one third of world production (3), will continue to increase, along with bioenergy competitors, thus removing cereals from human consumption.

The economic impact of this competition will be an increase in grain prices; due to the change of use, cereals will be quantitatively insufficient for a human population of over 7 billion in 2014 that, in 2050, is expected to exceed 9.3 billion (4).

In this context, scientists may help to improve lifestyles modifying the future livestock sector through the so-called "green revolution", a vision proposed by Woodrow (Nobel Prize for Peace, 2007) (5). It is based on the integrated use of primary resources and the recycling of energy sources already available in nature to reduce wastes and optimize their use. The answer to the growing demand of animal products in the forthcoming decades (2009-2018: developed countries +7%; developing countries +14%) (6) could be the use in the animal diets of the “Green Feeds”: nutritious substances that are not consumed by humans and/or are currently classified as wastes.

Aim of this paper is to show the unsustainability of current livestock production systems, valuing feed conversion index and daily gain of different pig genetic types in relation to different breeding systems and the use of food as feed.

II. MATERIALS AND METHODS

In Europe the pig industry relies on a limited number of breeds well adapted to intensive animal production systems. The requests for organic animal products, animal welfare and conservation of old germoplasm are pressing people to pay more attention to old breeds.

In Europe 25 local breeds exist and of those, 5 in Italy. One of them, the Mora Romagnola was used in this experiment. It was fairly common until the mid '50s in Emilia Romagna (NW Italy) and in 1949 there had been more than 22,000 animals. This breed began to disappear as the Large White took over the area; in 1998 only 12 animals survived.

In a number of trials of different duration, throughout 4 years, 55 animals of different breeds (19 Mora Romagnola (MR), 7 crossbreeds of Duroc and MR (DMR), 29 crossbreeds of Large White and MR (LWMR) were reared testing two types of husbandry and two methods of feeding. The Average Daily Gain (ADG = total weight gain/days) and the Feed Conversion Index (FCI = total feed intake/weight gain) were evaluated using diets formulated for the growing - finishing hybrid pigs, as the needs of this old breed were unknown (Table 1). Meals were given mixed with water.

Table 1 Food as feed in pig diets (%DM). DM=dry matter; CP=crude protein; DE=digestible energy; ME=metabolizable energy.

	Live Weight (kg)		
	<60	60-90	>90
Corn	32.5	45.0	55.0
Barley	25.0	18.0	15.5
Soybean meal 44%	20.0	16.0	12.0
DM%	87.5	87.6	87.2
CP%	18.6	17.2	15.5
DE MJ/kg	14.2	14.4	14.7
ME MJ/kg	13.6	13.8	14.1

A. Husbandry

Two types of husbandry were tested: intensive (low animal welfare) and semi-extensive (high animal welfare). In the intensive practice pigs were reared indoors in 2 slatted floor pens; one of them equipped with a self-feeder. In the semi-extensive practice pigs were reared in two large corrals with a pound in the centre and a hut with straw; one of the corrals was equipped with a self-feeder (7). All the animals reached the final weight of about 168 kg. The animals were raised at the Experimental Station of the Department of Agricultural, Forest and Food Sciences, University of Turin (Italy).

B. Method of feeding

Two feeding systems were compared during the intensive and the semi-extensive husbandry. In the traditional system animals received feeds twice a day *ad libitum*, distributed in two long troughs with a space allowance of 0.33 m/head. In the other system pigs received feed individually by a self-feeder, *ad libitum* but divided in small quantities at meals to simulate natural conditions. This self-feeder is part of a structured self-made feeding station.

Statistical analysis was carried out by SAS/STAT in SAS 9.4 using a three-factorial (husbandry, breed and method of feeding) covariance analysis with the final live weight as covariate (8). Covariance analysis removes dependent variable variations associated with different final live weights resulting in more precise estimates and powerful tests. Results are presented as LSmeans \pm S.E.M.

III. RESULTS AND DISCUSSION

Results of the experiment were shown in table 2. The intensive and semi-extensive husbandries were significantly different and the Feed Conversion Index was 4.50 vs 5.67 to obtain a final weight of 168 kg and 104 kg live weight gain, during the trials. An intensive reared pig used 467.6 kg of feed vs 589.2 kg of the semi-extensive reared one. Of this quantity the intensively reared pig used 321.0 kg of food grain and 404.5 kg the semi-extensive reared pig. According to table 1, pigs were fed on average of 68.6% of food grain (corn 52.5% and barley 16.1%). The semi-extensive FCI was 1.17 (5.67-4.50) significantly higher than the intensive FCI, which caused a semi-extensive husbandry pig to consume 121.6 kg more of feed (589.2-467.6) that is 83.5 kg (404.5-321) of food grains. The 83.5 kg out of 321 kg fed to a semi-

Table 2. Effects of different factors (LSmean±SEM) on the two parameters FCI and ADG.

Factors	Levels	Parameters	
		FCI	ADG (g)
Husbandry	Semi-extensive	5.67±0.201 ^A	549±20.6 ^A
	Intensive	4.50±0.186 ^B	661±18.4 ^B
Method of feed distribution	Self-feeder	4.89±0.217 ^a	637±21.4 ^a
	Self-feeder and traditional	5.38±0.387 ^a	535±38.2 ^b
	Traditional	4.99±0.192 ^a	644±18.9 ^a
Breed	Duroc x Mora R.	5.13±0.330 ^a	642±32.5 ^a
	L.White x Mora R.	4.94±0.229 ^a	603±22.6 ^{ab}
	Mora R.	5.19±0.190 ^a	571±18.7 ^b

LSmeans by factor and levels in the same column with different letters differ significantly (a, b: P<0.05; A, B: P<0.01).

extensive reared pig is 26.0% of corn and barley, food grains, to ensure better animal welfare. Moreover the ADG was higher in the intensive husbandry than the semi-extensive.

The use of a self-feeder did not make any difference to the FCI. The self-feeder reduced feed competition as each pig is protected during feeding. When moved to traditional feeding they suffered the competition which caused a significant lower ADG. Moreover the self-feeder is closer to pig's natural way of feeding as they have to look for feed.

The breed factor seemed not to have an effect on FCI, but ADG was significantly lower in MR vs DMR. To obtain the same live weight gain the MR breed was fed with 11.2% more feed of which 7.7% corn and barley. This was a clear effect of genetic selection but this not absolutely means the old MR breed is useless as the diet was typical for modern breeds. Using corn and barley as feed is clearly more ethical to feed modern breeds than old ones.

In brief, results showed that pig feeding production costs were:

- from an ethical point of view 68.6 % of food grain used as feed;
- animal welfare had an additional cost of 26.0% of food grains, used as feed;
- the conservation of old breeds consumed 7.7% more food grains used as feed.

Applying the experimental conditions (180 d until 160 kg LW) and results to the over 13.37 million of pigs slaughtered in Italy in 2012, they would have consumed more than 4.3 million Mg of food grains (3.34 million Mg of corn and 1.02 million Mg of barley). This data are the origin of ethical and bioethical issues in a world with more than 13% of undernourished persons (9).

IV. CONCLUSION

The conversion index of “food grains” in specialized breeds is higher than in less specialized breeds.

Ethics of animal production is more likely to be “ethics stating which type of feed is to be used in animal nutrition, with respect to human beings and animal welfare”. Gardner (10) says that perhaps the greatest way to increase food use efficiency is to reduce the world's consumption of meat but this is not sufficient at all.

What to do? Animal production strategy should be to introduce and replace food grains by “Green Feeds”, nutritious substances that are not consumed by humans and/or are currently classified as wastes. Animal nutrition science already supports this opportunity and already farmers try to replace grains with by-products for economical reasons. This could help to reduce or resolve conflicting ethical obligations. Moreover, it would allow to pay more attention to enhancing feed quality and feed ingredient usage to improve feed efficiency with a corresponding decrease in methane, as confirmed by Knapp *et al.* (11). Consumers, aware of the recommendations to reduce animal food consumption for a healthy human diet, can induce producers to change their policies to ethical animal food production by adopting an “Ethical Index” branding animal food, to indicate the quantity of ethical feed used to produce it, for a conscious consumption.

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