Can pig breeding contribute to the sustainability of low input production systems?

Lotta Rydhmer¹ & Jean-Luc Gourdine²

¹ Dept Animal Breeding and Genetics
Swedish University of Agricultural Sciences

² Unité de Recherches Zootechniques, INRA

Lotta.Rydhmer@slu.se
Jean-Luc.Gourdine@antilles.inra.fr
What is a “low input production system”?

Parr et al (1990): Low input farming systems “seek to optimize the management and use of internal production inputs (i.e. on-farm resources)… and to minimize the use of production inputs (i.e. off-farm resources)”

A closed nutrient cycle
Crop production
  - energy
  - protein

Animal production
  - pigs
  - cattle, sheep, goat, ...

Meat production
  Animals sold

Crops sold

Residues
  By-products

Organic fertilisers

- Materials
- Fertilisers
- Plants, seeds...

- Feed
- Animals, semen
- Materials...

- Feed
Internal resources

- Optimize

- land for feed production
- feed
- waste and by-products
- manure
- land for pasture
- water
- biofuel, biogas
- labour
- animals for replacement

External resources

- Minimize

- equipment, construction material
- feed (soya!)
- feed additives
- waste and by-products
- pesticides, herbicides
- fertilizers
- fossil fuels, electricity
- animals for replacement,
- semen
- drugs, antiseptic products
A variety of low input systems

1. Low input system as a consequence of lack of external resources

2a. Low input system based on specific added values such as cultural and regional traditions

2b. Low input system based on stated principles, e.g. organic production

Commission regulation No 889/2008 on organic production: “Preference is to be given to indigenous breeds and strains.”
Low inputs systems have a lower output of pig meat. But all systems have to be efficient, to be sustainable.

Efficient in producing a combination of different goods.
Wish-list of breeding goal traits for low input systems

- feed efficiency
- ability to efficiently use local feed, waste and by-products
- ability to graze and use marginal land
- stay healthy and fertile
- maternal ability
- thrive in their climate
Heat resistance in Creole and Large White sows

- **Ambient temperature**
  - Appetite
    - 14% decrease
    - 20% decrease

- **Mobilisation of body reserves**
  - + 0.3 kg
  - + 10 kg

- **Weaning-to-conception interval**
  - + 1.7 days
  - + 9.6 days

Gourdine et al, 2006
Heat resistance

Farrowing rate

fr Bloemhof et al., 2013

'Sensitive'  'Robust'

Max. temperature 3rd week before insemination
Per cent of producers ranking a goal trait among the top 5 highest priority

Wallenbeck et al, 2013

- Fertility
- Piglet survival
- Leg health
- Feed efficiency
- Disease resist.
- Sow longevity
- Growth rate
- Parasite resist.
- Meat quality
- Litter size
- Birth weight
- Shoulder ulcers
- Piglet growth
- Roughage cons.
- Meat %

Legend:
- Conventional
- Organic
Genetic trends from selection index, based on economic weights given by producers

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>Organic</th>
<th>Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piglet survival, % of live born</td>
<td>+</td>
<td>+</td>
<td>n.s.</td>
</tr>
<tr>
<td>Litter size, born alive</td>
<td>-</td>
<td>-</td>
<td>n.s.</td>
</tr>
<tr>
<td>Sow longevity, d</td>
<td>+</td>
<td>+</td>
<td>n.s.</td>
</tr>
<tr>
<td>Meat percentage</td>
<td>-</td>
<td>-</td>
<td>n.s.</td>
</tr>
<tr>
<td>Growth rate, g/d</td>
<td>+</td>
<td>+</td>
<td>n.s.</td>
</tr>
<tr>
<td>Disease resistance, % healthy</td>
<td>+</td>
<td>++ +0.09</td>
<td></td>
</tr>
<tr>
<td>Parasite resistance, % healthy</td>
<td>+</td>
<td>++ +0.001</td>
<td></td>
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</tbody>
</table>

Wallenbeck et al, 2012
Pig farmers opinions on 15 goal traits. Associations to pig welfare and environmental impact.

<table>
<thead>
<tr>
<th>Pig welfare</th>
<th>Environmental impact</th>
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</thead>
<tbody>
<tr>
<td>Leg health</td>
<td>Feed conversion</td>
</tr>
<tr>
<td>Disease resistance</td>
<td>Growth rate</td>
</tr>
<tr>
<td>Shoulder ulcers</td>
<td>Piglet growth rate</td>
</tr>
<tr>
<td>Parasite resistance</td>
<td>Piglet survival</td>
</tr>
<tr>
<td>Sow longevity</td>
<td>Roughage consumption</td>
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<tr>
<td>Piglet survival</td>
<td>Disease resistance</td>
</tr>
<tr>
<td>Piglet birth weight</td>
<td>Sow longevity</td>
</tr>
<tr>
<td>Roughage consumption</td>
<td></td>
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</tbody>
</table>

>75% of farmers consider these goal traits important for pig welfare and environmental impact, respectively.

Wallenbeck et al, 2013
Who pays for less progress in production traits?

Breeding for welfare in outdoor pig production: A simulation study

Growth rate, lean%, litter size, piglet mortality, piglet growth, weaning-service-interval, growth rate, strong legs

To avoid deterioration:
- 3 x ‘conv. weight’ for legs
- 2 x ‘conv. weight’ for piglet mortality
- 7 x ‘conv. weight’ for weaning-service-interval

Cost in growth rate, lean% and litter size

Gourdine et al, 2010
Evaluation of sustainability of 15 European farming systems in QPorkChains

High input (?)
5 conventional
1 adapted conv. - animal welfare
2 adapted conv. - meat quality
1 adapted conv. - meat quality, conv × local breed
1 adapted conv. - meat quality + environment friendly

Low input (?)
3 traditional - local breed
2 organic – conv. breed

Bonneau et al, 2011
Evaluation of sustainability of breeding activities

Rydhmer et al, 2013
Small scale of low input systems
Selection is less efficient for small populations
Less financial, human and technical resources
Cooperation!
“European Saddleback pig breeder network”

Larger risk of inbreeding in small populations? Yes - but large awareness, and interest in the future of ‘my breed’

Optimal contribution selection
Local breed, 30 herds, 1 boar and 10 sows/ herd, natural mating, some exchange of boars, one selection trait, $h^2 = 0.2$

Genetic gain per year, inbreeding rate per generation

<table>
<thead>
<tr>
<th>Scheme</th>
<th>$\Delta G$, gen std</th>
<th>$\Delta F$, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>No selection</td>
<td>0.00</td>
<td>0.80</td>
</tr>
<tr>
<td>Truncation sel.</td>
<td>0.35</td>
<td>5.70</td>
</tr>
<tr>
<td>Opt. Contr. Sel.</td>
<td>0.24</td>
<td>0.95</td>
</tr>
</tbody>
</table>

No selection – no genetic gain and inbreeding increases
Only EBV – highest progress, but high inbreeding increase
Optimum contribution selection – high progress and acceptable inbreeding increase

Gourdine et al, 2012
G x E

Growth and carcass traits, conventional and organic

Several breed x environment interaction studies

*Brandt et al (2010)*: “Although statistically significant GxE exist … no special breeding programme is necessary for organic production systems”

 Few genotype x environment interaction studies based on individual data records

*Wallenbeck et al (2009)*: “our results indicate weak GxE for both growth rate and carcass leanness … An organic breeding index within a conventional breeding program is better than a separate organic breeding program”
G x E

What about reproduction and health traits?

Sow line selected outdoors for high postnatal survival HS, compared with control, C

<table>
<thead>
<tr>
<th></th>
<th>HS</th>
<th>C</th>
<th>HS</th>
<th>C</th>
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<tbody>
<tr>
<td></td>
<td>out</td>
<td>out</td>
<td>in</td>
<td>in</td>
</tr>
<tr>
<td>Total mortality, %</td>
<td>12.2</td>
<td>17.9</td>
<td>14.9</td>
<td>12.3</td>
</tr>
</tbody>
</table>

Less crushing! More savaging!

HS gilts indoors showed piglet-directed aggression suggesting a genetic effect on environmental sensitivity

Baxter et al, 2011
Organisation of a special breeding program for low input systems

The Flower breeding system

Merks, 2003
Use the conventional breeding program and choose the best suited animals

‘MaxLegs Hampshire’ - AI boars recommended to Swedish producers with organic production

200 boars at AI station
Conventiona economic weights
Ranking based on EBV for osteochondrosis and movements
Semen from the 15% with highest EBV for legs sold as ‘MaxLegs‘

www.qgenetics.se
Evaluate the balance between farm conditions and animals’ demands

Not good enough?
1. Change the environment  
   Remember: Low input!

Not enough?
2. Choose the most suitable males and females

Are there no suitable animals?
3. Change breed

Is there no suitable breed?
4. Develop a special breeding program

Unrealistic?
5. Change species
Can pig breeding contribute to the sustainability of low input production systems? Genetic progress in traits important for environment and market
Choose the most suitable animals
Traditional breeds – optimum contribution selection

Can low input production systems contribute to the sustainability of pig breeding?
Raise new questions and stimulate discussions
• Ask for new goal traits
• Ask for changed economic weights and a longer time perspective


