Modelling of a recording scheme for market-oriented smallholder pig producers in Northwest Vietnam

R. Roessler a,⁎, P. Herold a, A. Willam b, H.-P. Piepho c, L.T. Thuy d, A. Valle Zárate a

a Hohenheim University, Institute of Animal Production in the Tropics and Subtropics, Department of Animal Breeding and Husbandry, Garbenstr. 17, 70599 Stuttgart, Germany
b Division of Livestock Sciences, BOKU-University of Natural Resources and Applied Life Sciences, Vienna, Austria
c Hohenheim University, Institute for Crop Production and Grassland Research, Department of Bioinformatics, Fruwirthstr. 23, 70599 Stuttgart, Germany

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A B S T R A C T

Village breeding programmes are being developed by an integrated long-term project for smallholders in Northwest Vietnam to improve pig production in different production systems. In total, 120 smallholders with 169 sows in 5 of the 9 project villages were approached in single person interviews, using a structured questionnaire. Frequency analysis of data on breeding management and ranking of smallholders' trait preferences and selection criteria used for pigs were performed with SAS 9.1, using the FREQ procedure. Survey results indicate that both improved local breeds and exotic genotypes should be incorporated in future village breeding programmes for market-oriented smallholder pig production, improving the reproductive and growth performance as well as the carcass quality. In a next step, a model reflecting the status quo at farms with market-oriented pig production was developed integrating data from farmers' survey and information from the project’s current recording scheme. A deterministic approach was used to assess the profitability and genetic merit of the current recording scheme. Modelling results show that the current recording scheme is unprofitable (−33.90 € sow⁻¹). As continued success of village breeding programmes depends on the profitability of breeding measures, the long-term sustainability of the current recording scheme seems unlikely. Genetic gains are achieved in production and carcass quality traits, while a small reduction in reproduction traits can be observed. In a last step, possible effects of increased pig performances on the profitability and genetic merit of the current recording scheme were evaluated. Effects of increased pig performances on the genetic and economic success of the recording scheme are generally limited. Further model calculations are necessary for finding possibilities to improve smallholder pig breeding in a profitable way.

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1. Introduction

Pig production in Vietnam is expanding at a rapid pace with an average annual growth rate of 5.3% for the period 1995–2005 (GSO Vietnam, 2007). According to the Vietnamese Ministry of Agriculture and Rural Development, the national pig herd will continue to grow from nearly 27 million head (2006) to 33 million head in 2010. Today pork represents 77% of the total meat produced in Vietnam (2.3 million tons in 2006) (GSO Vietnam, 2007). Production is expanding all over the country, boosted by national and international investments. The national government has been strongly promoting the pig production development by releasing a series of policies, targeting industrialisation and modernisation of pig production. Nonetheless, it is estimated that still 80% of the national pig population are kept at smallholder farms (FAO, 2005). In contrast to farms in southern Vietnam where exotic pigs are gradually replacing local breeds, smallholder pig production in the north, particularly in mountainous areas, is still mainly based on local sows. These are mated to exotic boars in order to meet the demand for lean pork. However,
the growth rate and carcass quality of crossbred pigs remain poor as compared to exotic breeds. Growth rates of crossbred pigs have been reported at 404 g day\(^{-1}\) (19 to 67.5 kg live weight) (Hang, 1998) and 200 g day\(^{-1}\) (age 60 to 180 days) (Lemke et al., 2006) and backfat thickness at 3.03 cm (Hang, 1998).

One key entry point to improve smallholder pig production is the development of village breeding programmes. Such breeding programmes have to integrate appropriate pig breeds that can make efficient use of the limited resources and that can perform the multiple roles pigs have for smallholder production (Valle Zárate et al., 2003), besides targeting profit maximisation and improvement of production traits. Therefore, procedures for planning of breeding have to be adjusted to the specific conditions of smallholder pig production with low and unsteady resource availability. The aim of the present study is to evaluate the current recording scheme for market-oriented smallholder pig producers. Evaluation criteria are the annual genetic gain of breeding objective traits and the discounted profit. In a subsequent study, alternative breeding scenarios will be evaluated and compared with the main recording scheme evaluated in this study. Results will support the development of village breeding programmes that are planned to be implemented in villages in Son La province, Northwest Vietnam, by deriving recommendations for alternative breeding programmes.

2. Materials and methods

The bases of this study were numerous interviews conducted in Vietnam and the existing recording scheme implemented on smallholder farms. Information and data from the recording scheme and from the interviews were used to derive a model of the recording scheme. This model was economically and genetically evaluated. In a last step, the model was modified to evaluate possible effects of increased pig performances on the economic and genetic success of the recording scheme.

In the following, the recording scheme and methods used to conduct and analyse the interviews are described. Then the developed model is illustrated, giving an overview about the method and input parameters used.

2.1. Existing recording schemes

Research was conducted in the frame of the Uplands Programme, a Thai–Vietnamese–German collaborative research programme. One of the projects in the programme aims at the development of village breeding programmes for different smallholder pig production systems in the Son La province in Northwest Vietnam, i.e. for market-oriented and resource-driven production systems. Production systems differ in distance to towns and markets, resource availability, distribution of pig breeds and production intensity. A detailed description can be found in Lemke et al. (2006). The project has established recording schemes on 177 smallholder farms in a total of 7 villages. Local Mong Cai (MC) and Ban sows are distributed to farmers and make up the female side of the different mating schemes. Through comparative performance testing of the local sows and their offspring (from pure breeding and selected crossbreeding), genotypes with high productive adaptability are to be identified. The main mating scheme at the project farms with market-oriented pig production is cross-breeding between MC sows and Yorkshire sires, besides pure breeding of the MC breed. Data on reproduction, off-take and purchase of pigs, diseases, treatments, losses, and purchase of feed and veterinary products are continuously recorded, in addition to pigs’ individual weight and body measures.

2.2. Survey in the project villages

In addition, a survey was conducted in five project villages with market-oriented pig production. In total, 120 smallholders with 169 sows were approached in single person interviews. A structured questionnaire was used to obtain data on the pig herd, smallholders’ breeding management, as well as on smallholders’ breed and trait preferences, and selection criteria. Smallholders were asked for which traits they prefer a certain sow and boar genotype and to state if they consider a number of predefined traits to be good (= 1), average (= 2) or poor (= 3) for the specific breed or if they do not consider the trait (= 4) for this breed. Predefined traits are listed in Figs. 2 and 3. The FREQ procedure of the statistical package SAS 9.1 (SAS Institute, Cary, NC) was used for frequency analysis of smallholders’ breeding management, trait preferences and selection criteria for pigs. Village and breed differences were evaluated by chi-square test or Fisher’s exact test, when the first test was not valid due to low numbers in some cells.

2.3. Modelling the existing recording scheme

In a next step, the current main recording scheme of market-oriented smallholder pig producers was modelled and evaluated by a deterministic approach, using the computer programme ZPLAN, Version Z10 (Willam et al., 2008). Based on genetic, biological and economic parameters the annual genetic gain for the breeding objective as well as for single traits and the discounted profit sow\(^{-1}\) in the population was calculated for a given investment period by subtracting discounted breeding costs from discounted returns, combining selection index and gene flow methodologies (Hill, 1974; McClintock and Cunningham, 1974). It was assumed that parameters remain unchanged and only one round of selection is considered. Decreased genetic variance due to further selection rounds and inbreeding was ignored. An overview about the costs that were incurred for the current recording scheme is also given in Table 1, specified together with their average time of occurrence. Costs were divided into fixed and variable costs associated with selection and breeding. The variable costs are directly related to performance and pedigree recording and only apply to the group of recorded sows and their offspring. The costs were discounted at 2%, and returns at 3%. The investment period was assumed to be 10 years.

Based on the information from the interviews and the project’s recording scheme at market-oriented smallholder pig farms, two breeds were considered for the model: the MC as sow breed and the Yorkshire (Y) and MC as boar breeds (Fig. 1). Assuming that three quarters of the 681 farm households in the investigated villages keep an average of
1.4 breeding sows and that nearly 60% of these sows belong to
the MC breed (also cp. Table 3), the total population of MC
sows is 390. The current recording scheme includes 12 boars,
6 MC and 6 Y boars that have been distributed by the project.
MC sows are further divided into two groups: the groups of
sows that are performance tested by the project (recorded
sows) and sows that are not performance tested (untested
sows). In accordance with the number of performance tested
sows in the project at the time of data collection, the number
of recorded sows was set to 90. Thus, the number of untested
MC sows used by farm households not participating in the
project, amounts to 300 sows.

In the investigated villages, the main activities of small-
holders include the production of crossbred slaughter animals
and selection of purebred MC female breeding stock. Accord-
ing to the project’s recording scheme, half of the recorded
sows are mated by Y and half by MC boars. For untested sows,
the same proportions are 80% and 20%, respectively (cp. Fig. 4;
Results). Genetic gain generated in the group of recorded
sows is transferred to the group of untested sows, 30% of
replacement stock in the group of untested sows originating
from the group of recorded dams. Fig. 1 shows the general
flow chart of the current main recording scheme on farms
with market-oriented pig production.

For the respective MC populations, Hau (2008) calcu-
lated 2 litters year\(^{-1}\) with an average number of piglets born
alive of 9.4 litter\(^{-1}\) and an average number of piglets weaned
of 8.0 litter\(^{-1}\), resulting in a piglet survival rate of 0.85 until
weaning. 70% of the progeny are performance tested, bringing
about 503 crossbred and 503 pure tested offspring per year.

According to Roessler et al. (2008), breeding programmes
for market-oriented smallholder pig production in Northwest
Vietnam should concentrate on the improvement of produc-
tion traits, while maintaining reproduction rate and adapta-
tion to farm-produced feed. Results of the present study
largely support this statement, yet indicating that the
reproductive performance of sows should be further improved
(Figs. 2 and 3; Results). A simple breeding objective was
defined, considering a limited number of production and
reproductive traits, as well as carcass quality traits, reflecting
traits of economic importance for market-oriented small-
holder pig production. The overall goal is to improve
production, carcass quality and the reproductive performance.

Index equations were constructed and solved in ZPLAN.
The user has to specify the breeding objective traits and

![Diagram](image), which provides a visual representation of the recording scheme.

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**Table 1**

Selected variables used in the basic breeding programme.

<table>
<thead>
<tr>
<th>Biological–technical parameters</th>
<th>Occurrence (years)</th>
<th>Euro (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average productive lifetime of sows (years)</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Average productive lifetime of boars (years)</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Average age at birth of first offspring (years)</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Average number of piglets born alive (piglets)</td>
<td>9.4</td>
<td></td>
</tr>
<tr>
<td>Farrowing interval (years)</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Weaning rate (year(^{-1}))</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>Genetic superiority of Y sires in ADG ((\sigma_A))</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>Genetic superiority of Y sires in BF ((\sigma_A))</td>
<td>-0.36</td>
<td></td>
</tr>
<tr>
<td>Genetic superiority of MC sires in ADG ((\sigma_A))</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Genetic superiority of MC sires in BF ((\sigma_A))</td>
<td>-0.17</td>
<td></td>
</tr>
<tr>
<td>Fixed breeding costs (year(^{-1})) (€)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staff salary (data entry)</td>
<td>2400</td>
<td></td>
</tr>
<tr>
<td>PigChamp software licence</td>
<td>450</td>
<td></td>
</tr>
<tr>
<td>Rent rooms</td>
<td>1800</td>
<td></td>
</tr>
</tbody>
</table>

**Variable costs**

<table>
<thead>
<tr>
<th>Variable costs</th>
<th>Occurrence (years)</th>
<th>Euro (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average costs of recording (sow(^{-1})) (30% of salaries)(^a)</td>
<td>1.0</td>
<td>19.00</td>
</tr>
<tr>
<td>Average costs for measurement/weighing (piglet(^{-1})) (70% of salaries)(^a)</td>
<td>0.2</td>
<td>4.16</td>
</tr>
<tr>
<td>Purchase costs of boars (per boar(^{-1}))</td>
<td>0.6</td>
<td>100.00</td>
</tr>
<tr>
<td>Costs for artificial insemination</td>
<td>0.6</td>
<td>1.53</td>
</tr>
<tr>
<td>Costs for natural mating service</td>
<td>0.6</td>
<td>2.05</td>
</tr>
</tbody>
</table>

\(^a\) Calculation basis: Staff salaries for measurements and recording data in the field plus farmers’ compensation (totalling 475 Euro month\(^{-1}\); 90 recorded sows and 1006 tested offspring year\(^{-1}\).

Y = Yorkshire; MC = Mong Cai; ADG = average daily gain; BF = backfat thickness; \(\sigma_A\) = genetic standard deviation.

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**Fig. 1.** General flow chart of the modelled recording scheme.
Selection criteria, their economic values, phenotypic standard deviations, genetic and phenotypic correlations and heritabilities. Selection criteria were chosen to represent the traits that are recorded in the recording scheme implemented at farms in the investigated villages. They include average daily gain (ADG), backfat thickness (BF), number of piglets born alive (NBA) and the farrowing interval (FARROW). Genetic standard deviations, economic weights per genetic standard deviation, heritabilities, genetic and phenotypic correlations among traits in the selection index are given in Table 2. Ideally, estimates for genetic and phenotypic parameters should be derived from the respective populations used in the breeding programme. As these were not yet available for the populations under investigation, estimates were derived from literature (Ducos and Bidanel, 1996; Hermesch et al., 2000; Holm et al., 2004; Peskovicova et al., 2002; Serenius et al., 2004a,b; Serenius and Stalder, 2005; Tholen et al., 1996a) and, where possible, from studies with MC pigs (Duc, 1999; Van and Duc, 1999). The economic weight for NBA was defined based on results of Roessler et al. (2008). Economic weights for the other traits were then chosen in a way to put more emphasis on NBA and FARROW as compared to ADG and BF, with about 34.5% of the economic weight being on NBA, 24.9% on FARROW, 22% on ADG and 18.6% on BF.

For each selection group, the available information sources and selection criteria were defined. The selection index for the

Fig. 2. Smallholders’ trait preferences for Mong Cai sows.

Fig. 3. Smallholders’ trait preferences for exotic boars.
group of recorded sows included all four traits. Replacement stock is selected on the individual performance (ADG and BF). The information sources also include available records of ADG and BF of five full-sibs, as well as records of the reproduction (FARROW, NBA) of the dam, for both traits two repeated measurements were assumed. Both Y and MC boars were purchased from large breeding farms in other provinces and no exact information about their genetic potential (e.g. breeding values) was available. Although it can be assumed that both boar breeds have a higher genetic potential for ADG and BF than the MC sows and that Y boars have a higher genetic potential than MC boars (Table 1), their contribution to the genetic gain was not considered for the evaluation of the recording scheme. Annual genetic gains and annual monetary genetic gains were therefore only calculated for the MC sows. Untested sows are selected by physical appraisal on their exterior and body condition (healthy and strong), being strongly correlated to the body weight (BW). Due to a low genetic correlation of BW with BF, correlated genetic gain for this trait can be expected.

Increased pig performances may have a positive effect on the profitability and genetic success of the current recording scheme for smallholder pig production in the study area, since an increased farrowing and rearing performance reduces replacement rates and consequently leads to higher selection intensities. Thus, following simulation scenarios by Lemke and Valle Zárate (2008), pig performances were increased to 10.5 piglets born alive litter−1 and 2.2 litters year−1, reducing the piglet mortality to 5% to evaluate possible effects of increased pig performances on the profitability and genetic success of the current recording scheme.

3. Results and discussion

3.1. Survey results: Farmers’ breed and trait preferences

Most smallholders in the market-oriented production system used improved sow genotypes, i.e. the improved Vietnamese MC breed (60%) or exotic genotypes (26%), albeit with considerable differences between villages, giving ranges from 40% to 81% for the MC and from 6% to 51% for exotics (Table 3). These differences may be explained by the farmers’ attitude to follow a “trial-and-error” approach, repeatedly changing the breed used for breeding, to find the most appropriate pig breed being well adapted to the local conditions (limited feed resources, low labor input, climatic and housing conditions).

Smallholders preferred the MC breed for the spectrum of feed intake, including locally produced feed, and its feed intake capacity (96%), as well as for its prolificacy (70%). A considerable number of smallholders, however, wanted the latter to be improved, with only 52% of smallholders perceiving this characteristic to be good (Fig. 2).

Smallholders preferred exotic boar genotypes, because these showed a good growth performance (84%) and their offspring were easier to sell (93%). Given the proportions of smallholders perceiving the growth rate and the carcass quality of the offspring to be good (51% and 73% respectively) (Fig. 3), both traits should, however, receive proper attention in future breeding programmes. Crossbreds’ improved marketing chances are due to a higher lean meat content in the carcasses, their lean meat percentage ranging between 40.3% and 42.1% (Hang, 1998) compared to percentages between 35.4% and 39.2% for the two MC lines MC3000 and MC15, respectively (Duc et al., 2006).

In line with their trait preferences, smallholders considered the adaptability to local feed (overall ranking ranging from 0.17–0.36) as the most important selection criterion for female breeding stock, besides the exterior and the number and size of teats (Table 4). Lemke et al. (2000) also reported that Thai farmers in northern Vietnam considered specific selection criteria for their pigs, such as feed consumption, size, health, beauty, condition, body conformation, and number of teats.

3.2. Survey results: Farmers’ breeding management

Sources for female breeding stock were manifold. Smallholders preferred to buy gilts from other smallholders within the village or from relatives in order to be sure about the gilts’ origin and to avoid the import of diseases, with no significant differences between breeds or genotypes (Fig. 4). Thus, smallholders avoided to purchase local gilts at the markets. Exotic sow genotypes were frequently own bred (50%), as exotic pigs for breeding were hard to find at the local markets or within most of the investigated villages. Smallholders also obtained local sows by the project (25% of the MC and 16% of the Ban sows), while exotic sows were not distributed by the project.

Table 2

<table>
<thead>
<tr>
<th>Trait</th>
<th>Unit</th>
<th>α_h</th>
<th>w*α_h</th>
<th>h^2</th>
<th>FARROW</th>
<th>NBA</th>
<th>ADG</th>
<th>BF</th>
</tr>
</thead>
<tbody>
<tr>
<td>FARROW day</td>
<td>day/2</td>
<td>7.2</td>
<td>-0.14</td>
<td>0.10</td>
<td>0.10</td>
<td>-0.00</td>
<td>0.00</td>
<td>-0.00</td>
</tr>
<tr>
<td>NBA piglet</td>
<td>piglet/day</td>
<td>0.4</td>
<td>0.20</td>
<td>0.10</td>
<td>0.00</td>
<td>0.00</td>
<td>0.02</td>
<td>0.00</td>
</tr>
<tr>
<td>ADG μ/day</td>
<td>μ/day/2</td>
<td>25.5</td>
<td>0.13</td>
<td>0.50</td>
<td>0.00</td>
<td>-0.05</td>
<td>0.40</td>
<td>0.00</td>
</tr>
<tr>
<td>BF mm</td>
<td>mm/mm</td>
<td>2.1</td>
<td>-0.11</td>
<td>0.45</td>
<td>-0.10</td>
<td>0.10</td>
<td>0.05</td>
<td>-0.20</td>
</tr>
<tr>
<td>BW kg</td>
<td>kg/kg</td>
<td>2.5</td>
<td>0.00</td>
<td>0.30</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.10</td>
</tr>
</tbody>
</table>

For trait abbreviations see text. Bold values: females for Mong Cai populations.

Table 3

<table>
<thead>
<tr>
<th>Village</th>
<th>Ban Bo</th>
<th>Ban Buon</th>
<th>Ot Luong</th>
<th>Na Huong</th>
<th>Bo Duoi</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewed hh</td>
<td>N</td>
<td>29</td>
<td>23</td>
<td>23</td>
<td>27</td>
<td>18</td>
</tr>
<tr>
<td>Sows</td>
<td>N</td>
<td>36</td>
<td>37</td>
<td>26</td>
<td>44</td>
<td>27</td>
</tr>
<tr>
<td>Mong Cai</td>
<td>%</td>
<td>80.6</td>
<td>73.0</td>
<td>46.2</td>
<td>39.5</td>
<td>55.6</td>
</tr>
<tr>
<td>Ban</td>
<td>%</td>
<td>13.9</td>
<td>5.4</td>
<td>46.2</td>
<td>9.3</td>
<td>7.4</td>
</tr>
<tr>
<td>Exotic genotypes (exotic breed lines and their crosses)</td>
<td>%</td>
<td>5.6</td>
<td>21.6</td>
<td>7.7</td>
<td>51.2</td>
<td>37.0</td>
</tr>
</tbody>
</table>

hh = households; village differences significant at χ^2 = 18.56* (Mong Cai sows); χ^2 = 25.09*** (Ban sows); χ^2 = 28.55*** (exotic genotypes), degree of freedoms = 4, *p = 0.05, ***p = 0.001.
Sows were predominantly mated with exotic boars to produce crossbred fatteners (88%), with significant differences between sow breeds and genotypes. The mating with exotic boars was more common for MC sows and exotic sow genotypes as compared to Ban sows (88% and 79% respectively compared to 44%). Local boars were only used to produce purebred replacement stock (9% for MC and 13% for Ban breed) (Fig. 4). Lemke et al. (2006) observed already four ...

Table 4
Characteristics used to select female breeding stock (by village).

<table>
<thead>
<tr>
<th>Village</th>
<th>Respondents</th>
<th>Body size</th>
<th>Exterior</th>
<th>Number/size of teats</th>
<th>Feed intake spectrum/capacity</th>
<th>Behaviour</th>
<th>Health status</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>a/b</td>
<td>a/b</td>
<td>a/b</td>
<td>a/b</td>
<td>a/b</td>
<td></td>
<td>a/b</td>
</tr>
<tr>
<td>Ban Bo</td>
<td>18</td>
<td>16.7</td>
<td>0.16</td>
<td>22.2</td>
<td>33.3</td>
<td>–</td>
<td></td>
<td>22.2</td>
</tr>
<tr>
<td>Ban Buon</td>
<td>21</td>
<td>14.3</td>
<td>0.22</td>
<td>13.3</td>
<td>19.1</td>
<td>0.09</td>
<td></td>
<td>0.11</td>
</tr>
<tr>
<td>Ot Luong</td>
<td>7</td>
<td>0.22</td>
<td>–</td>
<td>0.05</td>
<td>0.20</td>
<td>–</td>
<td></td>
<td>18.8</td>
</tr>
<tr>
<td>Na Huong</td>
<td>16</td>
<td>0.22</td>
<td>–</td>
<td>6.3</td>
<td>0.27</td>
<td>–</td>
<td></td>
<td>0.09</td>
</tr>
<tr>
<td>Bo Duoi</td>
<td>11</td>
<td>9.1</td>
<td>0.27</td>
<td>9.1</td>
<td>45.5</td>
<td>0.27</td>
<td></td>
<td>0.05</td>
</tr>
</tbody>
</table>

Multiple answers were possible.

*Proportion of interviewed households ranking characteristic first. Village differences significant at \( p = 1.8 \times 10^{-3} \) (health status; Fisher’s exact test).

Index = \( \sum \) of (4 for rank 1 + 3 for rank 2 + 2 for rank 3 + 1 for one tick) given for an individual characteristic divided by \( \sum \) of (4 for rank 1 + 3 for rank 2 + 2 for rank 3 + 1 for one tick) summed over all characteristics.

Fig. 4. Breeding management at smallholder farms with market-oriented pig production.
years earlier for the same area that Large White was becoming the most common boar breed in villages close to towns. Increasing scarcity of purebred MC and Ban replacement stock is being perceived as a problem by the project.

In general, smallholders preferred natural mating over artificial insemination (74% and 26% respectively), mostly using boars kept by a village boar keeper (79%), while the use of boars from outside the village and of an own boar was not common (8% and 10% respectively) (Fig. 4). The proportion of smallholders using artificial insemination was higher in Ban Buon than in the other investigated villages. Smallholders had better access to this service as it was offered by one farmer from within the village. Lemke et al. (2006) mentioned a higher proportion of artificial insemination in Ban Buon due to the village’s proximity to a provincial breeding centre. Average fees were estimated at approx. 2.05 € for natural mating and approx. 1.53 € for artificial insemination.

3.3. Modelling results: Genetic and economic merit of the current recording scheme

The annual genetic gains of the single traits for the current recording scheme with present pig performances and assuming increased pig performances are given in Table 5. Annual genetic gains are only presented for the MC breed, since the contribution of the boars to the genetic gain could not be considered due to missing information about their genetic potential. In further research within the project, priority should be given to obtain actual breeding values, particularly for terminal sires, as they have a shorter genetic distance to the fatteners, thus showing a faster transfer of genetic superiority and leading to high contributions to returns (Wuensch et al., 1998). One possibility to get more detailed information about the genetic potential of boars could be a closer cooperation with breeding centres, selecting boars according to an index correlated with the breeding objective of smallholders. Breeding values could be also obtained through selection of boars from the project village herds (MC breed).

Although reproductive and fertility traits were weighted with about 60% in the total merit index, the annual genetic gains for FARROW and NBA are slightly negative, while the annual genetic gains are positive for ADG and BF. A negative sign (reduction) in BF is favourable, since reduced backfat thickness would accompany an increase in lean meat content of carcasses, thus improving the marketing chances of fatteners. Positive genetic gains in ADG and BF may be attributed to high heritabilities of both traits, while one reason for the unfavourable annual genetic gains in NBA and FARROW could be that fertility and reproductive traits are generally very lowly heritable. Possible solutions to avoid a negative genetic development in reproductive and fertility traits may be to increase the economic weights of these traits to find a better balance between production and reproduction traits, or to consider other traits, e.g. stay ability, in addition to conventional production and reproductive traits (Tholen et al., 1996b). Putting more emphasis on NBA and FARROW may, however, result in lower values for ADG and BF, and including more traits in the total merit index would lead to higher costs associated with performance recording and data management. Restricting genetic gains in production traits may therefore be a better alternative for minimizing a reduction in reproductive traits than including more traits in the total merit index.

A positive effect of increased pig performances on the genetic success can be only observed in ADG and BF. By contrast, the annual genetic gain in NBA and FARROW is even lower (however on very low level) when assuming increased pig performances. The overall annual monetary genetic gain of the current recording scheme based on present and improved pig performances is very low (0.03 €).

Modelling results indicate that the breeding programme reflecting the current recording scheme for market-oriented smallholder pig production is economically not profitable (−33.90 € sow⁻¹), increased pig performances having no effect on the profitability. Both the high negative profit and relatively low annual genetic gains may be explained by the small population size that leads to a high fixed costs burden, and the low selection intensity.

3.4. Further study

Continued success of village breeding programmes depends on the profitability of breeding measures. The current recording scheme implemented at smallholder farms in the market-oriented production system is economically unprofitable and its long-term sustainability seems uncertain, even with increased level of sows’ reproductive performance.

A further study therefore focuses on the development of alternative breeding schemes that are evaluated with ZPLAN. In a first alternative breeding scheme, breeding objective traits and selection criteria are adjusted to account for the feed intake capacity and spectrum of feed intake of pigs. These are traits that smallholders commonly select for, because feed is the major cost component of smallholder pig production in the area (84% of variable costs) (Lemke et al., 2007). They are, however, difficult to measure under prevailing production conditions and thus are not recorded in the current recording scheme. Including feed intake in the total merit index would therefore lead to higher costs associated with performance recording and data management. Higher costs should not be ignored in optimizing breeding schemes for smallholder production systems, as these are a significant
barrier to the adoption and sustainability of any beneficial breeding programme. Taking all this into consideration, the restricted selection index approach is used, restricting the genetic gain in ADG. Because this trait is positively correlated to feed intake (Rauw et al., 2006), the correlated genetic response of feed intake is expected to be limited too. A second alternative breeding scheme is developed to consider a two-way and three-way crossbreeding system with the local Ban breed. The aim is to derive possible linkages between different production types, i.e. resource-driven and market-oriented pig production.

Since financial and technical capacities of smallholders to continue the current recording scheme after the project's completion are limited, investigations are needed in how far cooperation and integration with other institutions having the necessary financial resources and technical know-how may enable the long-term sustainability of future village breeding programmes.

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