Community-Based Breeding Programmes Incorporating Local Breeds: Concept, Research Results and Implementation Strategy on Pigs in Northern Vietnam

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Introduction

The present paper reviews the research concept of community based breeding programmes (CBP) on the example of a long-term research project in mountainous regions of northern Vietnam aiming at the development of a CBP for pigs building on local resources, local knowledge and organizational opportunities at village, regional and national level. The results of past years' investigations, as well as the current challenges faced in attempting a successful transition from research to the practical implementation of a sustainable CBP are presented and discussed. The project is conducted by the University of Hohenheim within the frame of the Thai-Vietnamese-German Collaborative Research Programme "Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia". Long-term funding allowed for a comprehensive design and implementation of the research programme that is currently in its tenth year.

The concept

Today, a large number of indigenous breeds or varieties in the developing world are at risk of becoming extinct (Hall and Ruane (1993); Drucker et al. (2006)) and for some of them conservation efforts may be successful. A promising conservation strategy can be seen in an efficient on-farm utilisation for sustainable use of the specific breed in question, taking into account both, genetic diversity and non-genetic criteria for prioritizing breeds at the national level (Simon (1999); Ruane (2000); Gizaw et al. (2008)). For this means, CBP have been suggested for unfavourable environmental conditions, as an alternative to governmental breeding programmes. Under marginal conditions, breeds with an appropriate combination of production yield and adaptation are required and locally adapted breeds may contribute to this. CBPs may also work for other breeding options and have to compete with other commercially oriented breeding programmes for economic, socio-cultural and environmental sustainability. The specific properties of such programmes that often aspire to actively incorporate small farmers in remote regions are seen in the organisational set-up and the numerous technical constraints arising from a suboptimal set of production conditions (Valle Zárate (1996); Sölkner et al. (1998)).

Breeding and conservation activities in smallholder production systems in the tropics are typically constrained by small animal populations, lack of systematic animal identification, inadequate performance and pedigree recording, low levels of literacy, ineffective participation of farmers in breeding schemes and organisational shortcomings (Kiwuwa (1992); Jaitner et al. (2001); Kosgey and Okeyo (2007)). A significant number of failures of livestock development programmes have been reported in the past due to various reasons

(Sölkner et al. (1998); Kosgey et al. (2006)). Kahi et al. (2005) pointed to the potential of community-based organisations to overcome local socio-political, socio-economic and infrastructural limitations, especially regarding the local management of recording schemes through the promotion of farmer groups and cooperatives (see also Trivedi (1998)).

Apart from several technical and infrastructural related issues that hamper the development and maintenance of such programmes in low-input systems, genetic improvement has to be generally considered as a long-term financial investment. The required levels of investment for longer periods are often not provided and have thus not been available to many research projects concerned with the utilisation and conservation of indigenous animal breeds. Strategies for the conservation of domestic animal biodiversity include direct support for national purebred conservation programmes by different subsidy types and levels. However, also methods of livestock conservation by utilisation of indigenous breeds in pure- and crossbreeding have been suggested (e.g. Shrestha (2005) for composite sheep breeds; Omondi et al. (2008), and Gizaw et al. (2009) also for sheep; Djemali et al. (2009) for goats and Ngowi et al. (2008) for cattle). Utilisation in this regard may refer to traditional management practices, but also to often underrated breeding and crossbreeding measures that contribute to management issues by the organisational requirements of breeding programmes, add cumulative value to the livestock resources by directed matings and selection, or conserve a local breed within a more sophisticated crossbreeding scheme. However, Cardellino and Boyazoglu (2009) have only recently reconfirmed that within a wide range of thematic areas for animal research, the biggest gap in knowledge is animal breeding for local populations in harsh environments.

In Vietnam, pig production is of great economic and nutritional importance with pig meat accounting for an estimated 76.7% of the total meat produced in 2001 (FAO (2003)). Since the start of the system reform in 1986, the Vietnamese government and the Ministry of Agriculture and Rural Development (MARD) legislated a considerable number of laws and provisions to enhance the national pig production development to meet the local demand for pork (Lemke et al. (2008)). Though large pig production units have been promoted by the government, the pig production sector in Vietnam, especially in the north, is still dominated by small-scale production, accounting for 80% of the total production (Lapar et al. (2003)). Smallholder production systems are still strongly associated with the keeping of local breeds. However, by the introduction of exotic pig breeds, the population of local breeds has steadily declined. Out of the 25 pig breeds in the country, 15 are local, only one of which is reported as being ‘not at risk’ and ten have entered *ex situ* and/or *in situ* conservation programmes in the past or at present (Drucker et al. (2006)). In northern Vietnam, local pigs made up 12% of the total population in 2006, compared with 14% exotic pigs and 74% crossbred pigs (DLP (2007)).

The present long-term research project aimed at building the breed planning process on a characterisation of the production environment and available genetic resources, including the evaluation of farmer’s preferences, before proceeding to an evaluation of alternative organisational set-ups and modelling of alternative breeding plans.

During its first phase, which started in 2000, a comprehensive analysis of smallholder livestock production systems with a special focus on pig production has been carried out (Lemke et al. (2006)). Resource-driven and demand-driven systems were identified and distinguished depending on their location, distance to town and access to input and output markets, providing the analytical frame. Whereas demand-driven systems prevail near town

with higher population pressure and land scarcity, resource-driven systems are found in more remote areas, making use of available resources with minimal investment for external inputs. Initially four research villages were selected by the project along a gradient of increasing remoteness and altitude, and decreasing production intensity, including the ethnic groups of Black Thai and H'mong. Close to town, farm sizes are small and the availability of communal land is low, but infrastructure and market access are favourable so that production is geared towards meeting the market demand. In the remote uplands, infrastructure and market access are severely limited and livestock production makes use of resources that are not suitable for alternative utilization.

In the study villages, between 90% and 100% of households keep pigs. In areas close to town, the improved local Mong Cai (MC) pig with medium productive and reproductive performance is commonly used as sow line, whereas Large White (LW) and Yorkshire boars are used for mating to produce fatteners. In the more remote areas, farmers predominantly keep the indigenous black-coloured pig breed called Ban (Vietnamese "Ban" = "mountain village", locally known as "Dan" (Vietnamese: "people") or "Meo"). Following the in-depth characterisation of the livestock production system in Son La province, 'On-Farm Performance Testing Schemes' (OPTS) for pigs were established for a regular pig herd monitoring by farmers and researchers and the management of the performance data with a professional software data bank (Markemann et al. (2003); Lemke (2006)). The OPTS are based on the concept that pigs of one village represent a pig herd. In a further step, MC and Ban gilts were distributed by project staff to the farmers according to a regularly adjusted mating plan to safeguard breeding and multiplication of local breeds and to achieve a distribution of breeding sows allowing for the calculation of genotype x environment interactions. In the OPTS, data is collected by farmers, who insert data in Vietnamese-language data sheets, covering the topics of reproduction, off-take and purchase of pigs, diseases, treatments, losses, and purchase of feed and veterinary products. Researchers conduct bi-monthly farm-visits, at which they check and copy the data sheets of farmers (which remain at the farm) and additionally record pigs' individual weights and biometric measures. In parallel, pigs are individually identified by ear tags. Data is entered into a data bank running on the herd-management software PigChamp® (PigCHAMP, Ames, Iowa, USA). Information from the data base is used for original research, supporting breeding management and controlled mating, and the optimisation of pig keeping through individual advice and training sessions. Thereby the methodological approach aimed to conform to both, active farmer participation, motivated by an immediate benefit through management advice and a long-term on-farm recording system, as a basis for long-term benefits through a CBP, also considering farmers interests as expressed in their trait and breed preferences (Roessler (2009); compare to Bebe et al. (2003)). Involvement of farmers is regarded an essential element when designing sustainable breeding strategies (Kosgey et al. (2006); Gizaw et al. (in press)). Regarding pedigree and performance recording, dissenting opinions exist. Nucleus breeding schemes avoid on-farm data recording and associated breeding costs. This may be an advantage even though genetic gain may be similar in both approaches (Gizaw et al. (2008)). Some researchers have recommended mass selection in the absence of pedigree recording under village conditions to prevent serious inbreeding with increasing genetic gains (Wurzinger et al. (2008); Gizaw et al. (2009)). Others regard animal identification, performance and pedigree recording as the most essential elements in genetic improvement and the development of sustainable selection decisions (Olivier et al. (2005);

Bett et al. (2009)). Since its implementation, the OPTS-procedure in the research project in northern Vietnam was continuously refined, and additional villages have been included to account for both, a larger and more comprehensive data base and an aspired balance between data of different pig breeds originating from different production systems and thus environments. Simultaneously, a very dynamic spontaneous transition process towards a more market oriented pig production had to be considered. Currently, seven villages are included in the OPTS data collection, i.e. three in the demand-driven system, two in the system in transition and two in the resource-driven system, respectively.
OPTS data were used for a village-specific performance analysis of local breeds and their crosses (Hau (2008)). The data was complemented by farmers' breed and trait preferences (Roessler et al. (2008)) that entered breeding model calculations for the demand- and resource-driven system (Roessler et al. (2009); Herold et al. (2010)). By means of putting emphasis and perpetual control on pig distributions and directed matings, the extension of a pedigree connected database and the subsequent estimation of population-specific parameters is aspired. The resultant parameters will considerably contribute to precise model calculations for planning of breeding with the deterministic breed planning software *ZPLAN* (Willam et al. (2008)), administered by the institute.
Within the next two years it is envisaged to test the developed breeding procedures for both, the transferability to other research areas of Vietnam and the implementation for general applicability to community-driven breeding programmes. This might succeed in the transfer of the research programme into sustainable practice, linking the consulting service of national and international research institutions with cooperatives of farmers and the market-oriented private sector.

Research results

In the mountainous province Son La, Northwest of Vietnam, two distinct production systems were clearly identified, differing in remoteness, market access, resource availability, distribution of pig breeds and pig production intensity. Differences in management intensity were found at a high degree between them, reflecting farmers' production objectives of more market- (demand-driven) or more saving-oriented (resource-driven) pig production (Lemke et al. (2006)). A higher productive adaptability of pigs was observed in parallel with higher incidences of MC sows and crossbred LW×MC offspring in the demand-driven system, while a lower productive adaptability was associated with a higher incidence of Ban sows and pure Ban in contrast to crossbred (LW×Ban) offspring in the resource-driven system (Lemke et al. (2006)). The actual growth rate of Ban pigs was found to be 119 g/d (169 g/d in MC pigs), backfat thickness of 30.4mm (28.5mm in MC pigs) and 6.1 piglets were born alive (9.3 piglets born alive for MC sows) (Hau (2008)). Yet, it is assumed that these pigs do not express their full genetic potential and higher performances are expected under improved management conditions (Hau (2008); Lemke et al. (2006)).
Reproductive performance, growth performance, carcass characteristics and meat quality of the MC and Ban pig breeds was further analysed, relating the first also to genetic polymorphisms of candidate genes. The significant higher reproductive performance of MC over Ban sows was modified by a significant interaction village x breed. For the Ban breed, differences between the villages were lower than for MC. Under better village conditions, the superiority of MC was higher than under poor village conditions. The effect of selected loci

on the reproductive performance indicated a strong influence of the oestrogen receptor locus (ESR). The frequency of the favourable B allele was found to be higher in MC sows, which contributes to a generally higher reproductive performance of MC over Ban sows (Hau (2008)). Besides the clear genotypic effects on the reproductive performance of the two breeds, high performance variation within villages was observed and can be predominantly explained by different management practises applied by farmers. Research on the background impact of different management practices as to be explained by differences in farmer's access to information and knowledge networks is currently analysed.

The continuous refinement of the OPTS data collection since its implementation seven years ago, led to a number of modifications in terms of villages included in the OPTS, their systems' classifications changed according to permanently changing conditions during the course of the project. The current seven villages included in the OPTS comprise in total 182 farmers. The total Ban and MC population amounts to approximately 730 sows with a fluctuatiing 25-35% of animals under the OPTS system (200 to 260 animals). Six Yorkshire, six MC sires, distributed by the project, and five Ban sires are available for directed matings.

OPTS data collection and processing in the respective villages is well established and operating. The working concept proved successful by participatory farmers' meetings, the development of datasheets in Vietnamese-language, continuous distribution of sheets to farmers and back-checking data by researchers and participatory feedback seminars evaluating performance testing schemes and making testing results available and applicable for farmers (Lemke (2006)). Generally, the data show that in the course of time pig mortalities have been reduced and pig performance has increased, contributing to the continuous interest of the farmers in the project. Breeding model calculations for MC pigs in the market-oriented system however revealed that the present breeding scheme is economically not profitable (Roessler et al. (2009)). Instead, a stratified pig breeding scheme is suggested, building on existent organisational links with Yorkshire as terminal sires and the local pig breeds Ban and MC on the maternal side and showing highest overall genetic gain in model calculations. This scheme seems promising for both, production and marketing of pig meat in the uplands of Northern Vietnam and the controlled conservation of the local Ban breed (Herold et al. (2010)). In spite of the lower production and reproduction performance of the local Ban, the high appreciation of Ban pig meat by the market due to its special taste characteristics (Huong et al (2009); Hau (2008)) is supporting its incorporation in the breeding programme.

Horizontal integration of a smallholder breeding organisation at village level along with a vertical integration focussing on members' joint marketing have been discussed. An institutional analysis on the organisational feasibility of village breeding programmes suggests breeder cooperatives being a promising option to improve smallholder pig breeding (Roessler (2009)) building on a potential integration into existing regional and national . Within a stratified breeding system local genetic resources would be systematically conserved in remote rural areas and supply farmers there with meat with higher fat content. In addition, crossbred animals would be bred and fattened in the areas close to markets and would supply leaner meat to urban households (Herold et al. (2010)).

Implementation strategy on pigs in Northwest Vietnam

Building on the results of the modelling of breeding programs and organisational analysis as presented by Roessler et al, 2009 and Herold et al. (2010), a stratified breeding scheme with

the construction of a short food supply chain is proposed, requiring innovative organisational setups, building links between remote and close-to-market farmers' villages and pig populations. Small food supply chains combine the attributes of certified supply chains with the aim of rural development and would add in this particular case additional value to the pig meat of local breeds by linking the produced product to a special region with a defined quality and safety standard. This marketing strategy is expected to safeguard the economic sustainability of the breeding programme.

Regarding the current planning to transfer the research results and experiences into practice and hence, realising a sustainable, beneficial and profitable, CBP, optimisation of the genetic programme (regarding population size, efficient performance testing, accuracy of the breeding value estimation and selection intensity) along with optimization of organisational and marketing structures are being addressed.

Two different pork markets can be distinguished in Vietnam: a high demand (40% of meat consumed) of lean pork in urban areas, whereas in rural areas demand for lean pork is still rather low (18% of meat consumed) (Tung (2001)) and rural households mainly consume meat with a higher fat content (Cuong (2004)). For the optimal exploitation of these promising prerequisites, however, the future demand for branded regionally produced pork still has to be evaluated. The optimal size of the programme in terms of number of villages, farmers and sows to be included needs to be determined. The optimal size required for market supply has to be contrasted with a suitable population size to avoid inbreeding and assure long-term genetic gain. For this purpose, in depth market analysis on the one hand and various sensitivity analyses within modelling scenarios on the other are currently conducted.

All breeding schemes evaluated up to now, i.e. Yorkshire×MC (Roessler et al. (2009)), Yorkshire×Ban and Yorkshire×(MC×Ban) (Herold et al. (2010)), showed high breeding costs leading to a negative profit. However, costs so far assumed in the modelling approaches have been mimicking data recording for the purpose of a research project. These costs are intrinsically higher than those that would actually incur with a reduced routine data collection in the proposed breeding system. A reduction of data recording costs can be achieved by reducing the number of traits to be recorded and by using genetically adequate auxiliary traits that are easier and cheaper to record as has to be determined by model calculations (compare Pitchford, 2007).

The organisation of the pork supply chain in Son La province is still unsystematic and quality control systems have not been established so far. A public-private partnership is sought to support high quality and cost-efficient inputs and high price outputs of the system. The societal context in Vietnam has shown the capacity and motivation of farmers to organise in cooperatives. The latter would constitute a crucial prerequisite for a farmers' breeding programme linked to a vertically integrated production chain. The stratified system is currently build up, including a transfer period, in which research will accompany the implementation phase and draw general conclusions for the applicability of the CBP model developed for pigs in northern Vietnam and prospects for upscaling to other species and regions.

References

Bebe, B.O., Udo, H.M.J., Rowlands, G.J. *et al.* (2003). *Livest. Prod. Sci*. 82:117-127

Bett, R.C., Kosgey, I.S., Kahi, A.K. *et al.* (2009). *Trop. Anim. Health Prod.* 41:307-320.

Cardellino, R.A. and Boyazoglu, J. (2009). *Livest. Sci.* 120:166-173.

Cuong, T.H. (2004). GEF-UNDP 2715-03-4709. Hanoi, Vietnam.

Department of Livestock Production (DLP, 2007). *Ministry of Agriculture and Rural Development. Draft August 2007.* (In Vietnamese).

Djemali, M., Bedhiaf-Romdhani, S., Iñiguez, L. *et al.* (2009). *Livest. Sci.* 120:213-217.

Drucker, A., Bergeron, E., Lemke, U. *et al.* (2006). *Trop. Anim. Health Prod.* 38:305-322.

FAO (2003). *Vietnamese Country Report on Animal Genetic Resources*. FAO, Rome, Italy: pages 17-18.

Gizaw, S., Komen, H., van Arendonk, J.A.M. (in press). *Livest. Sci.,* doi:10.1016/j.livsci.2009.10.016.

Gizaw, S., Komen, H. and van Arendonk, J.A.M. (2009). *Livest. Sci.* 124:82-88.

Gizaw, S., Komen, H. and van Arendonk, J.A.M. (2008). *Livest. Sci.* 118:92-98.

Gizaw, S., Komen, H., Windig, J.J. *et al.* (2008). *Genet. Sel. Evol.* 40:433-447.

Hall, S.J.G. and Ruane, J. (1993). *Conserv. Biol.* 7:815-825.

Hau, N.V. (2008). *PhD Thesis*. Institute of Animal Production in the Tropics and Subtropics, University of Hohenheim, Stuttgart, Germany. Cuvillier Verlag Göttingen, Germany.

Herold, P., Roessler, R., Willam, A. *et al.* (2010). *Livest. Sci.,* doi:10.1016/j.livsci.2010.01.004.

Huong, P.T.M., Hau, N.V., Mergenthaler, M. *et al.* (2009). *27th Conference of the IAAE,* August 16-22, Beijing, China.

Jaitner, J., Sowe, J., Secka-Njie, E. *et al.* (2001). *Small Rumin. Res.* 40:101-108.

Kahi, A.K., Rewe, T.O. and Kosgey, I.S. (2005). *Outlook Agric.* 34:261-270.

Kiwuwa, G.H. (1992). In *Proc 1st Biennial Conf. of the African Small Ruminant Res. Network*, ILRAD, Nairobi, Kenya, 10–14 December 1990, pages 423–434.

Kosgey, I., Baker, R.L., Udo, H.M.J. *et al.* (2006). *Small Rumin. Res.* 61:13-28.

Kosgey, I. and Okeyo, A.M. (2007). *Small Rumin. Res.* 70:76-88.

Lapar, L., Binh, V.T., and Ehui, S. (2003). In *Socioeconomics and Policy Research Working Paper No. 56*, ILRI, Nairobi, Kenya, 50 pages.

Lemke, U. (2006). *PhD Thesis*. Institute of Animal Production in the Tropics and Subtropics, University of Hohenheim, Stuttgart, Germany. Cuvillier Verlag Göttingen, Germany.

Lemke, U., Kaufmann, B., Thuy, L.T. *et al.* (2006). *Livest. Sci.* 105:229-243.

Lemke, U., Kaufmann, B., Thuy, L.T. *et al.* (2007). *Trop. Anim. Health Prod.* 39:237-254.

Lemke, U., Mergenthaler, M., Roessler, R. *et al.* (2008). *CAB Reviews* 3:1–15.

Markemann, A., Binh, N.T., Thuy, L.T. *et al.* (2003): In *Workshop on Efficiency of Smallholder Husbandry in Mountainous Regions of North Vietnam at DARD Son La*, 2 June 2003, Son La, Vietnam.

Ngowi, E.E., Chenyambuga, S.W. and Gwakisa, P.S. (2008). *Livest. Res. Rural Dev.* 20(6).

Olivier, J.J., Cloete, S.W.P., Schoeman, S.J. *et al.* (2005). *Small Rumin. Res.* 60:83-93.

Omondi, I., Baltenweck, I., Drucker, A.G. *et al.* (2008). *Trop. Anim. Health Prod.* 40:615-626.

Pitchford, W.S. (2007). *Livest. Sci.* 110:141-147

Roessler, R. (2009). *PhD Thesis*. Institute of Animal Production in the Tropics and Subtropics, University of Hohenheim, Stuttgart, Germany.

Roessler, R., Herold, P., Willam, A. *et al.* (2009). *Livest. Sci.* 123:241-248.

Roessler, R., Drucker, A.G., Scarpa, R. *et al.* (2008). *Ecol. Econ.* 66:184-192.

Ruane, J. (2000). *Conserv. Biol.* 14:1385-1393.

Shrestha, J.N.B. (2005). *Small Rumin. Res.* 56:3-20.

Simon, D.L. (1999). *Anim. Genet. Res. Inf.* 25:79-99.

Sölkner, J., Nakimbugwe, H. and Valle Zárate, A. (1998). In *Proc 6th WCGALP* 25:273–280.

Trivedi, T.R. (1998). In *ICAR Technical Series No. 1*, ICAR, Anand, India, pages 27-41.

Tung, D.X. (2001). In *Proceedings of National Workshop on Animal Husbandry and Health*, Hanoi, Vietnam.

Valle Zárate, A. (1996) *Anim. Res. Develop.* 43/44:101-118.

Willam, A., Nitter, G., Bartenschlager, H. *et al.* (2008). *ZPLAN* – Manual for PC program to optimize livestock selection schemes. Version 2008, Hohenheim University and BOKU Vienna.

Wurzinger, M., Willam, A., Delgado, J. *et al.* (2008). *J. Anim. Breed. Genet.* 125:311-319.