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**Priorities for Pig Research in
Southeast Asia and the Pacific
to 2010**

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PRIORITIES FOR PIG RESEARCH IN SOUTHEAST ASIA AND THE PACIFIC TO 2010

Roger Jones

<RKJones@bigpond.net.au>

INTRODUCTION

The principal objectives of the workshop were to:

- *develop an understanding of the current state of the pig sector in Southeast Asia and the Pacific;*
- *identify investment priorities in research, development, and extension to improve the profitability and sustainability of smallholder pig production in Southeast Asia and the Pacific by 2010, in order to assist investment decision-making by individual countries and donor agencies; and*
- *develop implementation strategies for tackling the main issues facing the pig sector in the region during this period*

CHARACTERISTICS OF THE REGION

The Southeast Asian region was represented at this workshop by Cambodia, Indonesia, the Philippines, Thailand and Vietnam, and the Pacific by Papua New Guinea (PNG) and the South Pacific Commission.

After presentation of papers by these representatives and discussion of the major characteristics of each country, the workshop attempted to characterise the region as a whole. It did this by considering its important features, aspirations, key drivers, and likely development pathways relevant to pig production. These regional characteristics are outlined below.

Important Features

Smallholders are very important

The majority of pig producers are smallholders, most of whom are located in rural areas. Depending on the country and scale of production, pigs are important to them as a major source of family income, as a sideline for raising funds for particular purposes, as a 'savings bank', as a source of protein for the family, and/or for cultural reasons. Because of their numbers and generally low standard of living, smallholders are an important focus for poverty alleviation and development programs by the government, assisted at times by various donor agencies.

Productivity of smallholder systems is often low

The productivity of smallholder systems is often well below potential levels. As a group, smallholders are generally 'price takers' not 'price makers'. Pig production systems are generally tightly linked to rice production and the use of other locally available feed ingredients. Ration quantities and compositions, however, are often inadequate or unbalanced because of poor understanding of nutritional requirements, difficulties with the supply of ingredients, and lack of knowledge of their quality. Disease control is a difficult issue, both at the national scale (particularly for countries with long land borders with their neighbours) and at a local level (particularly for smallholders with poor understanding of diseases, limited funds, and poor access to drugs and other veterinary services). Management of wastes from pig production at all levels is generally poor, and natural resource management is a very serious problem particularly in peri-urban areas and in countries with limited land mass, e.g. coral atolls. Veterinary and extension services generally need improvement.

Commercialisation is proceeding rapidly

Dependence on imports of feed ingredients, veterinary supplies, and exotic genetic material is increasing in most countries as commercialisation accelerates. The speed and extent of commercialisation, however, varies between countries.

Regional Aspirations

Pork production is important at the national level

All countries are motivated by the desire for food security, alleviation of rural under-employment, and increased income levels, particularly for smallholders. In general, they want to maintain or increase local production of quality (which often means lean) pig meat at affordable prices.

Exports and imports

Most countries wish to initiate or expand their exports of pigs and pig products and reduce their imports of pigs, pig products, and production inputs such as feed ingredients and veterinary supplies. However, it was

realised by some that these aims were not always realistic or achievable, and may not even be desirable, for a particular industry component of the agricultural sector.

Important Drivers

Government priorities

All countries are reported as being committed to improving human health, particularly reducing the malnutrition of women and children; encouraging foreign investment; developing orderly marketing systems; managing market access; and protecting local pig production from competition or at least of unfair competition (e.g. through the use of disease/trade barriers, subsidies etc.). However, it was considered that, in some countries, government policies and interventions might in reality have only a minor influence on the development of the pig industry.

Markets are developing rapidly

Rapid development of commercial and semi-commercial pig production in many countries is being strongly driven by the private sector (business, farmers etc.) as it seeks to make profits by meeting increasing consumer demand for pork and pork products, and responding to changing consumer tastes and perceptions of quality.

Development Pathways

Many countries appear to be on a common development pathway but are currently located at different steps along that pathway. Countries like PNG and Cambodia that are dominated by traditional smallholder production systems appear to be just commencing along the pathway. Others, like Vietnam and particularly Thailand, are well advanced along the pathway towards the dominance of commercial production systems, importation of feed bought on the world market etc. Globalisation trading forces are likely to put increasing pressure on smallholder systems and may force them completely out of pig production other than for home and traditional use.

Having explored the main characteristics of pig production in the region, the workshop then went on to examine regional research and development (R&D) priorities in each of the six disciplinary areas (genetics and genotype \times environment (G \times E), nutrition, health, reproduction, housing and environment, product development and quality, and socioeconomics and technology transfer). A summary of the outcomes of this workshop session at the individual discipline level is given in the Appendix.

The principal objective of the workshop, however, was to decide what were the major regional R&D issues or

themes requiring attention for the system as a whole, taking account of all three dimensions of sustainable development—the economic, the environmental, and the social. This objective was achieved by clustering the major disciplinary issues into systemic themes that affected all or most countries in the region. After much discussion, five themes emerged as being regional priorities for R&D.

While the themes were not formally prioritised, the amount of discussion generated, and the strength of the views held, suggested that the order was as follows, with higher priority areas shown at the top of the list:

- *Information systems and technology transfer*
- *Policy development*
- *Environmental management*
- *Health and food safety*
- *Feeding and breeding*

REGIONAL R&D PRIORITY THEMES

The five priority themes listed above were considered in some detail using, for focus, all or most of the following questions:

- *Is R&D the major constraint to progress or are other factors/constraints more important?*
- *Is transfer of existing knowledge and experience from another country within the region a solution to progress in this theme?*
- *Is the R&D deferrable without serious consequences? If not, what are those consequences?*
- *Is cooperative regional R&D on this theme necessary or desirable, or can this theme be adequately addressed within individual countries?*
- *Is it likely that R&D-driven progress will truly benefit pig producers, particularly smallholders?*
- *Is the time scale of the required R&D short or long, and is there a logical sequence for the components of that R&D?*
- *Is a lack of skills or resources limiting progress, and are inputs required from outside the region?*
- *Is there an optimum strategy for implementation of R&D in each theme?*

Theme 1: Information Systems and Technology Transfer

Background to the issue

Access to information and training by extension staff and producers, particularly smallholders, was seen as seriously lacking in all countries in the region. Thus,

there was general agreement that appropriate packaging and transfer of existing information on all aspects of pig production (nutrition, genetics, health, market conditions etc.) was a higher priority than R&D on these aspects to generate new information.

Outcome

The desired outcome is that all sections of the pig industry in the region have equitable access to carefully targeted information and training on all aspects of the pig production and marketing chain.

Consequences of failure to address this theme

If this issue is not addressed, the probability of the serious consequences outlined in Theme 2 occurring will be increased. In other words, the differential between commercial and smallholder producers will increase because the commercial sector has, and will increasingly have, superior resources and access to the national and the world knowledge/information base on pig production technology and marketing.

Possible solutions

While the ultimate target group consists of those producers who have decided to 'make a business out of pig production', the key target group for simplified information and training packages, CD-ROMs, manuals etc. is seen as those who are in closest (e.g. daily or weekly) contact with them. These, for example, may be village-level extension staff, key farmers or farmer groups, or commercial input suppliers. Some desirable characteristics for the information/training packages are that they:

- provide producers with information that will improve their capacity to manage their enterprises more efficiently and profitably;
- supply credible, balanced information that is sufficiently accurate for the main task at hand;
- are relatively brief and simple, emphasising (and reiterating) only three or four points; and
- provide relevant performance parameters so that farmers can compare productivity with their peers. (This will almost certainly involve increasing the emphasis on record-keeping.)

Delivery of information and training may need to take account of the following observations and points.

- Communication is a two-way process. Advisers/trainers may well have as much to learn from smallholder producers about operational, tactical, and social aspects of pig production as they have technical knowledge and understanding to impart.
- Effective communication can occur through a diversity of routes (e.g. formal training courses,

word-of-mouth, and actually seeing new technologies in practice on other farms).

- Provision of information and training entirely from government resources can be extremely expensive, so financial or in-kind contributions from participants should be a prerequisite, and support from commercial groups, donors, and non-government organisations (NGOs) should be sought.
- Information on costs, prices, and their trends is as important, if not more important, than technical information on the various aspects of production.

R&D program

It is likely that much of the information required will be available in the grey literature (e.g. project/donor reports etc.) within the country or in other countries in the region with similar production systems. R&D in Themes 3, 4, and 5 can be expected to provide some of the required information inputs.

Assembly of information and training aids, and their subsequent delivery to target groups, must pay careful attention to the points made under Possible solutions above. Evaluation of the success of the technology transfer process should be an integral part of the R&D from the outset.

Theme 2: Policy Development

Background to the issue

Government policies and regulations or the lack of them can have a major influence on the way the pig industry develops in a country and/or in a region. In many countries in Southeast Asia and the Pacific, policies and regulations, where they exist, often:

- lack an industry-wide perspective;
- are short term in nature, failing to take account of the longer-term economic, social, and environmental consequences, particularly on smallholder producers;
- suffer from a lack of emphasis on policy development by donor agencies (donors have tended to focus on development of an area or region, on specific technologies, and on poverty alleviation, rather than taking an industry or sectoral approach); and
- are strongly influenced by the powerful commercial sections of the industry.

Despite rapidly increasing demand for pork and pork products, smallholder producers are considered to be the most vulnerable group within the pig industry. This is because of their poor understanding of technical aspects of the production system, their inferior access to

improved genetic strategies, feed ingredients and diets, their slowness in responding to market signals, and their weak bargaining position within the market chain. If smallholders are forced further to the margins of the production–processing–marketing chain, serious social and possibly political consequences are inevitable. At the same time, commercialisation is expanding rapidly in most countries, often with little regard for the consequences in terms of land quality and effluent disposal. Frequently, feed imports are subsidised, favouring larger units. Such commercial units are often located in peri-urban areas presenting additional health hazards. Analysis of the full cost to society of all enterprises is an essential component for proper consideration of the role of pig production in a country.

Outcome

The desired outcome for the Southeast Asian region is that individual countries and/or regional groupings of countries have development plans and concrete implementation strategies and actions in place for the pig industry that aim to satisfy consumer demand for pork in a socially equitable and environmentally friendly manner. In short, a Policy for Equitable Production of Safe Economic Pork = PEPSEP.

Consequences of failure to address this theme

If this theme is not addressed satisfactorily, in one or two decades the following consequences will be of common occurrence in the region.

- The economic, social and environmental benefits of crop/livestock systems based around the integration of rice and pig production will be in disarray.
- The number and prosperity of smallholder pig producers will be in steep decline. They will have poorer access to knowledge and training, to improved genetics, to feed ingredients and diets, and to veterinary services. (Smallholders may, however, derive some minor flow-on benefits in inputs and services that are associated with a strong commercial sector, but overall they will be relatively worse off than they are now.)
- Large-scale fully commercial production systems will dominate the production, processing, and marketing of pigs and pig products. These systems will increasingly have higher production efficiency, superior technical expertise, greater buying power for inputs on the world market, and greater political influence than other systems. However, many of the ‘whole system’ costs of such production systems, such as environmental damage, will be borne by others.

As a result of such anticipated consequences, there is likely to be a higher level of rural poverty, a desperate search for replacement cash-generating enterprises, an

accelerated drift of population to the cities, and resultant social and political instability.

Possible solutions

Enlightened and well-integrated policies could help alleviate many of the above trends associated with globalisation of trade and failure to conduct complete system costing of pig production. With the demand for pork and pork products in the region anticipated to double over the next 20 years, governments could, for example, set in place policies that:

- enhance to sustainable production of crops and livestock by closer integration within suitable areas, and the use of regulatory and fiscal mechanisms to support sustainable production practices;
- encourage smallholders to organise into cooperatives and buying groups so that their inputs are cheaper and more accessible, and their market power and market access are enhanced;
- encourage large-scale commercial producers to develop niches in the production chain for smallholders (e.g. contracting out to smallholders the production of weaners); and
- preferentially support education, training, and technology transfer programs for smallholders, particularly in rural areas. Such support may perhaps include subsidising appropriate programs provided by the private sector (e.g. by companies supplying veterinary products and feeds).

R&D program

A regional program to develop pig industry policies would cover the following aspects, most of which have an R&D component in this or other Themes:

- studying the potential consequences of present industry structures and practices on the economic, environmental and social ‘health’ of the country
- developing policy development plans for individual countries;
- developing information systems for all levels of the pig industry;
- gathering information on pig industries within and beyond the region;
- formulating policy development options based on the above; and
- conducting national and regional workshops and developing national and regional training programs for policymakers.

Theme 3: Environmental Management

Background to the issue

Management of the impacts of pig production on the environment is emerging as one of the most pressing problems facing the pig industry in Southeast Asia and the Pacific. The main problem lies with producers located in peri-urban areas. In general, smallholders lack the knowledge, resources, and the affordable technology to deal with these intractable problems. The major commercial producers, on the other hand, generally have the resources to use the best available technologies to address the problem, although they will probably require government legislation to induce them to comply.

Pig production is already contaminating surface and groundwater and, in some cases, the marine environment, and adversely affecting the quality of drinking water—leading to human health problems. Thus, safe, sustainable disposal of liquid and solid wastes from pig production and management of the associated odours, flies, rats etc. is a massive and growing problem.

Outcome

The desired outcome is that all sectors of the pig production and processing industry are managed in such a way as to minimise impacts on the environment, and to maximise value adding for the industry, particularly smallholders.

Consequences of failure to address this theme

If the environmental problems associated with pig production are not effectively addressed, environmental conditions, especially in the vicinity of pig enterprises, will continue to decline. It is thought that national and local community pressure will eventually force major changes (such as banning certain effluent disposal practices and possibly prohibiting pig production altogether in certain areas). The most vulnerable pig producers are considered to be those located in peri-urban areas surrounding the fastest growing cities. Experience elsewhere in the world suggests that such enterprises will be banned, probably within a decade. As in Theme 2, this may lead to adverse social outcomes.

Possible solutions

The solutions probably lie in a mixture of legislative action and enforcement, and development of improved technologies to deal with solid and liquid effluents and odours. Unfortunately, existing biogas technology seems to be beyond the financial and management resources of many smallholders, although it has an important role to play in semi-commercial and commercial production systems.

Separate solutions are needed for systems when pigs are kept largely for ceremonial purposes, as in the Pacific, or when kept for generation of income in mixed crop/livestock systems. In the former case, smallholders will be reluctant to institute change that requires expenditure, so legislation/regulation or fiscal action may be the only solution. In the latter case, any changes would need to be seen to add value to the crop/livestock system.

It would seem also that a mindset change is required—from regarding pig effluent as an embarrassing waste product to regarding it as an important resource requiring integration into the crop production system. Successful examples of such a mindset change, however, are few, although disposal of solid effluent using worms has apparently been practised successfully in Cuba, with the final product being worms (a possible protein source) and nutrient-rich organic matter. Pelleting solid manure for use in horticulture or crop production may also warrant further attention.

R&D program

R&D should start by assessing developing country experience elsewhere in the region and the world, in the hope that existing technologies may be able to be adapted to the Southeast Asian situation. This may provide a useful starting point for innovative R&D. This R&D effort may require the assembly of teams with access to a wide range of skills (e.g. biological, engineering, and policy development skills) to tackle this age-old problem. Government policies on effluent disposal that are effective but, if possible, do not further disadvantage smallholders should also be studied in other comparable countries, in association with R&D in Theme 2.

Theme 4: Health and Food Safety

Background to the issue

Good pig health and careful attention to food safety issues are prerequisites for profitable and sustainable pig production. Management of disease outbreaks and control of endemic diseases in smallholder pigs are generally poor in the region. High mortality and morbidity rates continue to be a major problem for smallholder pig producers in many countries. Disease control is more difficult in countries with long land borders and substantial movement of pigs across those borders. The lower ranking of this two-component Theme at the workshop was probably because:

- the sale of pig products in the region is predominantly through a wet market (fresh, boned out meat)—a practice that is highly likely to continue for the foreseeable future and for which the need for hygiene/food safety intervention is currently poorly defined;

- export of pig products between Asian countries is a minor part of the overall industry in the region at present, and hygiene strategies to accommodate this trade are either in place or are readily available; and /or
- research, management, and legislative solutions to many of the problems are already known.

Outcome

The desired outcome is that pig health issues are under effective control in all countries in the region; food safety, particularly for the non-wet market is assured; and emergency and preventative procedures are in place to deal with disease outbreaks and food safety incidents affecting human health.

Consequences of failure to address this theme

In relation to the health of smallholder pigs, continuation of poor access to animal health services and good quality veterinary inputs will allow the high mortalities and morbidities to continue, and production to suffer. Pigs raised by commercial producers, on the other hand, generally have adequate health inputs, so failure to address this theme would have little or no consequence. Inadequate attention to disease by smallholders, however, could have feedback effect on the productivity and profitability of major commercial producers.

In relation to food safety, local markets will probably continue to be based on wet markets where hygiene issues are not so important, so consequences for this market would be low. However in non-wet markets, failure to address food safety issues may impact on consumer confidence.

Thus, in both health and food safety, the differential between smallholders and commercial-industrial pig producers could increase, and contribute to the economic, social, political consequences outlined under Theme 2.

Possible solutions

In pig health, regional cooperation through the Office International des Epizooties (OIE) and the Food and Agriculture Organization of the United Nations (FAO) in quarantine inspection and disease surveillance and management requires greater emphasis. Programs in individual countries to improve access of smallholder farmers to animal health services need to be continually improved (e.g. disease diagnosis, vaccination programs, training and extension, access to veterinary services, and supply of veterinary products). In food safety and human health, implementation of programs based on existing knowledge should provide many of the required solutions. This will involve increased emphasis on activities such as registration and

inspection of slaughterhouses and animal health services, and training in food hygiene for meat handlers and processors.

R&D program

R&D to support the above ongoing activities should continue and possibly include:

- work on the design and implementation of different delivery systems of animal health service, and evaluation of their efficiency and effectiveness
- new work on the epidemiology of important pig diseases;
- development of thermo-stable vaccines, particularly for swine fever; and
- development of new diagnostic procedures and test kits.

Theme 5: Feeding and Breeding

Background to the issue

The genetic potential of pigs and the quality of their feed are of course absolutely crucial to efficient profitable pig production. However, these fields have received massive R&D investment by governments and donors over the last three decades, and most countries in the region have a considerable bank of knowledge/experience to draw on, and relevant improvement programs in place. This is the reason that the workshop gave a relatively low priority ranking to this Theme. Nevertheless, aspects of these topics are essential components of the two highest priorities for R&D identified by the workshop, namely information systems and technology transfer, and policy development. Future work in this field should concentrate on enabling smallholders to meet market requirements through the combination of genetic improvement and nutrition.

It was felt that the commercial–industrial pig producers were self-sufficient in knowledge and experience on feeds and breeds and needed little further government- or donor-funded R&D investment. Smallholder producers, however, would need continuing investment particularly in feed- and breed-related information systems and technology transfer (see Theme 1).

Outcome

The desired outcome is that all pig producers have access to productive breeds and crossbreeds that are adapted to their environments and production systems, together with appropriate access to knowledge and training on nutrition and feeding.

Consequences of failure to address this theme

If smallholder producers do not improve the genetic potential and nutrition of their pigs, their competitive

position vis-à-vis the commercial-industrial pig producers will be further eroded. In time, this will lead to the serious social and economic consequences outlined under Theme 2.

Possible solutions

It was felt that the major emphasis in feeds and breeds should be on aspects such as:

- providing simple tools for smallholder farmers and/or their advisers (e.g. 'fuzzy feed calculators') that are simple to use but draw on detailed understanding of the basic science behind them, and on past research and experience in the region;
- encouraging smallholder farmers to be more aware of, and responsive to, market signals on carcass quality; and
- seeking opportunities for closer integration of feed and breed aspects of their production systems with those of the commercial-industrial producers.

R&D program

In addition to R&D to investigate the possible solutions listed above (for input into Themes 1 and 2), some further investment is required to:

- investigate cost-effective ways of conserving the genetic diversity present in native pig populations;
- match genotypes to production systems, particularly those based on sub-optimal or lower feeding intensity;
- characterise any previously-unstudied potential feed ingredients that are available in sufficient quantities to be regionally important; and
- implement breeding strategies to accelerate the infusion of improved genetics into smallholder herds to optimise efficiency of the particular production system.

APPENDIX

Disciplinary Priorities

Before discussing and agreeing on the highest priority regional Themes, the workshop discussed the priorities within each of the major scientific disciplines. The outcomes of this session are presented below.

Genetics/G×E interactions

R&D should focus on the following priorities:

- Improving the three most important traits—average daily gain (ADG), feed conversion ratio (FCR), and carcass quality, particularly leanness.
- Improving other traits (reproductive performance under various management/environmental conditions, and disease tolerance/resistance).
- Evaluating the interactions between breeds/crossbreeds and diets.
- Developing structured processes to better exploit heterosis.
- Conserving native breeds as a source of important traits in the future (but who bears the cost?).
- Determining the respective roles of governments and private industry in genetic improvement (much variation between countries in the region).

Nutrition

R&D should focus on the following priorities:

- Understanding imported feed issues (currency impacts, cost, alternative ingredients to replace imports).
- Investigating opportunities for use of local feedstuffs and by-products (e.g. availability of information on nutritional value, stability of supply, evaluation methods (*in vitro* or *in vivo*?), possibilities for fermenting cassava in some countries to improve digestibility, effectiveness for different classes of stock).
- Improving feeding practices (information, extension, correct formulation of feeds, development of pig business concepts).
- Addressing feed quality issues (storage problems, e.g. with rice bran, processing).
- Understanding the environmental and health aspects of nutrition (impact of diet on effluent 'quality' and meat quality, e.g. chemical residues, need for regulations).
- Determining the nutritional requirements/capabilities of local breeds (different from improved breeds or not?).

Health

R&D should focus on the following priorities:

- Improving disease control measures for panzootic disease.
- Improving disease control measures for, and increasing awareness of, zoonoses.
- Evaluating and improving access of smallholders to veterinary and extension services.
- Developing cost-effective disease treatments, and assessing the efficacy of alternative/traditional medicines.
- Developing and improving on-farm diagnostic tests.
- Assessing the impact of nutritional and genetic disorders on productivity.
- Assessing/monitoring the health effects of antibiotic (and other feed additive) residues in meat.
- Improving the knowledge/training in veterinary matters of smallholder pig producers.
- Monitoring the impact of increased intensification of pig production on disease incidence.
- Developing appropriate quarantine measures.
- Improving the communication/information flow between countries (particularly contiguous countries) in the region about disease epidemics.
- Developing collaborative regional health initiatives (planning, policy, and R&D).
- Assessing the national and regional threats of new diseases (e.g. bovine spongiform encephalopathy (BSE), Nipah virus).

Reproduction

R&D should focus on the following priorities:

- Improving the record-keeping systems of smallholder producers.
- Utilising crossbreeding and improved nutrition to increase litter size, and reduce inter-farrowing intervals and pre-weaning losses.
- Determining the pros and cons of government or privately-funded artificial insemination (AI) schemes versus 'boar-for-hire' schemes, under a range of circumstances.
- Utilising extension services to improve heat detection, mating management, and feed management by pig producers, particularly smallholders.

Housing and environment

R&D should focus on the following priorities:

- Improving the standard of housing (appropriate materials, adaptation to the local environment, adequate ventilation and temperature control, and with good feeding and watering systems).
- Improving the management of effluent from pig enterprises (to reduce human health, environmental, and lifestyle impacts such as contamination of surface and groundwater supplies). This issue is a particular problem for coral atolls and other low-lying areas.
- Changing the way pig effluent is regarded—from a difficult-to-handle noxious waste to a valuable resource (valuable for biogas and fertiliser production for additional cash).
- Understanding cultural and social objections to pig production near residential areas.
- Developing policy, regulation, education, and training responses to cope with the environmental effects of pig production.

Product development and quality

R&D should focus on the following priorities:

- Supporting activities in genetics and nutrition that help producers meet the market demand for lean meat.
- Addressing other meat quality issues (e.g. marbling, moistness, smell, colour, chemical residues).
- Developing new products with longer shelf life that add value to lower-value pork cuts.
- Accommodating existing markets (e.g. the PNG preference for fatty native pigs) or developing niche markets for specific breeds of pig or raising conditions.

- Developing policies and practices that deal with public health and hygiene issues associated with slaughterhouses, butcher shops, and sales outlets.
- Training smallholder farmers to better understand the implications of their management actions on product quality further down the market chain.
- Managing the impact of cysticercosis (upland, range pigs).

Socioeconomics and technology transfer

R&D should focus on the following priorities:

- Enhancing the business skills of smallholder pig producers.
- Understanding the domestic/social and economic role of pig production in smallholder systems, where the object of pig raising may vary from a secondary 'piggy bank' role through to a primary income generation role.
- Developing social and economic policies that are tailored to the differing needs of the various sectors of the pig industry, and that avoid excessive dominance by the commercial sector.
- Developing policies that foster improved integration of smallholder pig producers into the overall pig production system.
- Encouraging private industry to undertake much more of the technology transfer to small holders via the provision of training courses, targeted information packages, and decision aids.

WHAT SHOULD I DO? RESEARCH FOR PEOPLE, NOT PIGS

John Perkins

Institute of Land and Food Resources, University of Melbourne, Victoria, 3010, Australia.

Summary

1. Worldwide, the pig is possibly the most massively researched farm animal species. A huge range of well-researched data and results is already available within the public domain. It is reasonably accessible (although often difficult to understand), continuously updated and covers almost every aspect of production.
2. There are limited benefits to refining this research under Southeast Asian and Oceanic conditions. There are much greater benefits to be yielded from the intelligent utilisation of available information.
3. Pig industries throughout Southeast Asia and Oceania have undergone continuous change along a familiar path and at a now-quickenening rate. In essence, this involves the creation of larger, vertically integrated production units that displace some of the traditional mixed-farm production systems. The range of preferred breeds, crosses, and breeding and feeding systems is narrow. Efficient production within such systems is already well understood by the larger commercial piggeries and their highly trained management.
4. Smallholder farmers seeking to increase family income and welfare by becoming more efficient specialised, and commercially-oriented pig producers are very conscious of the competitive nature of the markets for pigs and their associated inputs and products. They must expose themselves to greater physical and financial risk in the hope of achieving larger financial returns.
5. To succeed requires wise choices and better decisions, made daily within a very dynamic environment. Their greatest need, thus, is to become better managers. What better managers need most is advice on making effective decisions—decisions that frequently will have an economic component.
6. The farmer, therefore, and not the pig should become the focus over the next ten years of collaborative investment within the region in research, training and communication.
7. There is good scope for some research into farmers' decision-making processes, i.e. a business-centred approach to the management of pigs in a mixed-farm, smallholder system. This would not repeat previous research, and will be a demanding task. It will require novel, allusive and intuitive approaches, possibly based on detailed case studies of management choices made in dynamic settings.
8. There is much greater scope for R&D, extension, and donor agencies to apply their skills in synthesis, communications and training. Farmers are not looking for detailed and esoteric information—they want to build a mindset that enables them to apply efficient solutions to daily problems, with confidence.
9. Two specific areas of applied research are also identified. These are the development of a 'fuzzy' diet calculator which would simplify decision-making in the formulation of home-mixed feeds, and the improvement of effluent management in small piggeries, in recognition of increasing social concern about environmental pollution.

INTRODUCTION

Pigs provide the major source of animal protein for human consumption throughout the Association of South-East Asian Nations (ASEAN) and Oceania regions, with most production being by smallholder farmers. For example, statistics provided in the Food and Agriculture Organization of the United Nations' (FAO's) on-line databases indicate that ASEAN produced 4.1 million tonnes of pig meat and 3.6 million tonnes of chicken meat in 2000; production of all other types of meat was well below these levels (FAO 2001). FAO estimated total pig populations in 1980 at 30.4 million in ASEAN and 1.4 million in Oceania. By 2000, these numbers had almost doubled to 57.2 million and 2.2 million, respectively. The rate of increase in domestic pigs outstripped that of the human population: an ASEAN-wide gross ratio of 12 persons to each pig in 1980 had shifted to 9:1 by 2000. The comparable figures in Oceania were 4:1 in 1980 and 3:1 in 2000 (Table 1).

If a nominal value of US\$50/pig is applied to these statistics, the current capital value of the livestock exceeds US\$3 billion in ASEAN and US\$100 million in Oceania, to which should be added capital values of buildings and other infrastructure. Substantial working capital is also required to finance major inputs such as feeds and there are very high inputs of labour and management. The latter two are often 'free' in cash terms but represent very significant opportunity costs. In sum, farm pigs are a large, widespread, important and highly valued component of the agricultural sector in both regions, however measured.

Research and development (R&D) and extension agencies, often in collaboration with donor agencies such as the Australian Centre for International Agricultural Research (ACIAR), face a difficult task when prioritising the investment opportunities to help this sector develop in a sustainable and socially acceptable manner. This paper presents a view as to how these agencies should use their limited resources to maximise the impact of their investment on pig farming in the ASEAN and Oceania regions.

In this short paper, arguments and discussion have been kept to essentials. Inevitably this means that many important side issues can neither be thoroughly explored nor implications fully developed. The great diversity of physical and social environments, farming systems, pig husbandry practices, and farmers' expectations are fully acknowledged but, for the purpose of brevity, put to one side.

Table 1. Statistical summary of pig and human populations for the Association of South-East Asian Nations (ASEAN) and Oceania Regions, 1980–2000.

Year	1980	1990	2000
a) Pigs	----- stocks (10 ³ head) -----		
Brunei Darussalam	10	10	5
Cambodia	131	1,515	2,600
Indonesia	3,155	7,135	9,352
Laos	1,111	1,372	1,101
Malaysia	1,837	2,678	1,828
Myanmar	2,196	2,278	3,914
Philippines	7,933	7,989	10,398
Singapore	1,000	300	190
Thailand	3,020	4,761	7,682
Vietnam	10,001	12,260	20,193
ASEAN total	30,396	40,301	57,266
Oceania^a total	1,358	1,659	2,232
b) People	----- (million) -----		
ASEAN total	359,626	440,225	517,596
Oceania total	5,006	6,168	7,652
c) People:pig ratio	----- People:pigs -----		
ASEAN total	12:1	11:1	9:1
Oceania total	4:1	4:1	3:1

^a Comprising: American Samoa, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Federated States of Micronesia, Nauru, New Caledonia, Niue, Pacific Islands Trust Territory, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna Islands.

Source: FAO (2001).

OBJECTIVES

It is assumed that agencies represented at the workshop wish to be involved in activities that ameliorate poverty and increase the welfare of smallholder farming families. Further, it is assumed that they agree with the overall aim of the workshop, i.e. to identify the highest priority investment opportunities that will maximise benefits to smallholder pig farmers.

The objective of this paper, against which its recommendations can be measured, is:

to identify an investment strategy which, in relation to the management of farm pigs, will yield the greatest dividend to the target group—farm families.

MAIN CONCLUSIONS

For readers who want to get straight to the point, the most important conclusions are listed below. The rest of the paper discusses the reasoning behind these recommendations. In summary, agencies with a role to support the smallholder pig sector should:

- not invest further in the ‘traditional’ research areas of pig husbandry (e.g. feeds, breeds, reproduction, health etc.);
- recognise that farmers treat the pig enterprise as a business, however small that business may be;
- recognise that effective business management is the farmer’s main concern about the pig enterprise;
- put some resources into exploring the types of management information which are most keenly sought by pig-rearing farmers; and
- put many more resources into effective ways of providing them with useful answers.

THE AUDIENCE FOR THESE RECOMMENDATIONS

Comments made in the paper are directed mainly to donor agencies that have a role in research, communication and training, and to the national agencies with whom they collaborate. It is certainly not intended that the recommendations be viewed as the only useful investment strategy for all pig research institutes. There are many such regional, national, provincial, and local agencies, each of which has developed objectives and projects in response to issues of perceived importance, or as part of a policy direction. The number and diversity of places, people and disciplines involved will ensure that most aspects of pig research are always being freshly examined and evaluated by someone, somewhere.

The objective of this paper is to look for an investment strategy (physical, financial and intellectual) which yields the greatest impact on pig farming. The paper assumes that such a strategy has the freedom to integrate research, communication and training activities.

THE PIG INDUSTRY

Worldwide, development of the pig industry has followed a familiar path: the creation of increasingly large, vertically integrated production units that have progressively displaced traditional mixed-farm production systems. Australia, for example, has maintained a total farm pig population of some 2.4 million head for the last 30 years. In 1969, about 40,000 farms were involved in pig production but by 1995 only some 3,000 farms remained (Hughes 1996). After the

market’s slump in 1997, this figure has probably dropped to less than 1,500 producers, with large farms (>1000 breeding sows) providing more than one-third of output.

The circumstances in Southeast Asia and Oceania are somewhat different to those in Australia. Three main types of production system can be identified:

1. *Subsistence systems* in which pigs are raised by smallholder farms mainly for the purposes of subsistence, local consumption, and maintenance of important cultural values. These systems are very common in many Pacific Island nations.
2. *Dual-purpose systems* in which pigs are raised by smallholders both for subsistence and commercial reasons, with an increasing emphasis on the latter role. These systems are probably the most common production type in Southeast Asia.
3. *Commercial–industrial systems* in which pigs are raised in vertically integrated, large-scale piggeries. These systems are of growing importance in Southeast Asia, with a few countries (e.g. Thailand) already hosting large industrial sectors.

Producers in the commercial–industrial systems are technically efficient, aggressive and highly competitive. They continue to expand despite frequently voiced concerns about effects on rural employment, the costs of importing feeds and livestock, and issues of environmental management. Increasing globalisation of input and output markets, historically low international transport costs, and the removal (or avoidance) of trade barriers now mean that the productivity and cost levels achieved by industrial pig producers are the performance yardsticks in many countries. A village-level farmer has to achieve reasonably comparable management standards to remain a viable pig producer.

The whole industry is not an easy one in which to operate, given the tight competitive situation and a gradual shift of market power to the large industrial piggeries. At a national level, research, extension and donor agencies need to consider carefully who is their target audience if they are seeking impact on the industry.

WHO SHOULD BENEFIT?

It is not possible to conduct work that is of equal relevance to all current participants. Long experience with participants involved in subsistence systems would indicate that they are often slow adopters, frequently indifferent to incorporating new technologies or to significant shifts in long-established

management practices. Investments in pigs kept for cultural purposes are unlikely. Resources invested here are likely to result in minimal change.

Participants involved in commercial–industrial systems already have good access to professional advice and information. Managerial knowledge and capabilities are often very advanced, well beyond those of official extension agencies. Investment here would simply strengthen a sector that is already well resourced, powerful and expanding.

This leaves the participants involved in dual-purpose systems, the second group. These are generally farm families who have already moved to a more commercially-oriented outlook, or are seriously considering doing so. They are the most numerous type of pig producer in Southeast Asia and currently contribute the greatest share of output. The typical small-scale, mixed-system village farmer is also the producer whose livelihood is under greatest pressure from the expansion of industrial piggeries.

If the objective is to maximise impact, this is the group most open to suggestion and most actively interested in benefiting from profitable change. It is also worth noting that this group will remain active pig producers for many years to come. Changes to the structure of the pig industry will not occur as quickly, or as profoundly, as has already occurred in the high-income economies, where large-scale production has largely centred on the substitution of capital for labour. In low-income economies, particularly in the ASEAN region, rural populations have continued to increase despite the drift to urban centres. As a result, rural labour remains cheap (and often exploited) while the true costs of capital and credit are very high. Large-scale piggeries will certainly be established but a different structure will evolve—one that is likely to contain a large core of small-scale pig farmers.

WHAT DO FARMERS WANT?

Farming is a deliberate, purposive human activity. Smallholder farmers have objectives and use their available resources in an attempt to meet some mix of economic, social, cultural and personal goals. Decision-making is a constant necessity. The family's labour and time must be allocated among a number of alternative uses. Choices are made on the best use of land and water; balances are struck between preference and necessity; and social obligations are given careful thought and discussion. Margins of error are thin and the consequences of poor decisions can be catastrophic, so strategies are continuously assessed in the light of risk and returns. R&D agencies will deliver the greatest impact when this mix of circumstances is analysed from the farmer's perspective.

Smallholder farmers are sensible and rational people. They are adept and generally efficient in what they do, spreading their very limited resources across a mix of interlinked enterprises as a means of obtaining production and income while reducing risk. So, how will a typical mixed-farm smallholder view the role and importance of pigs in his or her system? What might they want from the range of services available to them?

An example

Consider a hypothetical example. A villager runs a small mixed farm, including some subsistence pigs. The family decides to increase welfare and reduce poverty through earning more money. Pig rearing is chosen by the farmer as the 'money-making' specialisation (although it could be any crop or animal enterprise). What happens next?

The farm family will be aware of a number of things. They are choosing to enter a very competitive market for pigs, plus associated inputs and products. They will have an increased exposure to technical and financial risk, undertaken in the hope of achieving larger financial returns. Success (i.e. economic survival or growth) will depend on wise choices and good decisions, made daily within a very dynamic environment. Their lives must change, in a number of ways. More time, management, and resources will be devoted to pigs than has been the case to date; working patterns on the farm will have to be re-adjusted to fit this shift in emphasis. The patterns of managerial decision-making to which they have been accustomed will undergo significant transformation.

So, which decisions will loom large in the farmer's mind? In short, almost everything. Which breed of pig should be used? Will they be fed home-mix or purchased feeds? Should a building be constructed? Will mating be by AI or naturally? How are the changes to be funded? Where should the pigs be sold? What are the prices? What are other people doing?

A choice between two basic options will determine much of what happens in the future. Our hypothetical farmer already has some subsistence pigs within the system. At one extreme is the option to use these pigs as the basis for an expanded and re-modelled enterprise. Most local pigs will give a good production response to better and more selective feeding, health, and management. The farmer could grow appropriate feeds, mix diets, and gradually introduce a crossbreeding program. It is a cheap strategy, in cash terms, but technically risky, slow, and very demanding. The farmer has to become competent in the fundamentals of pig husbandry to ensure that he or she is making correct choices in key areas of feed formulation, reproductive management, and genetic change. Substantial changes

throughout the farm system will also be required, particularly in providing the required feed ingredients.

At the other extreme is the option to switch immediately to the purchase and use of exotic breeds and crosses, compounded feeds, and all the attendant requirements of a ‘packaged’ approach to pig farming. It is the highest cost option and incurs the greatest financial risk but, on the positive side, requires relatively little change to the rest of the farm system. Technically, it is less demanding as the farmer is generally adopting a proven ‘recipe’ for pig farming.

Which option do farmers usually choose? Many—probably the majority—select options that fall towards the ‘package’ end of the spectrum. The distinctive features of most current small-scale village piggeries are likely to include: white (or brown, or mottled) pigs of relatively exotic parentage, permanent buildings, and partially or fully compounded diets—a virtual miniaturisation of the large-scale systems.

An important assumption underlying this paper is that farmers view the ‘subsistence pig’ and the ‘business pig’ as different entities: the same species but not the same farm animal. The former, broadly, is a low-input, low-output, largely self-reliant scavenger of scraps and wastes; the latter a high-input enterprise specifically managed to make money. Hundreds of thousands of smallholder pig farmers have already made their choices, especially in Southeast Asia. Most have chosen some variation of the ‘business pig’ approach.

WHAT IS SOUGHT?

The factor most affecting farmers rearing pigs for commercial purposes is the requirement for **dynamic response**. Subsistence pigs are slow-growing and resilient. Time is not a critical factor. As long as the pig stays alive, the family is not much bothered whether it is putting on weight at one or one hundred grams per day. Business pigs are different. They have cost a lot of money and the farmer hopes to make a profit on them. Performance, markets, prices, and finance suddenly become very important. Everything accelerates. Decisions must be made; they are important and cannot be delayed. Farmers want to make good decisions. Their most pressing need is advice from someone. Their question, thus, is ‘What should I do?’

Answers to the question can be approached in two ways: what farmers **do not** particularly want to know, contrasted with the types of information they **do** seek. R&D agencies (with support from donors) can make their impact by concentrating on the latter. Taking the negative option first, it can be summarised by saying that farmers have a very limited interest in the detailed scientific or technical underpinnings of pig

husbandry—breeds, feeds, reproduction or health. Unfortunately, this has long been the staple work of most research institutes. The activities are necessarily theoretical, complex, and detailed. Typically, they are published in an indigestible format and the results are often of limited relevance to most farm situations, requiring considerable reinterpretation before they can be applied and used. Understanding the work requires good levels of formal education and scientific understanding. None of these conditions is met on most village farms and the impact of much research work thus rarely extends beyond the institutes’ fences.

Farmers may not be keen on learning the theories but they do want to apply any useful (i.e. demonstrably profitable) results. Pig farming is a business, however small that business might be. To succeed requires good management and good business management, in particular. **What farmers want most is advice that helps them build a business-oriented mindset in managing their pigs.**

Their greatest need is to become better managers. What a better manager seeks is the ability to make sensible and effective decisions, with confidence. Two areas dominate their decision-making:

Economic decisions

- *Output prices and trends.* Decisions are required in response to changes in prices for weaners, fattened pigs and breeders. The profitability of the business is increasingly affected by prices for imports and substitutes.
- *Input prices and trends.* These decisions are necessitated mainly by changes in the prices for feed ingredients and compounded feeds. Prices and trends are strongly affected by both crop production (national and local) and import prices.
- *Credit.* Since most working capital probably comes through informal credit sources, repayment terms and interest charges (common in contractual obligations with input suppliers and the purchasers of finished stock) have an extremely strong effect on profitability and decision-making.
- *Key ratios.* Producers are soon aware that it is the interactions of input and output prices that are significant, not the absolute level of the prices themselves. The permutations of rises and falls are many and producers have to make choices about what should be done, and why. Should they buy, sell, wait; expand or reduce production?

Production decisions

- *Feeds.* Feeds constitute the largest cash cost for piggeries and most farmers are very keen to discuss all aspects of feeding, particularly diet formulation.
- *Reproduction.* Decisions are required about the use of boars or AI; the design of pens and farrowing equipment; litter sizes; mortalities; and farrowing intervals.
- *Health.* Fast recognition, diagnosis, and treatment of common health problems are essential. Decisions are also required about the use and benefits of prophylactic programs.
- *Performance indicators.* Comparison of their performance with other farmers and with industry standards is inevitable. Producers need guidance on whether they are doing well or poorly, and where investing more in management might bear dividends.

Information and data alone are insufficient. Farmers want the information to be intelligently synthesised. They want to make sense of it and understand how it can be applied. They do not want to work through each problem from the basics upwards. Their preference is to build a list of sensible options that enable a quick response to shifts in conditions, confident that their choice will be 'good enough' in prevailing circumstances.

RESEARCH IN PIG SCIENCE

The pig is possibly the most massively researched farm animal species in the world. An enormous range of well-researched data and results are already available within the public domain. These are reasonably accessible (although often difficult to understand), continuously updated and cover almost every aspect of production, from the molecular level upwards.

Many commentators argue that much of this work is not relevant to conditions in ASEAN and Oceania because:

- it is focused mainly on breeds preferred for large-scale intensive production systems;
- it is conducted in physical environments which are very different to the humid tropical systems common to both regions;
- it is based on a relatively narrow range of feeds and dietary types, often not widely grown in the humid tropics;
- it assumes access to inputs and advanced technologies that are not available to smallholder farmers; and
- it focuses on indicators of efficiency that are not relevant to most smallholder systems, in particular the substitution of capital for labour.

These are valid points. The narrowing choice of breeds, for example, is leading to a loss of genetic diversity. Indigenous breeds of pig have long been selected for their ability to survive in demanding local conditions. Some possess traits that are highly valued, namely disease resistance, ability to utilise low quality feeds, good mothering instincts and high fecundity. Many breeds have not been deeply researched and their possible genetic benefits are quickly lost when modern types replace the indigenous pigs.

R&D agencies and donors are faced with a difficult choice in relation to indigenous breeds. There is a very positive, strongly research-oriented role available to assist national agencies with their continuing studies of breeds indigenous to ASEAN and Oceania. Most commercialising pig farmers, however, have clearly indicated their preference—local breeds are being replaced with exotics. Consequently, if the aim is to make an impact with farmers, agencies must work with the systems chosen by farmers.

If the latter option is selected, there are very limited benefits to gain from investing further in the 'classical' areas of pig research. Given the volume and quality of work that has already been completed (and continues), it makes much better sense to extract what is useful from the vast repository of available knowledge.

However, two honourable exceptions to this thesis can be mentioned. They are:

- *Diet formulation.* A number of least-cost diet formulation computer packages are available. Usually employing an objective-maximising linear programming approach, these commonly do not include tropical crop by-products in the ingredient list, are expensive to purchase, and unnecessarily accurate for the purpose needed. The production of a 'fuzzy' diet calculator, distributed without copyright protection, would seem to be a valuable tool for smallholder farmers.

'Fuzzy' in this sense means a diet formulator that provides a number of dietary combinations in response to current prices and assumed nutritional values of available ingredients. Each combination would lie within a broad boundary of 'profitability', enabling reasonable substitution of diets, in light of local circumstances. This would make better sense in an environment where the nutritional values of the components can vary quite widely and the availability of each component will fluctuate markedly at different times and locations.

- *Effluent management.* There is increasing social pressure for responsible environmental management, particularly the control and use of

piggery effluent (although it is only fair to mention that the discharge of untreated human sewage into waterways well exceeds that from pigs). Large piggeries are highly visible and somewhat easier to regulate; small intensive piggeries are a different story. Research that would turn piggery effluent into a profitable contribution to the smallholder's mixed-farm system would be very welcome.

WHAT'S MISSING?

The technical and business management of pigs and piggeries is already the subject matter of a substantial volume of publications—manuals, articles, computer programs etc. Print and on-line magazines and chat websites continuously update piggery managers on changes in market conditions and new ideas in the industry. Unlike research for the pig industry, however, very little of this management information is of relevance to smallholder farmers. Apart from being virtually inaccessible to non-specialists, it is aimed at a target audience that controls a very different set and scale of physical, financial and human resources. Education levels are high, the focus is almost entirely on industry issues and the target audience has a good understanding of the background issues covered. A farmer running 2–5 breeding sows within a very small mixed-farm system obviously has markedly different managerial needs to a piggery operator with 1,000–30,000 sows and a massive investment in buildings and equipment. The managerial needs of smallholder farmers are neither well understood nor much investigated by research and extension agencies. Investment in the following aspects of this area will make a most valuable contribution.

Key questions

What do smallholder pig farmers really want to know? We tend to make massive assumptions about these key questions, but rarely test them. The official extensions agencies are often prescriptive, dogmatic and hierarchical in their approach. They are more inclined to tell people; less inclined to listen. In practice, it is likely that the list of key points is very brief, pointed and quite different to the policy-driven interpretation of government agencies. Clarifying these issues would benefit everyone.

Devising strategies

Developing sets of pig management strategies based on sound technical and economic foundations is desirable. Farmers are thoughtful. They do not expect to receive recommendations that are a unique solution for their specific circumstance. They are much more interested in assimilating a few well-grounded guiding principles

that can be adapted and applied to the inevitable subtle shifts which affect their farming environment.

Disseminating strategies

Ideas and information are only of value if they reach the people for whom they are intended. Most farmers get their ideas from friends and other producers, from their input suppliers, and from pig buyers. The latter two groups are of increasing importance, particularly in the business pig sector. Through necessity they are regularly in contact with village farmers, who depend heavily on their market information and perceived technical skills. Commercial suppliers give farmers what they want: short, crisp answers to specific problems. Finding a way to plug good information into the burgeoning commercial smallholder sector, as well as into the traditional extension agencies, has a potential high impact value.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The farm pig sectors within ASEAN and Oceania are very large, valuable and significant components of both agricultural systems.
2. Smallholder farmers, typically operating a mixed-farm system, produce the majority of pigs.
3. Large-scale piggeries are increasingly powerful and influential operators in many markets. The cost and performance standards they achieve are becoming the yardstick for national industries. To remain viable, a smallholder pig farmer needs to achieve similar standards.
4. A commercial (or commercialising) small-scale pig farmer tends to choose a modern 'package' approach involving some combination of high-performance exotic breeds or crosses, partially or fully-compounded feeds, permanent housing etc.
5. The farmer's main interest is in improving his or her business skills in managing the piggery. Following the recipes associated with the 'package' approach largely accommodates the required technical management skills.
6. The results of detailed, high-quality research into all technical aspects of modern pig production are already available, in abundance.
7. There has been relatively little work of comparable quality undertaken to examine the business management of pigs from a smallholder's perspective.
8. There are very few sources of useful, impartial advice on business management available to smallholder pig producers.

Recommendations

1. The farmer, not the pig, should become the focus of collaborative investment in research, training, and communication over the next ten years.
2. Donor agencies should not invest further in the 'traditional' research areas of pig husbandry (feeds, breeds, reproduction, health etc.).
3. The best investment that R&D and extension agencies, along with donors, could make is to apply their skills in synthesis, communications and training. Farmers want advice that will help them shift from where they are to where they want to be. Most want to be good managers of a micro-business. Extension that concentrates on business management will help them achieve this goal.
4. A significant impact could be achieved through collaborative development of sound management strategies for small-scale piggery farmers. These should be disseminated through input and output companies involved in the pig sector, in addition to the traditional extension agencies.
5. There is good scope for some original research into farmers' decision-making processes, i.e. a

business-centred approach to the management of pigs in a mixed-farm, smallholder system. This would not repeat previous research, and will be a demanding task. It will require novel, allusive and intuitive approaches, possibly based on detailed case studies of management choices made in dynamic settings.

6. There is scope for continuing to work in two areas of applied research: development of a 'fuzzy' diet calculator to assist with feed formulation, and work on the profitable use of effluent from village piggeries.

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PIG PRODUCTION IN CAMBODIA

Sen Sovann* and Sorn San†

*Department of Animal Health and Production, #67 Monivong Blvd, Phnom Penh, Cambodia.

†National Animal Health and Investigation Center (NAHPIC), #67 Monivong Blvd, Phnom Penh, Cambodia.

COUNTRY BACKGROUND

1.1 The Land and its People

Cambodia has a total land area of about 181,040 km² and is bordered by Vietnam, Laos, Thailand, and the Gulf of Thailand (Figure 1). The territory is mainly a plain surrounded by mountains, like the Cardamon Mountains in the south-west and the Dangrek Range that rises abruptly from the plain in the north. The central basin, occupied by the Tonle Sap (Great Lake) depression, is the point of confluence of water that subsequently flows into the Mekong, one of the largest rivers in Asia. The climate is sub-tropical monsoonal with distinct wet and dry seasons.



Figure 1. Cambodia and its neighbours.

The total population was estimated in 1998 to be about 11 million. With an annual growth rate of about 2.8%, the population is predicted to double by 2024. According to the 1997 Human Development Report by the United Nations Development Programme (UNDP), Cambodia is ranked near the bottom on a human development index (153rd out of 175 countries listed). The principal ethnic group is Khmer but there are

minority groups of Vietnamese (5%), Chinese (1%), and north-east hill-tribes and other groups (4%). Buddhism is the major religion and is followed by about 80% of the population. The official language is Khmer, but in recent years English has emerged as the first foreign language and French the second. Most social and scientific documents are in both languages.

During the last four decades, Cambodia has suffered from the spillover of the war in Vietnam, a devastating civil war, and the despotic rule of Pol Pot and his Khmer Rouge Army. By the end of the Pol Pot era in 1979, Cambodia was in ruins—the country's infrastructure and economy were destroyed and thousands of orphans and widows were left behind. A number of non-government organisations (NGOs) entered Cambodia after 1979 to provide support. This occurred in four phases—an emergency phase (1979–82), a political and economic isolation phase, an embargo by Western countries phase, and a transitional development phase beginning in 1989. From about 1995, the NGOs began focusing on their traditional roles in community-based development projects.

Since its first democratic election in 1993, Cambodia has received substantial international support and cooperation for its program of national reconstruction and rehabilitation. Elected governments have adopted a free market policy and given priority to development of the national economy, food security, human resource development, and public sector reform.

1.2 Agriculture in the Economy

The gross national product (GNP) of Cambodia is about US\$300 per person per year, with the agricultural sector accounting for more than 50% of the gross domestic product (GDP). An estimated 7.5 million people (66% of the total) are dependent on agriculture for their livelihood and, of these, 4.1 million are directly employed in agricultural activities. Some 83% of the rural population undertake agricultural production to satisfy their own household requirements as well as to produce the surplus required to feed the rest of the nation.

An estimated 64,000 km² (35% of the total land area) is suitable for crops and livestock production. Rice production occupies 26,400 km²—mainly in the central basin. Land suitable only for cattle grazing is reported as 25,000 km² (14%). The crop–livestock farming systems of both the traditional farmers and the small emerging commercial farmers are rice-based. Rice production is dependent on livestock for cultivation and draught power, as well as for manure and asset security. Reciprocally, the nutrition of livestock is strongly dependent on the by-products of rice production. This interdependence is made more complex with the demands of other factors of production such as the physical and seasonal availability of land, labour, and technical expertise. It is compounded further with the scarcity of savings, difficulties in accessing credit, the occurrence of natural disasters, and the imperfections of the marketing system.

Most Cambodian farmers operate in a low-margin, high-risk production environment. Over centuries, they have evolved a risk-averse approach to farming characterised by diversification, cautious expansion or slow adoption of alternative technologies, and a primary focus on self-sufficiency.

2 OVERVIEW OF PIG PRODUCTION

2.1 Pig Industry Statistics

Pig production plays an important secondary role in subsistence farming, and nationally contributes 50% of the total value of livestock production. Pig numbers have doubled over the last 15 years (Figure 2) and are currently around 2.0 million, with 80% being raised in substantial family backyards. Pigs are mainly distributed in lowland areas where rice is the major crop

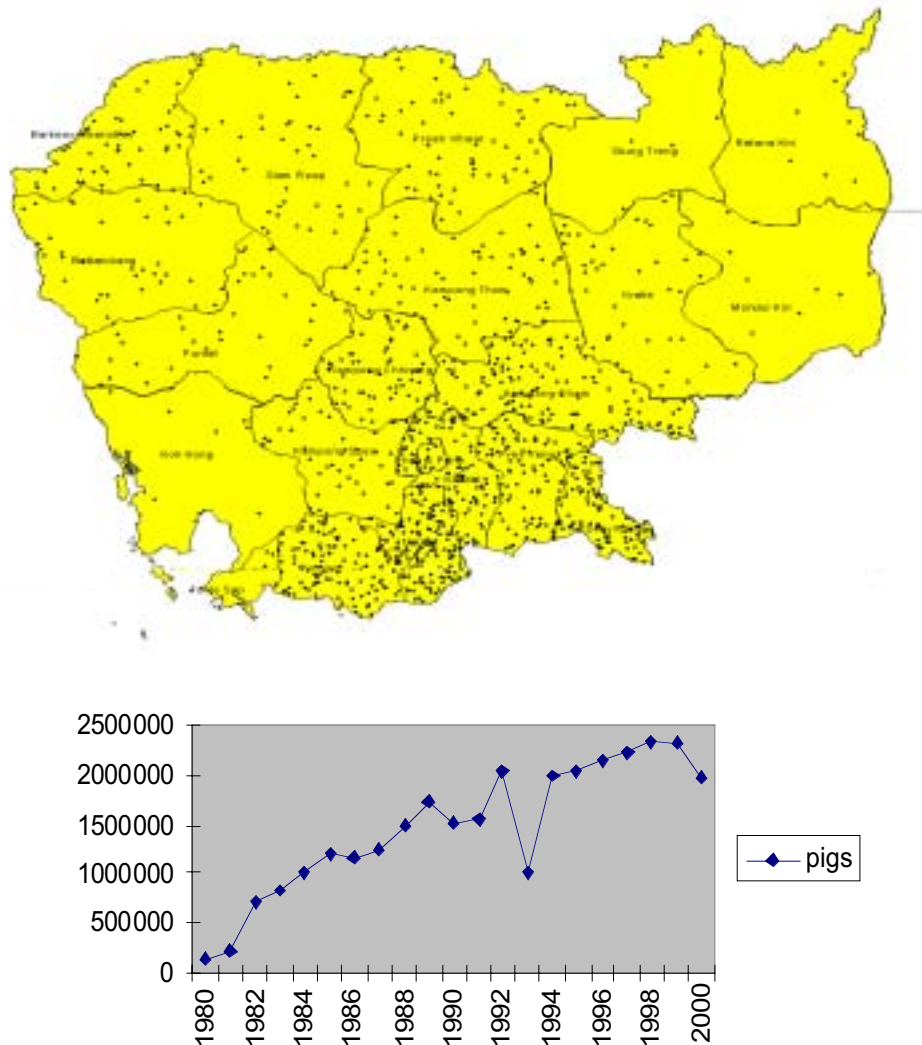


Figure 2. Pig numbers in Cambodia for 1980–2000. Each dot is equivalent to 2,000 pigs in the geographic distribution map.

(Figure 2). Traditionally, small-scale pig production is conducted by family farmers raising one or two pigs at a time for meat, cash income, and to act as a family security asset. Production is very much dependent on by-products from rice, such as broken rice, rice bran, vegetables, and fishmeal. Mortality is high.

Despite a steady increase in pig numbers, Cambodia is still not self-sufficient, so increasing numbers of pigs are being imported from Vietnam and Thailand. The small number of border checkpoints and the huge length of the borders with neighbouring countries mean that control of animal movements is almost impossible, and smuggling is rife. Movement of pigs is believed to be mostly inwards. According to reports, only one attempt has been made to officially import pigs for slaughter (from Thailand) but this request was denied. Official importation of pigs has been confined to breeding pigs in order to improve the genetic stock in the country. Companies like the CP Group that brought in high-quality pigs for reproduction in the country were able to get official permits.

Many pigs apparently come from Thailand by boat and are smuggled onto coastal farms from whence they are later sold for slaughter. A count of pigs in Prey Veng also indicated that between 200,000 and 300,000 slaughter pigs per year came by road from Vietnam through Nek Leung. As a result of illegal movements such as these, the number of pigs slaughtered in Cambodian slaughterhouses is far in excess of the estimated off-take from the Cambodian pig population. This importation of pigs is presumably having a depressing effect on the price of pig products within Cambodia.

Export is not officially permitted and it is probable that very little occurs. However, it has been suggested that some export smuggling of weaners has occurred from Svey Rieng Province, particularly when shortages of feed occur, and that finished pigs have been taken from Kampot by sea to Vietnam for sale. Naturally, no records or estimates of exports are available. In recent times, Vietnam has had a shortage of rice and has been buying the rice crop, particularly from Svay Rieng Province. An indirect outcome of this is that, with rice bran in short supply in the Province, piglets have had to be exported or rice bran imported at high cost.

2.2 Production Systems

Pig production in Cambodia is characterised by a wide mixture of breeds and crosses between local and imported breeds. There are very few purebred pigs except in the controlled breeding system and in farms of the large commercial producers. There are three major types of production—small or family subsistence

production, semi-commercial, and commercial production. Their essential features are outlined below.

2.2.1 Family subsistence production

The family scale of pig production accounts for the majority of producers. With remoteness and insufficient veterinary and extension services, productivity is often low and the rate of growth slow. Production also suffers from high mortality losses caused by a number of important diseases such as classical swine fever, swine erysipelotrix, salmonellosis, foot-and-mouth disease, and various parasitic diseases, as well as non-specific nutritional disorders related to husbandry practice. Many pigs are allowed to scavenge for themselves except when crops are threatened during the cropping season. At such times, pigs are kept in the backyard and offered feed.

The majority of farm households have between one and four pigs. Breeds are mixed, especially in remote areas where a local small black breed, the Condol, with a maximum body weight of about 60 kg, is crossed with the Hainan (also black in colour). In the more advanced family pig-raising systems in urban areas, Yorkshire, Berkshire, Large White/Landrace and Duroc are used for cross-breeding to produce stock for fattening. Close to the Vietnamese border, crosses between the Mong Cai breed and the Duroc are popular. The breeding fee is approximately US\$6 and may be paid in piglets when the litter is born. Well-grown weaning piglets at 2.5 months old, weighing 15–20 kg, are sold for fattening at US\$20–25. Poorly-grown weaning piglets, often the rejects from a litter, are transported by motorcycle in cages to the villages where they are sold for about US\$6 to poorer farmers. However, their production is unreliable and the mortality rate is substantially higher than that of healthy weaners.

Some family producers expand their number of sows to 7–10 and fattening pigs to 10–20 and become semi-commercial pig producers. Many of these make beer or own small rice mills, hence have opportunities for using brewery waste, rice bran, and broken rice for feeding.

2.2.2 Semi-commercial production

This type of pig production is found mainly in urban areas around Phnom Penh and other cities. Semi-commercial producers regard pig production as a major source of family income. The number of pigs kept varies widely and producers usually keep sows, sell piglets, and fatten pigs. Many producers own a rice-husking mill or a small feed-mixing facility. Production systems are more advanced and pigs are kept in pens and fed commercial feed mixes. Vaccination and veterinary health care are applied, either by themselves or by hiring a veterinary service. The mortality of pigs in this category is normally low, as they are much better

managed. As the margin between the cost of production and the price of pig meat is small, only the most efficient producers survive in the medium to long term.

2.2.3 Commercial production

There are only a few commercial producers. Two companies (Yu Tong and the CP Group) are rearing grandparent stock and also producing breeders and piglets for fattening—often by contract producers. Yu Tong is a joint venture between Cambodian and Taiwanese companies, while the CP Group is a Thai investment company. Both are well equipped and professionally managed with efficient, modern management systems, including micro-climate control of the environment. A number of breeds and bloodlines are used including purebred Yorkshire, Duroc, and Landrace.

2.3 Marketing Arrangements

The trading and marketing of pigs is generally carried out by a number of different traders who vary in size, function, and degree of specialisation. Apart from casual local traders, all traders have to register and pay a trader registration fee to the Provincial Governor's office.

At the lowest end of the market, small traders or farmer/part-time traders buy and sell weaners from smallholder farmers, turning a small profit in the process. The farmers who purchase piglets and fattening weaners do so as a repository for their money and/or as a business opportunity. This trade is carried out mainly using bicycles or motorcycles for transport, carrying half a dozen or more weaners in bamboo baskets strapped to their vehicle carriers. The traders' profit depends on their negotiating skills and the general state of the market, but depressing farm-gate prices is clearly to their advantage and is widely used—to the disadvantage of smallholder farmers who often need immediate cash. In addition to the trade between farms there is also a continuing trade in imported weaners, mainly from Vietnam, as noted above. These imported weaners are generally small in size and suffer high mortality rates, so prices paid are often only a third of that paid for local weaners.

The next level of marketing is practised by traders who purchase half-finished pigs, usually from farmers in grave need of cash. These traders are either other farmers or the same traders who deal in finished pigs. The latter are often agents for, or regular suppliers to, wholesale traders. They ply their business between farmer and farmer, and farmer and wholesaler. Scales for weighing pigs are not used and weights are gauged by eye—providing yet another opportunity for traders to depress farm-gate prices.

Distortion of the marketing system has become one of the most important damaging aspects of pig industry in Cambodia. The buyers develop the market through the establishment of monopolies and cartels. This has severely depressed the farm-gate price. Commercial pig producers who have applied modern equipment and technology, including better breeds, are in a much better position to market their products at favourable prices. Normally, such commercial operations have contracts with slaughterhouses and take the market-weight pigs directly to the slaughterhouse. In general, however, the main emphasis of these commercial farms is the production of piglets for sale as fattening pigs. In terms of market, this type of production has higher competitiveness and potential for further development. In addition to the above, there is also a thriving trade in suckling pigs for the table in the cities.

2.3.1 Prices

Prices are surveyed monthly in the markets supervised by the Department of Statistics, Ministry of Planning. Prices of pork meat with fat were consistently below those for pork without fat (Figure 3). On a percentage basis, the prices of pork have increased more than those of rice over the six-year period. The mean ratio of pork to rice prices during the first year of the period was 5.0 whereas the ratio for 2000 was 7.25.

As noted above, increased competition across the entire industry chain (e.g. by breaking down trader cartels and monopolies, and facilitating the movement of pigs within the country) is a high priority. With improved farm-gate prices and greater awareness of market signals, smallholder farmers would have greater incentive for improving their pig breeds and management systems.

2.4 Industry Services

2.4.1 Credit

Most Cambodian farmers are interested in raising pigs, poultry, fish, cattle, and draft animals to produce meat, eggs, and cash income and to increase land productivity. However, to do so they often require access to credit for the purchase of animals and/or supplies and services. Unfortunately, access to credit in Cambodia is difficult—a fact that acts as a severe constraint to increased agricultural production.

In recent years, a number of NGO and government schemes that have credit components have been developed. Examples include PRASAC, SEILA and the Heifer Project International. The last example works in partnership with local associations and is based on the principle of 'passing on the gift', whereby a breeding animal is given to an association member provided he or she agrees to transfer one or more of the progeny to another member, or back to the project, in

payment for veterinary and other services. Schemes such as these often also provide technical training and access to extension and other services. They make an important contribution to national development by building trust and self-confidence, and support progress towards gender equity and social change.

2.4.2 Animal health and extension services

The importance of village-level animal health and extension services in rural livestock development has been well recognised by the Ministry of Agriculture, Forestry and Fisheries of the Kingdom of Cambodia. A National Project for Animal Health and Production (AHP) funded by an International fund for Agricultural Development (IFAD) loan was initially implemented in 1997 under the World Bank Umbrella Project of Agricultural Productivity Improvement Project (APIP). This activity is primarily focusing on disease control, basic animal health, and promotion of animal production. It has a major emphasis on the training of village animal health workers under its Basic Animal Health Sub-component. This also provides national standards for Village Animal Health Worker Training and a legal framework for privatisation of veterinary services in the Kingdom of Cambodia.

A number of NGOs (e.g. Concern and Oxfam) also have training of village livestock agents as a core activity in their livestock credit programs. These agents have been instrumental in ensuring the efficient and

timely provision of veterinary services to many smallholder pig producers on a cost-recovery basis.

2.4.3 Slaughter

Slaughterhouses are located in the provinces and on the outskirts of the major cities. Phnom Penh has six slaughterhouses that handle pigs. Farmers can be disadvantaged by the lack of competition for their product, particularly in provinces with only one slaughterhouse. In general, slaughterhouses represent vehicles for the generation of cash for city-based officials, namely government officers, veterinarians, and traders.

Slaughterhouses are operated in a variety of ways:

- the slaughterhouse may be owned by the municipality but managed by a private trader who rents the premises and charges fees for each animal slaughtered;
- the slaughterhouse may be owned by the municipality but managed by a private trader who rents the premises and purchases all the animals slaughtered, selling the meat and offal to butchers and making profits on both transactions;
- the slaughterhouse may be privately owned and space rented out to a number of traders who provide their own labour for slaughter and dressing out; or
- home slaughter.

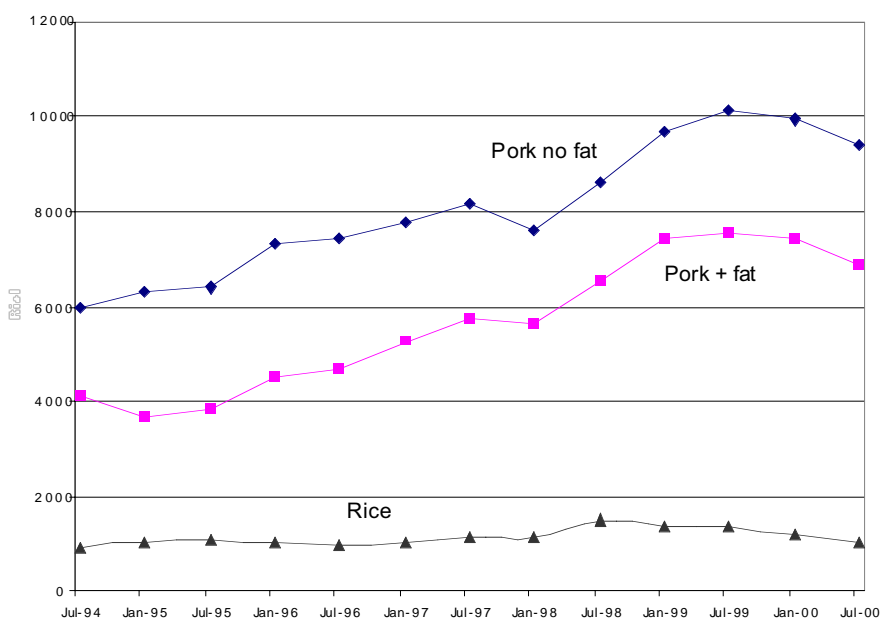


Figure 3. The change in the price of rice and pork since mid-1994 in Cambodia.

With the exception of home slaughter, government taxes are levied at slaughter. Taxes range from the equivalent of US\$0.26–0.77, while veterinary inspection charges vary from US\$0.18–0.38. In the provinces, the abattoirs were usually attended by at least two veterinarians per slaughterhouse but in Phnom Penh there is a pool of 27 inspectors, with at least three at each abattoir.

3 PRIORITIES FOR R&D INVESTMENT

3.1 Priorities Within Disciplines

Cambodia's public sector is gradually being reorganised as the country recovers from the devastation of the last 40 years. The respective roles of government and the private sector in the provision of services to industries are also being worked through. Against this background, the priorities for research and development (R&D) relevant to the pig industry would appear to be largely in health, and socioeconomics and technology transfer.

3.1.1 Nutrition and genetics

Nutrition is perhaps the most important aspect of the Cambodian smallholder pig industry that requires attention. Better use and management of local feed resources has an important role to play in improving nutrition, but attention should also be given to genotype by nutrition interactions in this work.

R&D should also help to define the appropriate ways of improving smallholder pig raising in order to satisfy market demand and foster competitiveness in small-scale production. Improved breeds need to be progressively introduced and suitable crosses developed and distributed at the local level. Such developments, to be effective, would need to be coupled with credit and technical support schemes.

3.1.2 Health

Disease control and management is a very high priority. Under the Agricultural Productivity Improvement Project of the World Bank/IFAD loan mentioned above, disease control, basic animal health, and capacity building for government staff charged with the delivery of technical assistance, are receiving strong emphasis. The village animal health system being developed will provide the legal framework for privatisation of the veterinary service. Substantial R&D effort is required to improve the control and management of important diseases.

3.1.3 Socioeconomics and technology transfer

The major priorities in this area are in improving the provision of extension services and technical support for farmers in all aspects of pig production, particularly animal health, genetics, nutrition, reproduction, and housing. Much of the information required is already known and available within Cambodia, or can be readily adapted from procedures and practices used in neighbouring countries. The major limitation is in making that information available at the village level in a form that can be readily understood and adopted by smallholder farmers.

Another high priority is the provision of a marketing information system for smallholder and semi-commercial farmers in order to improve their competitive position in relation to the various middlemen involved in the production chain.

3.1.4 Extension

Lack of information amongst smallholder farmers who own 80% of the country's pigs constrains the future development of pig production in Cambodia. Thus the extension priority for the improvement of pig production should be on:

- assisting the formation of farmer groups;
- providing direct technical assistance;
- improving the veterinary services (e.g. by training village animal health workers); and
- developing direct market schemes for farmer groups by improving information flow about marketing of agricultural products.

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PIG PRODUCTION IN INDONESIA

Djoni Liano* and Pollung H. Siagian[†]

* Sub-Directorate for Livestock Farming, Directorate General for Livestock Services, Jl Harsono Rm 3, Pasar Minggu, Jakarta, Indonesia

[†]Faculty of Animal Science, Bogor Agricultural Institute, Jl Rasamala, Kampus Darmaga, Bogor, Indonesia.

1. COUNTRY OVERVIEW

Indonesia is the largest archipelago in the world. Consisting of five main islands and 30 smaller archipelagos, it has a total of 1,667 islands, 600 of which are inhabited. The country stretches along a distance of 5,100 km from west to east and 1,888 km from north to south, and spans the equator from 6° north to 11° south. The climate varies from humid to semi-arid tropical. Average annual rainfall ranges from 1000 to 3,200 mm. Administratively, Indonesia consists of 26 provinces and more than 200 districts. The human population in 1998 was approximately 204 million, with about 58% living on Java, an island that accounts for only about 7% of the country's surface area. About 60% of the population lives in rural areas and 54% of the workforce is engaged in agriculture.

2. OVERVIEW OF PIG PRODUCTION IN INDONESIA

2.1 Role of Livestock in the National Economy

The agricultural sector plays an important role in the Indonesian economy. In 1997, livestock contributed 1.7% to the national gross domestic product (GDP) and 11.6% to that in agriculture. Although the contribution of livestock to the national GDP is trending downwards, its contribution to the agricultural GDP has shown a steady increase over the last five years. As an integral part of agriculture, livestock has contributed greatly to the general welfare of farmers. Besides providing nutritious food, cattle and buffalo are also used as a financial reserve, a source of income, a provider of draft power for cropping, and a means of transportation for the rural community. Dairy cattle, especially in Java, provide milk for the urban population and income for smallholder farmers. Like cattle, sheep and goats also provide ready cash for families and are extensively used in religious ceremonies.

Although about 80% of the Indonesian population is Muslim, pigs are also an important livestock species.

The majority of pig producers are smallholders (368,000 households) and most are located on the island of Java. In the last ten years, consumers and buyers have become much more knowledgeable and discerning about the quality of pork and other pig products. Hence, they now give feedback to the seller (through the price mechanism) on their quality requirements, especially their dislike of excessive fat on the carcasses and cuts. The price premium for quality lean pork is highest for that supplied to supermarkets and five-star hotels.

2.2 Industry Services

In relation to pig production, the main emphases of the Indonesian government are on the prevention of epidemic diseases, the supply of improved breeding stock to smallholder farmers, and the provision of extension services to farmers at provincial, district, and sub-district levels.

Private industries, particularly those involved in the supply of feedstuffs and veterinary medicines, also provide some goods and services to pig producers. For example, several feed companies are involved in producing pre-mixed feeds for pig producers, but the industry is small and poorly developed in comparison with that supplying the poultry industry. Other companies, often associated with major international pharmaceutical companies, produce and/or import veterinary medicines for pigs in Indonesia. These suppliers/sellers also provide health services for pig farmers but mainly service the large commercial breeders rather than the smallholder farmers.

2.3 Industry Significance

Pig farming in Indonesia produces the third largest amount of meat for human consumption, after ruminants and poultry. In 2000, pigs numbered about 10 million. Indonesia has also exported pigs to Singapore for many years, following the closing down of pig farming in that country in 1984. The number of pigs exported has been increasing steadily. For example, 154,800 pigs were exported in 1994 but by 1998 this had grown to 260,000, valued at \$US17.5m.

Pig exports are, therefore, an important source of revenue and foreign exchange for Indonesia, especially in the current economic crisis.

In many places in Indonesia, pigs have been seen as reliable livestock that can be sold at any time for the immediate family needs, as well as being available for customary rituals. Smallholder pig farming in rural areas is considered to be less labour-intensive than some other agricultural enterprises, since only a few animals are normally reared. It is regarded, therefore, as a sideline job or business utilising cheap, locally available feeds and requiring relatively little capital.

Government policies on the development of the pig industry in Indonesia have followed two main lines. On the one hand, agribusiness has been encouraged to develop large-scale commercial production using the latest science and technology. On the other hand, smallholder production has been encouraged through the provision of government-funded research and development (R&D) and extension services, support for the development of cooperatives, and encouragement for the provision of goods and services by the private sector.

The availability of suitable land has become a problem for peri-urban pig production, with the continuing expansion of the cities and the development of residential and industrial estates on their margins. Pig raising in such situations is seen as being socially, culturally, and environmentally offensive. Thus, smallholder pig production in peri-urban areas is under pressure and is moving more towards rural areas where small-scale production (often by housewives) fits more comfortably into the local culture and society.

3. INVESTMENT PRIORITIES FOR THE PIG INDUSTRY

The Indonesian Government, with support from the Asian Development Bank, has provided substantial support for the development of smallholder pig farming, principally by supplying breeding stock and providing extension services to farmers. It has also encouraged the private sector to invest in pig production for export.

3.1 Priorities Within Disciplines

3.1.1 Genetics

Indonesia has a number of indigenous pig breeds (such as the Bali pig, the Nias pig, and the Sumba pig) that are raised by smallholder farmers in their place of origin. Despite their lower genetic potential (reflected in slower growth rates and less efficient use of feed), they are still quite popular. However, there is now increasing interest in crossing these indigenous breeds with exotic

breeds such as Landrace, Yorkshire, Duroc, and Hampshire, and/or in using crosses between these exotic breeds. Private interests and government programs have, over the years, imported substantial numbers of such breeding stock into Indonesia with beneficial effects that flow in time to smallholder pig producers. Pig producers using such genetically superior pigs (particularly those operating at semi-commercial and commercial scales) usually also improve the standard of their management of health, hygiene, and nutrition. This leads in turn to shorter times for pigs to reach market weight of approximately 90 kg, more efficient use of feeds, lower mortality, and higher profits.

The government has invested in R&D to improve the genetic potential of pigs in Indonesia and realises that this is an ongoing task and one that must be carefully attuned to changing consumer demand. Part of this investment is channeled through the existing Breeding Centre for Pigs in Siborongborong (North Sumatra) that evaluates the strengths and weaknesses of indigenous breeds and produces improved breeds and crosses that are adapted to Indonesian conditions. However, lack of funding and insufficient human resources devoted to this task have limited the impact of the Centre.

The priority for R&D in this discipline is for government and private funding of existing work to be expanded.

3.1.2 Nutrition

The nutrient requirements of pigs in Indonesia have not yet been established for either local or imported pigs. As a result, most of the commercial pig farms have simply adopted nutrient requirements recommended by overseas bodies such as the National Research Council (NRC). Their recommendations—which are suitable for temperate and sub-tropical regions—may not be appropriate for pigs raised in the Indonesian tropics. Further R&D is required to address this important issue.

Feed ingredients for pig diets are either obtained locally or imported. A number of relatively cheap local feed ingredients are available throughout the year, namely rice bran, coconut meal, cassava chips/flour, tofu waste, palm kernel cake, and other plantation by-products such as rubber seeds and by-products of the cocoa industry. Substantial quantities of some of these ingredients are available—for example, in 1991, Indonesia produced approximately 607,100 tonnes of palm kernel cake. These feed ingredients usually contain high levels of crude fibre and some may contain toxins. Their quality is also variable and is dependent upon location of production, seasonal conditions, and postharvest handling. These factors limit the level of

inclusion in pig diets. Fermentation technology has been developed to improve the nutrient quality of some of these ingredients but has not been widely adopted.

The main imported feed ingredients are corn, soybean meal, fishmeal, meat and bone meal, and vitamin–mineral premixes. Since the monetary crisis, the prices of these ingredients have increased up to three times. Nevertheless, substantial quantities are still imported. For example, in 1998/99, Indonesia imported 904,759 tonnes of soybean meal, and 591,056 tonnes of fish meal.

It is anticipated that pig production in Indonesia would expand more rapidly if the government reduced the level of import tax on feed ingredients, government regulations about the locations of pig farms were made less restrictive, and government investment in R&D was substantially increased.

We believe that the R&D priorities for nutrition should focus on:

- improving the quality of local feeds (e.g. through the application of biotechnology); and
- finding and developing alternative protein sources that are locally available and suitable for inclusion in pig diets.

3.1.3 Health

The principal diseases affecting pig production in Indonesia are hog cholera, brucellosis, erysipelas, and diarrhoea in piglets.

Hog cholera. In 1996, piggeries in Indonesia experienced very high mortalities as a result of hog cholera. Some smallholder pig farmers even gave up raising pigs as the death of one animal could result in the death of all animals in their herd. Since then, farmers have been much more aware of the dangers of this serious viral disease and have vaccinated more of their pigs at their own expense. For example, the proportion of pigs vaccinated in North Sumatra increased to about 76% in 1999/2000 from 30% in the year before. In recent years, Japan, through the Japan International Cooperation Agency (JICA), has provided effective technical aid to Indonesia with the purpose of:

- improving the accuracy and speed of diagnosis of hog cholera;
- preparing programs to deal with outbreaks of the disease; and
- transferring technology in the production for hog cholera vaccine for use in eradicating the disease.

Brucellosis. In Indonesia, especially around Jakarta, brucellosis is an important disease, with 89% of

infections being caused by brucellosis biotype 1 and 11% by biotype 3.

Erysipelas. Erysipelas, an infectious bacterial animal disease mainly attacking pigs, is caused by *Erysipelothrix rhusiopathiae* or *E. insidiosus*. This disease was reported to occur in 1964, 1979, 1981 and 1991 in West Java, Jakarta, North Sumatra and central Java, respectively.

Neonatal diarrhoea. This condition occurs in most piggeries in Indonesia with prevalence varying between 13 and 44% and averaging about 25%. Mortality of piglets as a result of this condition varies between 12 and 32% and averages about 18%. Piglet neonatal diarrhoea has been found to be associated with enterotoxigenic *Escherichia coli*.

3.1.4 Housing and environment

Housing. Although the pens used by smallholder pig farmers are not as good as those in commercial piggeries, these farmers understand their function as places for modifying the micro-environment of the pigs. The pens are usually made of relatively cheap local materials.

Environment. Unfortunately, Indonesia is not yet taking pollution caused by farm effluents as seriously as it is taken, for example, in European countries. The high nitrogen and phosphorus contents of pig effluent have a high potential for polluting waterways, rivers, and lakes. Both substances speed up the growth rate of algae which may then cover the water surface, adversely affecting water quality, depressing fish growth, and potentially blocking the waterways. How serious this environmental pollution is on a national basis has not yet been determined. However, pollution surrounding animal farms is often serious, as evidenced by unpleasant odours and algal growth on water surfaces.

Smallholder pig farmers in rural areas often handle pig wastes in simple but very effective ways by collecting them for use as fertiliser on agricultural land. Serious environmental problems arise, however, with semi-commercial and commercial pig production, particularly in peri-urban areas. Here, cultural (religious), odour, and pollution problems often come together to cause serious problems and social conflict. Some peri-urban piggeries have had to go out of production as cities have spread into their less densely populated fringes, and this is likely to occur with increasing frequency.

Environmental management is clearly a very serious, under-emphasised issue for the pig industry in Indonesia. The long-term physical and social welfare of Indonesian society requires that much greater emphasis

be placed on the development of efficient production systems that make sustainable use of natural resources (soil, water, flora and fauna). Thus, the environment issue is one that will require increasing and substantial involvement of the various levels of government (in formulating policies, regulations, and monitoring procedures, and in supporting R&D to address the numerous problems).

3.1.5 *Product development and quality*

The national policy towards livestock production is directed at increasing the welfare and income of smallholder farmers by improving the productivity of their farming systems. One way in which this can be achieved is by producing products that are closely in line with consumer demand. In recent years, consumer demand for pig products has become much more sophisticated and there is now a strong demand (and high prices) for carcasses and cuts with a higher proportion of lean meat. Although a common system of carcass grading has not yet been adopted, market weight (90–100 kg) and backfat thickness are characteristics of rapidly increasing importance.

This change in consumer preferences is having, and will continue to have, a major impact on many aspects of pig raising, particularly by smallholders. Government-funded R&D centres/stations are playing an important role in dealing with this matter by improving the genetic potential of breeding stock and in formulating improved pig diets. Commercial pig farmers have also helped or collaborated as they have raised breeding stock with the genetic potential for lean meat that will in time influence the genetic potential of smallholder pigs.

3.1.6 *Reproduction*

Data on the litter size of pigs raised by smallholders indicate that small litters are common, with averages litter sizes of 7.5, 6.5, and 6.4 head at birth, and 6.3, 6.1, and 6.0 at weaning for indigenous, crossbred, and exotic breeds, respectively. Such litter sizes are well below those of commercial piggeries. The low litter size in exotic breeds when raised by smallholder farmers is probably due to poor feed quality and quantity. In general, knowledge and understanding about reproduction among smallholder pig farmers is not high. For example, there is little understanding of the value of flushing for increasing ovulation, and of the need for good care (particularly nutrition) during pregnancy, in order to avoid mortalities.

Artificial insemination (AI) is hardly practised at all in pig farming in Indonesia. Apart from the unavailability of the required facilities and infrastructure, pig farmers do not consider AI important since those who do not

have a boar can readily hire one for a fee to mate to a sow in heat.

3.1.7 *Socioeconomics and technology transfer*

Smallholder pig farmers generally raise only a small number of pigs as pig production at this scale is usually thought of as a side business. Hence, there is little consideration or understanding of the whole production system. Support, such as training and visits to successful semi-commercial pig farming enterprises, will be required to help smallholders make the transition from side business to commercial operation. R&D centres have an important role to play in this transition by assisting smallholder farmers to increase the efficiency of their production systems and the scale of the operations. Extension workers can also support such changes but, in some cases, they may not have the ability or the experience to do so.

In order to improve farming among smallholder pig farmers, three approaches can be taken—the technical, the integrated, and the agribusiness approach. The technical approach, for example, can help reduce mortality through disease prevention and eradication (by vaccination programs, extension activities, the use of animal quarantine stations, and by providing improved access to veterinary services). The integrated approach is aimed at increasing productivity by large-scale establishment of production technology, economic and social management programs (e.g. the provision of packages of production technologies, and assistance in organising smallholder pig farmers into farmer groups and cooperative institutions). The agribusiness approach is an effort to accelerate development by integrating the four major aspects of agribusiness—farm inputs, production, processing, and marketing. As an illustration, industrialisation of smallholder pig farmers would require full integration with the commercial production systems, taking account of these four aspects. It would be expected to bring benefits to all parties.

3.2 **Priorities Between Disciplines**

To develop pig farming in Indonesia, especially that by smallholder pig farmers, we consider that the most important disciplinary areas requiring R&D attention are environment, and socioeconomics and technology transfer.

3.2.1 *Environment*

This topic includes all aspects of production systems that affect the wellbeing of both the pigs and the human population in the immediate vicinity. It takes into account climatic, structural, health, nutritional, cultural, and social factors. The most important factor concerning the business of pig farming relates to the fact that the majority of Indonesian people are Muslim

and not allowed to consume pork. They also tend to object to the development of pig farming around their area—a fact that must be taken into account in planning, managing, and developing pig farming enterprises. The 1997 experience in reallocating pig farming from the capital city of Jakarta is instructive. The reallocation to a particular area in West Java was in the end unsuccessful for socio-cultural reasons rather than technical ones.

3.2.2 *Socioeconomics and technology transfer*

Pig farming contributes about 12% of the national meat production. Pigs therefore rank third after beef and poultry. Changes are occurring in the principal locations of pig farming in Indonesia, with significant increases occurring in north Sumatra, Nusa Tenggara, Bali, North Celebes, West Kalimantan and Riau.

The reality of much of Indonesian pig farming is that the productivity of the pigs of the dominant group of

pig producers—smallholders living in rural areas—is very low. This is principally because they still use very simple technologies in rearing their animals (mainly local breeds with some crosses with exotic ones) and unconventional, poorly balanced feeds, with the eventual result that their own living standards are well below average. Support from the government and foreign countries, therefore, is needed to overcome the many problems (particularly in access to better breeding stock, training in all aspects of pig raising, and awareness of the environmental implications of pig farming) faced by smallholder pig farmers.

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PIG PRODUCTION IN THE PACIFIC ISLAND COUNTRIES AND TERRITORIES

P. Saville and P. Manueli

Regional Animal Health Service, Secretariat of the Pacific Community, Private Mail Bag, Suva

1. OVERVIEW OF PIG PRODUCTION IN THE PACIFIC ISLAND REGION

1.1 Introduction

It is generally accepted that the earliest settlers introduced pigs to the Pacific region, carrying them on their canoes. In traditional societies, pigs continue to be kept to meet customary obligations and to signify wealth. In such societies, pigs are normally only slaughtered for special occasions. In some Pacific societies, pigs are still used to purchase wives (bride price). The extent of the region is shown in Figure 1.

In recent years, pig production has been increasing in importance in most countries in the Pacific, as farmers respond to the rising demand for animal products, and endeavour to generate income to raise their standard of

living. This trend is particularly evident in countries such as Papua New Guinea, Solomon Islands and Vanuatu where income-generating opportunities are limited and where the efficiency of existing production systems is very low. The same trend is also apparent in the atoll countries of Kiribati and Tuvalu where environmental pressure on limited resources has increased. Pig numbers and densities are outlined in Table 1.

1.2 Market Arrangements

Smallholder production still relies largely on the sale of live animals, but sales of carcasses and cuts are the predominant method of marketing for the semi-commercial and commercial producers (Table 2). Returns to the producer vary considerably between countries in the region with the extreme being reports of pigs being sold for ceremonial purposes in the Federated States of Micronesia for sums in excess of \$US1,000 per pig. Such

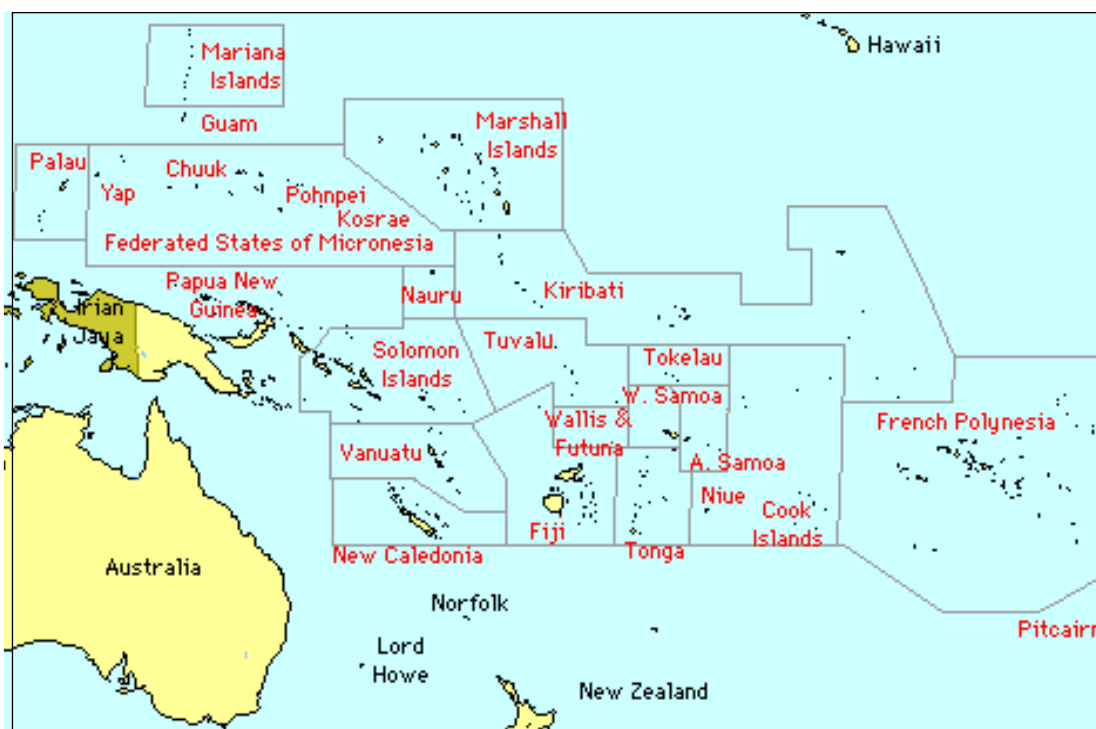


Figure 1. Pacific Island countries and territories.

returns have no relation to the costs of production and act as a disincentive to improved efficiency of production (Engelberger, pers. comm., 2001).

Table 1. Pig populations in the Pacific Island region by country (descending order).

Country	Number of pigs	Number of pigs per km ²	Number of pigs per person
Papua New Guinea	1,033,000	2.2	0.23
Samoa	179,000	61.0	1.02
Fiji	115,000	6.3	0.15
Tonga	80,853	108.2	0.83
Vanuatu	59,000	4.8	0.32
Solomon Islands	55,000	1.9	0.13
Federated States of Micronesia	40,000	57.1	0.35
New Caledonia	39,000	2.0	0.19
French Polynesia	38,000	10.8	0.17
Wallis and Futuna	30,000	117.6	2.11
Kiribati	27,622	34.1	0.32
Cook Islands	16,459	69.4	0.86
Tuvalu	13,000	500.0	1.18
American Samoa	5,000	25.0	0.08
Guam	4,000	7.4	0.03
Nauru	3,000	142.9	0.26
Tokelau	1,976	164.7	1.32
Niue	1,527	5.9	0.73
Palau	862	1.8	0.05
Total and means	1,742,299	69.6	0.54

Source: Unpublished data, Secretariat of the Pacific Community and FAO (1996).

In Niue, Ellison and Saville (1997) found that at 8 haircutting ceremonies per annum, approximately 425 small pigs (each about 24 kilograms dressed weight) contribute 11,840 kilograms of meat, equivalent to 5.7 kilograms per head per annum. The figures for 12 ceremonies per year are 636 pigs, 17,760 kilograms of pig meat and consumption of 8.5 kilograms per head. In some societies, pig tusks are an additional, valued product and pigs are grown on soft feeds to allow their tusks to grow. At slaughter, the tusks are removed and sold.

1.3 Industry Services

Support for the industry in the region is largely provided by the respective government extension and

research services (Table 3). The Community Colleges (US Land Grant) in the 'American Pacific' also operate an extension service. Feed mills play an important role through the supply of compounded feeds and advice on nutrition. Limited private consultancy services are also present in some countries.

1.4 Industry Significance

Within the Pacific Island region, pigs are recognised as an increasingly important source of dietary protein. They account for nearly 40% of the total value of all livestock products (Table 4). Pig production is particularly important where traditional sources of protein such as reef fish are diminishing as population pressures increase. It also contributes to the welfare and total productivity of rural people through the generation of rural employment and income. Governments in the region have promoted self-sufficiency and, in some cases, the development of an export trade in pigs and pig products, but with limited success.

Of special significance in all countries in the region is the traditional role of pigs during customary ceremonies such as funerals, weddings, and initiations. Large numbers of pigs are killed and consumed on such occasions.

The majority of small farmers have limited knowledge of pig and poultry nutrition and the adverse effects of moulds and other contaminants in feeds. Feeding practices, feed storage, and hygiene therefore need to be improved in order to minimise growth of toxin-producing organisms. Traditional herbs and local feed ingredients may have potential in this context and should appeal, particularly to women. Use of such local technologies may be of value in improving productivity and farmer income without increasing chemical usage.

Demand for increased production frequently results in overstocking. This can lead to increased susceptibility to the effects of both internal and external parasites in situations where access to anthelmintics and acaricides is limited, or where their cost is beyond the reach of the farmer. In such situations, the parasites further limit the productivity and profitability of smallholder pig units and, in some cases, represent a threat to public health. (Recent outbreaks of leptospirosis in Fiji and Palau are an indication of the impact livestock can make on public health.)

Similarly, increases in smallholder pig and poultry populations, particularly in atoll countries, are also creating increasing problems with animal waste management and environmental degradation.

Governments throughout the region have tried to improve the efficiency and economic performance of

pig production by both smallholders and commercial producers. Such policies, however, have had limited impact because of the low level of management, the impact of diseases, and the dependence upon imported feed or the large labour component involved in using locally produced feeds.

2. INVESTMENT PRIORITIES FOR THE PIG INDUSTRY

2.1 Priorities Within Disciplines

Priorities within disciplines were identified by participants at a workshop on sustainable livestock production organised by the Institute for Research,

Extension and Training in Agriculture (IRETA) of the University of the South Pacific and held in Suva, Fiji (25 June–6 July 2001). In order of priority, participants ranked food conversion efficiency, growth rate, fecundity, carcass quality and disease resistance as the most important issues.

2.1.1 Genetics

Food conversion efficiency and growth rate—both genetically controlled characters—have been identified as the highest priorities for genetic improvement in the region. Native pigs are known to have slower growth rates, lower food conversion efficiencies, smaller eye muscle areas, and less back fat than exotic (Berkshire or Tamworth) pigs reared under similar management

Table 2. Marketing arrangements for pigs and pig products in the Pacific Island region.

Holding type	Product	Marketing system	Market sector	Market signals
Smallholder	Live animals mainly for family use but with occasional sales	Informal, farm gate sales	Mainly rural	Growing
Semi-commercial	Live animals for ceremonial purposes	Informal farm gate sales	Rural and urban sectors	Demand is variable but continues to grow
	Carcasses for retail trade	Formal, butchers and supermarkets		Growing demand for lean carcasses by the retail trade
Commercial	Carcass for retail trade	Formal, butchers, supermarkets	Largely urban	Growing demand for lean pork
	Live animals for ceremonial purposes	Informal farm gate sales		Demand is growing

Table 3. Research and development (R&D), extension and other services for pig producers in the Pacific Island region.

Holding type	R&D	Extension services	Source of stock	Health services	Health products	Feed
Smallholder	Government (Govt), Community Colleges and universities	Govt, Community Colleges and universities	Govt and commercial holdings. Limited AI ^a	Govt PARAVET services	Imported medications if available	Mainly crop by-products and local feed. Some compounded feeds
Semi-commercial	Govt, Community Colleges and universities	Govt, Community Colleges and universities	Govt and commercial holdings. Limited AI ^a	Govt PARAVET services	Imported medications if available	Primarily commercial feeds with some local
Commercial	Govt, Community Colleges and universities	Govt, Community Colleges and universities. Some private companies and independent consultants	Govt and other Commercial holdings. Some AI ^a	Private, govt vet services and self	Imported medications	Commercial feeds

a AI = artificial insemination

systems (Malynicz 1973c). However, the use of improved breeds is only beneficial if the animals are well managed. Experience in Papua New Guinea has shown that improvement in the quality of the genotype must be accompanied by at least some improvement in standards of husbandry, nutrition, and disease control (Malynicz 1973a). If not, growth rates will generally be severely depressed and mortalities will increase (Malynicz 1973b).

Table 4. Relative values of livestock industries in the Pacific region.

Livestock Species	Value (\$USm)	Percentage
Pigs	107	37.4
Chickens	18	6.3
Cattle and buffalo	147	51.4
Sheep and goats	14	4.9
Total	286	100.0

Source: Unpublished data, Secretariat of the Pacific Community (2001).

An international conference on developing agricultural research programs for atolls suggested that priority be given to the identification of animal types already adapted to atoll environments and to their further improvement by the infusion of exotic genes (Chase and Thaman 1991).

The preferred methods of genetic improvement are, in order of priority, distribution of young boars, distribution of young sows, and artificial insemination (AI). While AI is not widely practised throughout the region, it is perceived as the most rapid means by which improvements can be made to the performance of breeding stock, and by which improvements can flow to the performance of the local pig herds.

2.1.2 Nutrition

Production efficiency is often limited by poor nutrition. We believe that the order of priority for further research and development (R&D) on nutrition is, in descending order, as follows: knowledge of feed formulation, knowledge of feeding value of local feeds, and quality control of commercial feeds.

High labour costs were not identified as a factor in the above rankings. However, the opportunity cost of labour for the production of feed from locally available materials often results in inadequate feeding practices. De Fredericks (1971) indicated that poor nutrition was the most important single factor limiting pig production in the Solomon Islands, with a total shortage of food being the most common problem. Jeffrey (1999) also identified inadequate levels of feeding and 'high in fibre' diets as major factors constraining pork

production in the Pacific region. A related problem—the lack of an adequate water supply—was also common and some pigs were not being given water at all. This is a common problem in atoll countries (Tuvalu, Kiribati, Marshall Islands, and Niue) where surface water is not available and drinking water has to be carried to the pen.

Increased use of local feed materials is seen as a way of increasing local livestock production, but their effective use will depend on further research (Ochetim 1989). Issues to be addressed in the formulation of such research include competition for resources with man; gut size and relative efficiency of pigs and poultry on local feeds; and the cost, nutritional characteristics, processing, and storage requirements of the local feeds. Chase and Thaman (1991) also identified the need to 'look for new sources of feed both locally and overseas'.

Feed formulation skills have been previously identified as lacking in staff of the various departments of agriculture and in farmers (Ajuyah 1999). Specific areas of deficiency were identified as knowledge of the feed requirements of pigs, the nutrient profiles and factors limiting the level of inclusion of local feeds, and costs of the various alternative feed sources.

2.1.3 Health

Surveys carried out by the Secretariat of the Pacific Community (SPC) have demonstrated the presence of a number of diseases of economic or public health significance (see Saville 1996a,b,c,d, 1999; Martin 1999a,b; Martin and Epstein 1999; ADAP 2000). Of particular concern are the prevalence of leptospirosis and the role of the pig as a source of human infection. It is interesting to note that island countries without surface water (atolls) and those countries that are susceptible to droughts record a low prevalence for leptospirosis, whereas those countries with high rainfall (mainly high islands) have recorded a high prevalence. Also of concern is the presence of *Brucella suis* in Fiji and Tonga. Another disease, Aujeszky's disease, has been recognised in a number of countries but its impact on smallholder production systems has not been established. The epidemiology and pathogenicity of *Trichinella papuae* also requires further investigation to establish its role as a potential zoonosis.

In most countries (except perhaps Tuvalu), health products for disease prevention are available. As they are almost universally subsidised by governments, they are seen to be affordable, and farmers generally make use of them. Further increases in the use of health products could be achieved by providing further subsidies or making them totally free, and by providing additional training to livestock officers and farmers on their use.

The animal health experience of one particular country, Kiribati, is instructive. Here, the Department of Agriculture implemented a novel Pig Health Scheme in 1991 (Nanjani 1993). Each pig farmer was visited twice a year and all pigs received an injection of the anthelmintic Ivermectin (ivermectin, MSD Agvet). This preparation was preferred because of its ease of use and its ability to eliminate both internal parasites, including lungworm (*Metastrongylus* sp.) and kidney worm (*Stephanurus dentatus*), plus external parasites such as lice (*Hematopinus suis*) and sarcoptic mange mites (*Sarcoptes scabiei*). These parasites were recognised as the main factors affecting pig health and the 'injection that makes pigs bigger' became very popular with pig owners.

2.1.4 Housing

With the exception of Vanuatu, the importance of housing was understood, and in all countries except the Cook Islands, Tonga, Samoa, and Vanuatu, most pigs are housed.

2.1.5 Environment

Most countries reported that wastes are generally composted and used as manures, but Tuvalu and the Cook Islands reported that pig wastes are commonly discharged into oceans and waterways. In those countries where pigs are not housed, wastes are not collected and dung is allowed to rot where it is dropped.

Demand for increased production, which frequently results in overstocking, has led to increased impacts of animal waste on the environment. The resultant environmental degradation leads to further depletion of scarce resources. The introduction of environmental legislation in most countries in the region has resulted in restrictions being placed on the disposal of animal wastes. This represents a major challenge to pig farmers who are being forced to modify their current waste disposal systems in order to comply. The use of biogas digesters for effluent disposal is not common in the region, despite being widely promoted by extension services.

2.1.6 Product development and quality

In smallholder systems, product quality in terms of lean content is not recognised as an important consideration, nor is product hygiene since pigs are often sold live. Unfortunately, abattoirs and butcheries are not available in a number of countries in the region, so opportunities for value adding and for closer control of hygiene during slaughter are limited.

2.1.7 Reproduction

In the Cook Islands, Kiribati, Tonga, Tuvalu, and Vanuatu, reproductive performance is reported as being unsatisfactory. Reasons stated for this include a lack of

knowledge of the management of reproduction, inbreeding, and poor animal control. In the Solomon Islands, a survey of pigs in village production systems (De Fredericks 1971) found that:

- almost half the village pigs were over one year old, indicating a low reproduction rate and slow growth rate;
- a shortage of boars hindered reproduction in many herds, and indiscriminate slaughter of sows caused a loss of breeding potential; and
- litter sizes were small, and intervals between litters long.

All countries indicated that the use of AI to introduce improved genetics would result in improvements in the reproductive performance of sows. In countries that do practise AI, the service is provided by the relevant agriculture department. The major problem faced in the implementation of these AI programs is the coordination of semen imports. Other countries that do not currently practise AI indicated a willingness to introduce the technology, but would require extensive training of local inseminators for it to succeed.

An AI program instituted in Guam, the Commonwealth of the Northern Marianas, and Federated States of Micronesia by the Agricultural Development of the American Pacific program failed to improve reproductive performance. This was attributed to problems with shipping semen, low conception rates, high piglet mortality rates, and limited knowledge of sow management including poor heat detection. However, it did produce improved genetic stock (ADAP 1999).

2.1.8 Socioeconomics and technology transfer

All countries reported that the role of pigs in smallholder systems is well understood. While information for farmers was generally available from agriculture departments, agricultural schools and colleges, and other farmers, it was recognised that farmers would benefit greatly from improvements in the availability of resource materials and in transfer of knowledge and technology concerning pig production. Currently, farmers seem to get their information from field days, training courses, radio, newspapers, other farmers, and extension officers. However, this information tends to concentrate on specific technical issues and does not cover other important topics such as problem solving, and analysis of whole-farm production systems.

Chase and Thaman (1991) also identified the need to 'develop appropriate livestock production systems which are compatible with local land and cultural systems' and also to 'develop an appropriate marketing

system for meat and animal products compatible with existing cultural systems’.

2.2 Priorities Between Disciplines

In considering overall priorities, we are fortunate in being able to draw on the outcomes and recommendations of a number of recent workshops and conferences. The SPC recently ranked problems affecting pig production in the region (Table 5), with nutrition, animal health, and genetic improvement emerging as highest priorities.

Table 5. Problems affecting pig production in the Pacific Island region, with their priority ranking.

Problems to be addressed	Ranking
Improving nutrition	1
Improving animal health	2
Improving genetics	3
Extension services and technology transfer	4
Housing and environment (waste management)	5
Fertility	6
Product development and quality control	7

Source: Unpublished data, Secretariat of the Pacific Community (2001).

Fertility was the particular focus of another workshop (CVA/CSP Workshop on Fertility in Village Herds, 1999), but it was clearly recognised that fertility was strongly affected by nutrition, breeding management, parasitism, and disease. The workshop recommended that:

- dietary deficiencies should be identified and diets improved accordingly;
- local breeds should be retained and exotic breeds made available for cross breeding. (Other factors which should be taken into account in breeding programs include: improving the number and quality of boars, improving the distribution of superior, hardier progeny, and improving fertility through farmer education using workshops, seminars, media, extension agents and lead farmers.);
- disease-free status be maintained and/or strengthened by quarantine procedures; and
- improvements in the management of the serious problem of parasitism should be made through improved education of farmers.

The third source of information on regional priorities between disciplines comes from the 14th Regional

Conference of Permanent Heads of Agriculture and Livestock Production Services (PHALPS). It recommended that:

- PHALPS continues to recognise the need for para-veterinary training in the region and that the SPC Animal Health Service give high priority to the project and continue to seek donor funding for the completion of the development and the delivery of the training materials;
- SPC, in collaboration with other agencies and national governments, identify means to address the emerging problems associated with zoonotic diseases in the region;
- SPC, in collaboration with other agencies and national governments, identify means to assist countries to address animal welfare issues in the region in order to improve livestock productivity and reduce the impact of the urban dog populations;
- SPC investigate the potential for organic livestock products and take steps to identify ways of providing certification acceptable to the market for such products;
- SPC, in collaboration with other agencies and national governments, identify means to assist countries address the impacts of animal waste on the environment in all countries but particularly in atoll countries; and
- SPC, in collaboration with the Food and Agriculture Organization of the United Nations (FAO), seek funding to facilitate regional participation in the preparation of The State of the World’s Animal Genetic Resources, through an assessment of national animal genetic resources.

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PIG PRODUCTION IN PAPUA NEW GUINEA

A.R. Quartermain and P.J. Kohun

National Agricultural Research Institute, Lae, Morobe Province, Papua New Guinea

1 OVERVIEW OF PIG PRODUCTION

1.1 Pig Industry Statistics

The structure of the pig industry in Papua New Guinea (PNG) is detailed in Table 1. The data are only approximate because smallholder commercial piggeries go in and out of business and the large-scale units change sow numbers to accommodate demand. The modern commercial pigs are now mainly Large White and Landrace, but some remnants of earlier Berkshire, Tamworth and Saddleback breeds remain. The main feature is the overwhelming dominance of the traditional sector in which pigs are largely run free-range, scavenging but generally confined at night and fed food wastes, food crop surpluses, sweet potato and/or coconut. This production system is a continuum of a 5000-year tradition.

The structure is differentiated by location. The highland provinces, with 45% of the total rural households, have 78% of households owning pigs. Four provinces have over 80% and Enga has 89%. Ratios of pigs/person average 1.2 in the central highlands, dropping to 0.6 in the highland fringes. Utilisation is largely geared to ceremonial feasting. Lowland and island provinces

have pig ownership ranging from 18–58% of rural households with pigs/person ratios averaging 0.3 for the inland lowlands and some coastal areas and 0.1 for most coastal areas and islands. Utilisation here tends to be more opportunistic with increasing sales of live pigs for cash needs. Nationally, some 50% of pig owners have indicated some intent to sell pigs (Sources: National census data and unpublished analyses of pigs/person ratios by R.M. Bourke).

In general, traditional smallholders have very little involvement in formal marketing. Their requirements may be to improve productivity rather than profitability. A differentiation with respect to needs must be made between smallholder owners following traditional practices and those required or choosing to confine pigs in permanent pens. This practice is only traditional in a few areas but is growing elsewhere due to local government regulation or population pressures on land use.

Total meat production from the smallholder sector is estimated at 27,000 tonnes per annum compared to a little over 1,000 tonnes from the modern commercial sector. Total local meat production from all species is estimated at 54,000 tonnes which, together with imported beef and sheep meat of some 45,000 tonnes,

Table 1. Holding type, herd and pig numbers, breeds, and trends for Papua New Guinea.

Holding type	Herd size	Number of herds	Number of pigs	Trends	Breeds
Smallholder traditional	1–20	360,000	1,800,000	Static. May be increasing with growth in human population	Native (Quartermain 1996)
Smallholder penned household	1–3	1000	2000	Growing slowly	Native
Smallholder commercial	10–100	50 (including prisons and high schools)	2000	Growing slowly	Modern commercial
Middle size commercial	100–500	4 (3 institutional)	1500	Static	Modern commercial
Large scale commercial	>500	7	20,000 (2,500 sows)	Static	Modern commercial

gives an average meat consumption of about 20 kg per person per year in a population of 4,829,000. However, consumption is most uneven, both in terms of location and timing, with large numbers of pigs being slaughtered periodically in ceremonial pig kills.

1.2 Market Arrangements

Pigs and pig products are marketed through a variety of mechanisms depending on the type of holding (Table 2). The only statistics available are abattoir throughputs from the commercial sector that in 1999 were 19,900 pigs with a total weight of 959,210 kg and average carcass weight of 48.23 kg. Sales by all producers are a mixture of live sales and carcass meat, but it is very difficult to get figures on the relative proportions. Buyers from the commercial sector buy on a carcass weight basis, with all legal slaughtering being done through three licensed abattoirs owned by the Livestock Development Corporation. The market prices adjust to the cost of production with some competition for market share, but production also adjusts to demand at these prices.

Increasingly, traditional smallholders are selling meat in the local markets, either fresh, cooked or smoked. Some such smoked meat comes from the hunting of feral pigs that make up an unknown, but judged significant, addition to the total pig population.

Pork is competitive with equivalent meats but volume is restricted by the size of the market able to afford high-quality chilled meat cuts. It cannot compete on price with cheap imported sheep meat (e.g. lamb flaps, neck chops, forequarter chops), nor with chicken. Canned meat is popular for rural sales or distribution because of lack of refrigeration. Imported pork is entirely in canned form and this is estimated at about 700–800 tonnes per year.

The proportion of local commercial carcasses that are processed into bacon, ham, and smallgoods is significant and could be as much as 50%.

Currently, the commercial sector is static and has been so for about the last 10 years. It is protected by a 25% tariff on the cost, insurance and freight (CIF) value for fresh pork and 35% for canned pork. The commercial industry grew under the protection of an import ban imposed in 1983 that has now been replaced by the tariffs. Ongoing monitoring and analysis is required to assess the probable effects of any changes to these tariffs and to ensure that the domestic industry is at least protected against dumping. Progressive change in the overall industry is likely, dependent on the further development of commercialisation.

1.3 Industry Services

Government and industry services for the pig industry in PNG are shown in Table 3, but it should be noted that research, development and, to a large extent, extension have been minimal to non-existent for almost two decades. The National Agricultural Research Institute (NARI) is now gearing up to undertake research, especially in nutrition, with some help from the two universities with agriculture departments. Extension has now been delegated to provincial governments operating through local level government (LLG) structures and with help also from a range of non-government organisations (NGOs). Little extension in pig production is currently being done because the services are constrained by lack of resources and because people have always kept pigs and consider they know how to do it. However, demand for information is now coming from owners required to confine their pigs, and from the smallholder commercial sector concerning cheaper ways of feeding. These are targets for planned research.

Table 2. Marketing arrangements for pigs and pig products in Papua New Guinea.

Holding type	Product	Marketing system	Market sector	Market signals
Smallholder traditional or household	Fresh warm carcass or portions; cooked or smoked meat	Live animals Local market	Local Roadside	Direct
Smallholder commercial	Fresh warm carcass Breeding stock or weaners	Live animals Carcass payment	Mostly urban markets Farm gate sales	Direct from buyers responding to consumer demand Costs of production
Middle and large-scale commercial	Breeding stock or weaners Chilled or frozen carcass or cuts Percentage processed	Carcass payment direct to wholesalers or retailers Some vertical integration	Urban markets Farm gate sales	Direct from buyers

There is now only one commercial feed mill servicing the industry. It produces starter, grower, and breeder meals using local maize and agro-industrial by-products and imported grains, protein meals and mineral/vitamin premix. These products are reasonably competitive with imported feeds. Large volumes of agro-industrial by-products are available and research and development (R&D) are to be directed towards optimal use of such cheaper feedstuffs in low-intensity commercial systems in comparison with local or imported grains, grain legumes and other protein meals.

Fortunately, PNG has few pig health problems that are not the consequence of inappropriate or poor management (parasites and piglet mortality). Veterinary coverage is constrained by a gross shortage of qualified personnel, distribution of effort across the range of livestock species, and quarantine matters. There are currently only five veterinarians in government service, four of them in the National Agricultural Quarantine and Inspection Authority (NAQIA). NAQIA is of vital importance to PNG in its attempts to keep out those exotic diseases that are so devastating elsewhere in Southeast Asia.

1.4 Industry Significance

The pig industry is of vital importance to the nation because of the widespread significance of pigs in social and cultural interaction and because 60% of rural families nationwide keep pigs. It is also nutritionally important in that about 27% of all meat consumed is pig meat, although geographic and temporal distribution of consumption is uneven or erratic.

Commercial pig production does not compete for resources to the detriment of other production sectors. However, traditional pig production, geared to social exchange and ceremonial pig kills, can place inordinate

burdens on the labour input (particularly that of women) and periodically on staple food supplies (mainly sweet potato). There is good evidence that control of pig breeding (e.g. withholding sows from mating, disposal of young pigs, or timing of kills) is adjusted to the supply of sweet potato available for pig feeding.

The commercial industry is still protected by the tariffs. Reduction or removal of these could leave this small industry vulnerable. Hence the desire and pending effort to reduce the costs of production through less intensive nutrition, both aimed at keeping the industry competitive with imports and increasing the market share of pork in the total meat market. No threats are posed to the traditional smallholder sector by any expansion of the commercial sector. In fact, there are important benefits—such as availability of improved breeding stock, supply of weaners, and support for the abattoirs—that flow from the large-scale sector to the smallholder commercial sector.

2 PRIORITIES for R&D INVESTMENT

2.1 Priorities Within Disciplines

2.1.1 Genetics

The importance of genetic traits for production depends on whether the smallholder farmer is keeping pigs commercially or for traditional reasons. In the first case, the farmer would have modern commercial pigs that are capable of high levels of production. If the farmer has easy access to commercial feed, there should be no major production problems other than those related to ability and experience to manage the enterprise. These non-genetic factors can often affect the level of production. For example, some smallholder commercial farmers have the tendency to retain

Table 3. Services provided to the pig industry by government and industry.

Holding type	Research	Extension and development	Source of stock	Health services	Feed
Traditional or household	National Agricultural Research Institute Two universities	Government extension services NGOs	Local native	Government veterinary services (minimal) Some traditional medicine	Food crops and surpluses Food wastes Scavenging and grazing
Smallholder commercial	As above	As above	Self plus larger units	Government veterinary services	Largely commercial feeds Some use of additional crop by-products
Middle and large-scale commercial	Own resources to access technical information	Own resources	Self, exchange and imports of improved genotypes	As above Quarantine services NAQIA	Largely commercial feeds or own milling and mixing

breeding animals on the farm for a much longer time than is normal practice. This may lead to an overall lowering of the herd productivity since fertility declines with age. It also delays the opportunity to bring into the herd genetically superior animals that are available from breed improvement programs. Some smallholder farmers may not have the resources to access genetically superior stock over time and therefore production is likely to be lower than for large-scale commercial enterprises that can do this. In general, artificial insemination (AI) is not commonly used in this sector though this service could be organised through cooperatives if these were formed. Semen can easily be obtained from Australia or New Zealand.

If the farmer does not have easy access to commercial feed, then there will be problems since all the important production traits will be affected. In this case, the farmer may be better off using a crossbred genotype. However, at this stage there is not very much known about the performance of crosses between modern commercial and native PNG pigs. The range of possible genotypes needs to be assessed in different locations with access to different types of locally available feed sources. There is an important role for R&D in this area.

In the case of smallholder subsistence farmers producing pigs for traditional pig exchanges and ceremonies, the animals being kept are predominantly native. The native pig is hardy and can survive well under the subsistence environment. Available production data are given in Quartermain (1996). The breed type is presumed to have remained pure over time since the survival rate of introduced pigs is very low. However, this needs research verification. Other than size (age related) and therefore level of fatness, the important commercial traits are often not given major consideration in this sector. Large fat pigs are desired. Farmers sometimes will deliberately not breed pigs or starve animals for varying lengths of time if there is competition for food between pigs and humans. There is a need to further assess the potential of the native pig to see if small inputs from R&D can lead to improvements in some production traits. An important area for R&D would be to assess the potential value of this genotype in crossbreeding programs, as indicated above. In order to do this effectively, it will first be necessary to further evaluate this genotype in terms of such important traits as parasite resistance and ability to deal with high fibre diets.

2.1.2 Nutrition

Traditional smallholders have a very clear understanding of how to raise pigs within the constraints of the environment in which they live. In essence, they understand nutrition in the same way they

understand their own needs for food and do the best they can. There are difficulties in satisfying the protein requirements of both species, even when the need is understood. Real deficiencies in understanding appear when changes to husbandry are attempted or imposed.

Such changes include the penning of pigs that deprives them of scavenging, especially if this is coupled with a change of breed to modern commercial pigs.

Smallholder commercial producers have only been successful when able to access and understand the efficient use of prepared milled feeds. Such feeds are of adequate quality but could be widened in range to include lower-cost feeds for lower-intensity systems. Research is required here to determine optimal economic inclusions of cheap agro-industrial by-products, mainly palm kernel meal, copra meal, wheat mill-run and rice bran. Farmers, who for one reason or another may run out of formulated feeds, often use these by-products as a stop-gap measure until the situation improves. However, while the factory-gate price of these products is low, the locations are scattered and internal freight costs are very high (see Figure 1).

There are two aspects to the building of smallholder farmer knowledge. One is to extend knowledge concerning the nutritional needs of pigs since these, especially those of young pigs and lactating sows, are so often seriously underestimated. Nutritional deficiencies may be qualitative, quantitative or both, even though inadequate quantities may be simply a matter of unavailability rather than lack of knowledge. The second aspect has to do with knowledge concerning the feeding values and possible use of available feedstuffs. Past research, mainly done in the 1970s, was concentrated on testing the use of a range of possible ingredients in diets for growing pigs. We have identified 17 feed items that have been investigated, tried in simple rations, or evaluated. Some of these items are routinely part of the diet of pigs in traditional systems but none of the results of this work have been adopted routinely into commercial pig feeding. Proposed innovations included the grazing of pigs on sweet potato, cassava, or green legumes in situ with appropriate supplementation, and the addition of small quantities of high-protein supplement to the diets of scavenging pigs. Feed mills have made and sold appropriate supplements, but with limited uptake.

Feeds available in considerable quantity and of particular interest, other than the by-products and food crops already mentioned, include by-product fishmeal from local canneries, coconut, cocoa pods, sago pith and residue, bananas and banana plants, tree legume leaves, the leaves of sweet potato and cassava, brewers grains and yeast, chicken manure, and a range of other

items. We believe that there is now renewed interest in the use of such items in the feeding of penned pigs.

Agencies working, or with the potential to work, in nutritional research include NARI, the PNG University of Technology, and the University of Vudal. As a general rule, smallholders will only adopt technology if it is socially acceptable, economically viable, and meets real, expressed needs. In such cases, adoption should occur as a result of farmer-to-farmer exchange of experience in spite of the inadequacies of the extension services.

2.1.3 Health

The main health problems affecting pigs, especially in the traditional sector, are internal and external parasites and the mostly-management-related diseases of young pigs. Baby pig scours (colibacillosis) and sarcoptic mange are actual or potential problems in all piggeries. Development of the management systems and of the extension service is required to deal with these. Perinatal and peri-weaning mortality can be very high if

nutrition, hygiene, or protection against chilling is inadequate.

Anthrax is endemic in the five highland provinces, with perhaps 25% mortality in each of two to three isolated outbreaks each year. There are no other serious epizootic related diseases. Hence the vital importance of the quarantine surveillance and the restriction of imports of breeding stock to Australia and New Zealand.

Accessibility and price constrain the widespread use of veterinary drugs but prevalent diseases can be kept under control through management. There are traditional medicines thought to be effective against internal parasites and infections but these have not been well investigated and could be researched.

There are no policy issues impacting on pig health, except for the magnitude of the allocation of funding for the veterinary services. These services are mainly concerned with regulation and quarantine, with clinical

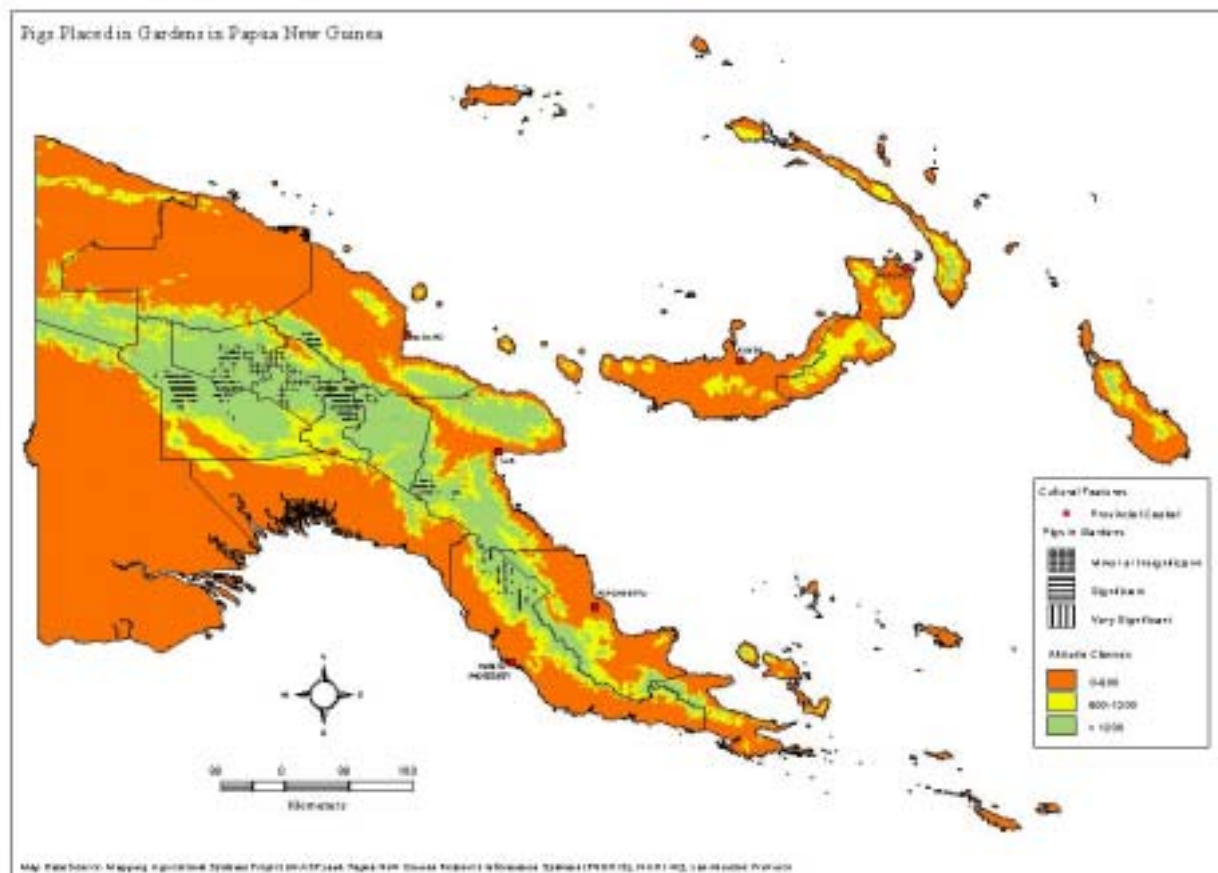


Figure 1. Map of Papua New Guinea showing provincial boundaries to locate the highland provinces, the six provincial urban locations of major agro-industrial and fishery by-product productions, and locations where pigs are deliberately placed in gardens between plantings within the gardening phase of the crop-fallow cycle. (Map prepared by Jimmy Naro, National Agricultural Research Institute.)

services provided when opportune. Apart from the four NAQIA veterinarians, there are three Senior Animal Health Inspectors (para-veterinary) strategically located for quarantine, and six meat inspectors to monitor the health of slaughtered animals and ensure public safety. Only one veterinarian is working with the extension services (Department of Agriculture and Livestock, Food Security Branch) to give support to smallholders.

Useful information in terms of disease prevalence comes from three sources—diagnostic services provided at cost by the NAQIA National Veterinary Laboratories, quarantine surveillance, and meat inspection. However, inadequacies in extension delivery mean that most smallholders receive little assistance.

2.1.4 Housing and environment

The importance of housing for herd productivity is probably well understood by smallholder commercial producers. A number of different types of housing are used and, although there have been some R&D inputs in this area, their effect on production level is not well known. In particular, it is necessary to understand the role of housing in parasite infestation and control. In the case of smallholder subsistence farmers, the importance of housing is probably not well understood. Housing of pigs at night is a practice that is more common in the highland areas. However, in some lowland areas in more recent times, regulations require pigs to be permanently penned, a practice which has important implications for feeding, hygiene and health for both animals and humans. In the smallholder subsistence sector, housing the sow and baby pigs for the first 10 to 15 days can be critical for survival of the baby pigs. R&D inputs in this area (housing and litter management) to improve baby pig survival have the potential to substantially improve overall herd productivity.

Pig waste management is not yet a major problem but may become so in future. There are already some situations where wastes are dumped straight into waterways, presenting problems for humans and aquatic organisms. There is a need for specific government regulations on the management of pig waste to be put in place. These should include penalties for those who breach the regulations. Use of waste as a source of nutrients for crop production and aquaculture is not very widespread. R&D can play an important role in finding better ways to manage and recycle wastes for productive purposes. In the smallholder subsistence sector, particularly in the highlands, pigs are often tethered or allowed to scavenge in gardens between successive crops or in fallows to break up the soil and

add nutrients via urine and dung before food crops are grown (see Figure 1).

2.1.5 Product development and quality

Currently, the arrangements for supply and marketing of meat and processed meat are meeting requirements. There is still a demand for fat in the traditional market, exchanges, and ceremonies, and production is geared to this end. Carcass and meat quality in the commercial market is addressed through the import of high-quality breeding stock, good nutritional management, and private industry standard control of quality through the complete marketing and processing chains.

The only area of potential concern is the local and roadside marketing of fresh portions and cooked or smoked product. Marketing control is the responsibility of local government and the national health services. It may be possible to develop more appropriate processed products, such as those produced by sun or smoke curing, salting, or pickling, to meet the growing casual snack-food market.

The PNG University of Technology is the only research agency currently involved in food technology, but NARI could be involved in collaborative activities.

2.1.6 Reproduction

Reproduction of pigs on smallholder commercial farms is well below our expectations. This is due mainly to poor litter management. There are also breed, nutritional, and other management factors involved. Extension and training inputs should result in improving the reproductive performance of herds. There is limited use of AI in the smallholder sector as mentioned above, so R&D interventions in this area may not have a significant impact on reproduction. There are no government policies in place that will impact on reproductive performance.

Reproduction in the native pig herd is considered satisfactory based on the limited inputs given. Sows will farrow on a regular basis provided they are well fed and managed. Litter size is small (5–7 piglets) for the native pig compared to temperate ‘improved’ breeds. There is no use of AI in this sector. Poor litter management, nutrition, traditional practices, and aspects of health and hygiene are probably the main factors affecting reproduction other than genetics. Extension and training in the areas of litter management, nutrition, and health should improve reproduction in the native pig herd.

2.1.7 Socioeconomics and technology transfer

The changes occurring in the slow but steady commercialisation of traditional pig keeping are not well understood. Farmers have increasing needs and

desires for cash. These may be at least partially satisfied either by establishing new production units, including smallholder commercial piggeries, or increasing productivity from traditional activities to permit increased sales. It is becoming necessary to identify the reasons for non-uptake of earlier technical change suggestions and ascertain to what extent smallholders are now willing and able to change, and what is driving or constraining change.

The expected providers of information, the provincial extension agencies, are unable to interpret existing information and adapt it to present farmer needs. Neither are they able to identify researchable elements from what farmers say they want to do. These agencies and relevant NGOs are over-stretched and under-resourced. It is therefore incumbent upon NARI and the universities to take the lead in socioeconomic research as well as that directly concerned with animal husbandry. Recent NARI provincial and farmer consultations have revealed the need for capacity building to enable both farmers and extension providers to identify and respond to developing economic opportunities. The NARI mandate is to do research and provide information relevant to smallholder farmers. The Institute has also recently been involved in the training of extension staff in the conduct of simple, on-farm technology testing, including testing in animal husbandry. Capacity building should include development of the ability to undertake farm management economic analysis and the provision of information to enable farmers to make decisions about investment, utilisation of resources, and effective marketing.

In the Papua New Guinea National Food Security Policy 2000–2010 (Department of Agriculture and Livestock 2000a), a pig development program is proposed under a farming systems approach to promote food security by diversification of production systems and involving the integration of livestock. However, there is no indication in the policy as to what should be done and how. Pigs do not rate a mention in the Strategic Plan of Action. The Strategy for National Agricultural Development: Horizon 2010 (Department of Agriculture and Livestock 2000b) proposes a rate of production increase in pig meat production of 4.2% per year and gives the constraints as a lack of local feed and generally high production costs. However, again no actions are specified. It would seem that either the task is regarded as too difficult or it has been concluded that farmers are not interested in change. Pig production is not given high priority in any government development plans, from local level through district and provincial to national level, even in lowland situations. This is probably because of presumptions about the strength of tradition, price competitiveness, or lack of appropriate

technology for change. There is no doubt that it will not be an easy task to raise production in the traditional sector but the rewards are potentially high if R&D agencies are successfully proactive. Farmers hold pigs in high esteem but they may not be able to effectively communicate with the R&D/extension service about the problems and issues to be dealt with in increasing production.

The traditional pig-keeping sector, the household production sector, and the smallholder commercial sector all have different needs. However, government development plans and the expressed opinions of farmers and extension staff do point to the need for information on the optimal use of local food crops, surpluses, and by-products in pig feeding in all production systems.

2.2 Priorities Between Disciplines

As will be clear from the above, we would put nutrition as first priority for R&D. The work would involve assessment of the past research results; a filling of the gaps in knowledge on the availability and values of the numerous feedstuffs with potential for more effective use; and specific new research to determine optimal levels of dietary inclusion of certain abundant ingredients. The work would need to encompass the full range of possible economic and productivity situations. The objectives are three-fold:

- To assess new options for lower intensity commercial production by smallholders.
- To assess options to meet the requirements for increased commercialisation of traditional production.
- To assist householders to increase production for home consumption.

We do not underestimate the problems involved in technology adoption, especially by traditional smallholders, and hence an emphasis must be given to making information on options easily accessible, and to the training of farmers and extension officers.

As a consequence of this we put socioeconomics and technology transfer as the second priority. Within this subject area, research is needed on farmer attitudes towards change, and on their capacity to adopt innovations. Work is also needed to determine the most effective means of packaging and delivering information, of increasing farmer knowledge concerning the options available to them, and of assisting them to choose the options that will be most beneficial. Surveys of existing or failed commercial ventures by smallholders may reveal what components of management are likely to be limiting. The implications of any technology adoption, especially in

terms of labour, investment, or credit requirements, social pressures, or prevalence of theft, need to be thoroughly investigated and interpreted to farmers. Gender-related implications may be important, given the specific roles of women in some traditional production systems. Most importantly, whole-farm economic analyses are required to facilitate choice and assess the consequences. There may be easier ways of generating income than keeping pigs.

We give our third priority to genetics. This is largely because of the shortfall in knowledge concerning the characteristics of the native pig and its possible contribution to production within low-intensity systems. We need to know more about its origins and genetic purity through DNA analysis. There is a possibility here for collaboration between PNG and Indonesia since the same genotype of native pig is presumed on both sides of the New Guinea border. The potentials for crossbreeding between modern commercial and native pigs, to take advantage of identified valuable traits within the latter, need assessment across the full range of possible genotypes and production systems.

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THE SWINE INDUSTRY IN THE PHILIPPINES: A FOCUS ON SMALLHOLDERS

E.C. Villar*, M.O. Maleon[†] and D.T. Facundo*

*Livestock Research Division, PCARRD, Department of Science and Technology, Paseo de Valmayor, Los Baños, Laguna, 4030 Philippines

[†]Philippine Swine Industry Research and Development Foundation, Inc, #12 Dona Consolacion Building, Gen. Santos Ave, Araneta Center, Cubao, Q.C., Philippines

1. OVERVIEW OF SWINE PRODUCTION

1.1 Swine Industry Statistics

The swine industry's share of the total value of agriculture and fisheries to the Philippine economy in 1999 was about 40%, or about 2.5% of the national gross domestic product (GDP).

The total swine population in 2000 was estimated at 10.8 million head, about 3.5% higher than the 1999 count (Table 1). The backyard or smallholder sector accounted for about 77% of the total inventory, with the commercial sector accounting for the remainder. Female breeding stock, comprising about 17% of the total population, had stabilised at 1.8 million head with large increases in breeder stocks held by the commercial farms (14.7%) almost completely offsetting a drop in stocks held by the backyard farms. The total stock of fatteners increased from 4.0 million in 1999 to 4.2 million head in 2000—an increment of 5.5%. Likewise, other swine classifications (growers, piglets, boars), comprising about 44% of the total swine inventory, were estimated at 4.8 million head or 3.4% higher than the 1999 level.

In 2000, 17.4 million head, valued at about 79 billion pesos were slaughtered—mostly in major abattoirs in Metro Manila (22%), Bulacan (5.4%) and Cebu (5.2%). Increments in both prices and production occurred during the year such that the swine industry's earnings went up by 5.3%. The top three pork-producing

regions—central Luzon, southern Tagalog, and southern Mindanao—shared around 40% of the total swine inventory. They accounted for 27 and 86% of the total swine stocks held by the backyard and commercial farms, respectively.

During the first three months of 2001, the Philippine swine industry continued to grow, with a 2.2% growth in gross receipts and 3.9% growth in production. There was an increase in inventory and in the volume of slaughtering. Prices for swine for the first three months of 2001 also went up, but at the slower rate of about 2.2%.

1.2 Market Arrangements

The production–marketing channel of the swine industry in the Philippines is composed of breeders, slaughter pig growers/raisers, traders, butchers/retailers, and processors (see Figure 1). The breeders produce quality pigs for breeding purposes, while the slaughter pig growers/raisers raise and grow hogs for slaughter. In general, both breeders and growers/raisers produce and sell live pigs. The hog traders and butchers/retailers market and distribute pork and pork products. The butchers also convert live pigs into consumable pork cuts, while the processors convert fresh pork into value-added processed pork products.

The key players of the Philippine swine industry can be grouped into swine producers and traders/processors. The Government agencies (research and extension organisations), non-government associations, and other

Table 1. Philippines swine inventory, by farm type for 1999–2000.^a

Farm type	Herd size	Inventory (million head)				% change
		1999	%	2000a	%	
Smallholder	≤ 20 head	8.18	78.7	8.33	77.4	+1.8
Commercial	> 20 head	2.22	21.3	2.43	22.6	+9.7
Total		10.40		10.77		+3.5

^a Preliminary estimates

Source: Bureau of Agricultural Statistics (BAS).

organised groups provide support services to the industry. Participants in the processed meat industry range from the large meat processors carrying well-known brand names, through the medium-scale meat processors, to the small-scale or home-based processors.

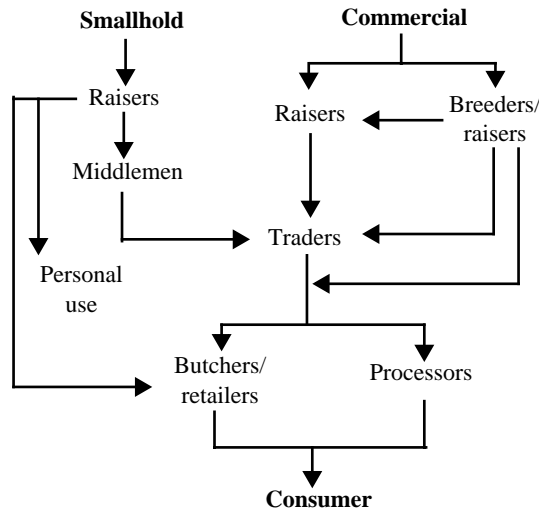


Figure 1. Production–marketing channels of the swine industry in the Philippines.

At present, markets for swine products are limited to domestic use and there are virtually no exports. However, the technology being adopted by commercial producers is on a par with that of other countries in the region, so export is a possibility in the future. Other meat products are imported from countries like India, the United States of America (USA), Europe etc., and this competes with local pork production as a source of animal protein. As international trade is further freed up under the General Agreement on Tariffs and Trade (GATT), strong competition from pork products from China and elsewhere is likely to impact on the Philippine industry. Rather than taking this as a threat, local producers see it as a challenge that will force them

to further improve the efficiency of production and marketing. Some comparative statistics for the Philippines, USA, and United Kingdom are shown in Table 2 and indicate that there is considerable scope for improvement in Philippine pig production.

About 33% of the swine raisers sell market hogs to retailers. Except in the provinces of Quezon, Leyte, and Zamboanga del Norte, hog raisers also rely on middlemen/agents in the sale of hogs. Wholesalers are the major buyers of 15% of the hogs produced. About 86% of the hog raisers prefer selling live while the remaining 14% prefer selling slaughtered hogs. Age and weight are the main considerations in selling/ slaughtering them, but there are times when backyard raisers are forced to sell or slaughter hogs at inappropriate times for other reasons (BAS 1999).

Table 3 summarises the marketing system for swine in the Philippines. The smallholder sector has no specific cuts and the meat is usually sold in fresh, warm portions. The commercial sector uses commercial cuts (usually USA-style) and has rigid product specification.

Table 3. Marketing of swine.

	Smallholder	Commercial
Marketing system	Live animal	Live animal, with vertical integration of growers, slaughter and retailers
Produce	Fresh warm portions, cuts	Commercial cuts, chilled
Market sector	Local, some leakage to cities, and to processing companies	Local, cities, and processing companies
Market signals	Through middlemen	Strong product specification by middlemen/buyers

Table 2. Swine production statistics—an international comparison, 1994

Parameters	Units	Philippines	USA	UK
Farrowing rate (proportion of sows that farrow)	%	75.9	85.0	83.0
Farrowing index (365/farrowing interval)	–	2.31	2.25	2.29
Pigs weaned per year (PWY)	number/year	19.03	19.50	19.80
Time to market	days	180	170	162
Food conversion rate (FCR)—whole herd	kg live weight (LW)/kg feed	3.75	3.10	3.04
Pigs produced per sow per year (PPSY)	number/sow/year	15.40	19.20	19.50
Average daily LW gain (ADG)	g	474	647	678

1.3 Industry Services

Government institutions like the Department of Agriculture, local government units (LGUs), state colleges and universities (SCUs), the private sector (drug companies, feed millers, and other organised groups), and professional organisations all support the swine industry in various ways—in extension, research and development (R&D), product development, feed resources and supplies, health services and products, policy advocacy, promotion, and marketing (Table 4).

The Philippine swine industry is considered to be a relatively advanced and competitive industry that is led by the private sector. However, problems such as unabated spread of diseases; limited availability and high costs of biologics, antibiotics and other medications; the need for continuous importation of breeding stocks and feed ingredients/supplements; and inefficient marketing systems and structure, still exist. Cooperation among the government, private, and public sectors in harnessing the available technologies and resources is being strongly encouraged to effectively address these problems and support the country's quest for global competitiveness.

The recent project 'Swine Production Performance in the Philippines' (Argañosa et al. 2000) is an excellent example of government and private sector cooperation. The project, initially funded by the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) and the Department of Science and Technology (DOST) in 1992, is now fully supported by its various cooperators (private swine farms, feed and veterinary suppliers, and private foundations). The main objective of this project is to monitor and evaluate the productive and reproductive performance of locally raised pigs in

commercial farms, with performance data such as those in Table 5 being collected. It also aims to encourage local pig producers to adopt and maintain sound recording systems and to participate in the national pig production monitoring and evaluation system. The project is ongoing and the number of cooperators has increased over time.

Another joint effort of the government and private sector is concerned with genetic improvement. The boar-testing program and the accreditation of swine breeder farms are considered to be very significant contributions from such collaboration.

In relation to disease, the government has put in place nationwide disease surveillance mechanisms. For foot-and-mouth disease (FMD), for example, the Department of Agriculture created Task Force FMD. This group serves to monitor and coordinate efforts or initiatives related to FMD. The Task Force, through the Bureau of Animal Industry, is working closely with the Office International des Epizooties (OIE) to declare the main island group, Visayas, as a FMD-free zone. Mindanao is traditionally a FMD-free zone.

1.4 Industry Significance

Swine are one of the most important agricultural commodities in the Philippines. During the decade 1990–99, swine accounted for 78% of the total value of livestock production and 10% of the gross value of agricultural output. The supply and utilisation of pork showed that the country has been partly dependent on importation of this commodity. Imports increased steadily over the period and averaged 6,670 tonnes per year. With the continuing increase in population, an expanding number of fast-food chains, and rapid development of food manufacturing, the domestic

Table 4. Services available to the swine industry in the Philippines.

Services	Farm Type	
	Smallholder	Commercial
Research and development	SCUs, DOST-PCARRD, DA, Foreign agencies	SCUs, DOST-PCARRD
Extension	SCUs, DA, LGUs, Foreign agencies and private drug and feed companies	Private, self
Source of stock	Among smallholders, government AI services, commercial farms	Self, imported
Health services	Government veterinary services	Private consultants, employment
Health products	Commercial veterinary drugs	Imported medication
Feed	Kitchen refuse, crop by-products, commercial feeds	Commercial feeds

Note: DOST = Department of Science and Technology; PCARRD = Philippine Council for Agriculture, Forestry and Natural Resources Research and Development; DA = Department of Agriculture; SCUs = State colleges and universities; LGUs = local government units; AI = artificial insemination.

Pig production in the Philippines: a focus on smallholders

consumption of pork is expected to follow the same upward trend.

The policy agenda in agriculture of the present Philippine administration is strongly focused on food security. The Department of Agriculture envisions that a dynamic self-sustaining community of organised farmer and fisher entrepreneurs, doing profitable business out of agriculture, will dominate the

agricultural economy. One such business is swine raising. However, this enterprise or industry, like many others, is vulnerable to changing conditions on both local and international fronts as globalisation and/or liberalisation of trade accelerates (Mangabat 2000).

Being the biggest and most organised industry among the local livestock industries, the swine industry provides business opportunities to Filipino

Table 5. Productive and reproductive performance of some commercial swine herds in the Philippines, 1992–2000.

Parameter	1992	1993	1994	1995	1996	1997	1998	1999	2000	Target
Participating farms	13	19	20	17	20	21	23	26	32	
Litters farrowed	20,306	24,192	26,493	22,098	28,187	23,099	26,197	21,759	34,410	
Litter size born										
Alive	9.14	8.86	9.13	9.14	9.14	8.98	9.10	8.99	9.21	9.50
Mummified	0.18	0.22	0.15	0.25	0.14	0.19	0.20	0.27	0.20	0.20
Stillborn	0.42	0.58	0.39	0.26	0.45	0.39	0.38	0.48	0.48	0.30
Total	9.74	9.66	9.68	9.65	9.72	9.66	9.70	9.74	9.88	10.00
Average birth weight, kg	1.40	1.39	1.40	1.40	1.44	1.47	1.45	1.46	1.47	1.40
Litter size at weaning	8.23	7.87	8.22	8.07	8.19	7.73	8.06	8.21	8.36	8.55
Weaning age, days	29.14	30.17	29.45	28.69	27.87	28.32	28.83	28.29	28.69	30.00
Dry/rest period, days	11.58	13.51	13.62	15.52	13.68	15.33	13.23	12.89	13.31	11.00
Gestation period, days	114.45	114.52	114.49	114.48	114.44	114.50	114.25	114.83	114.77	114.00
Farrowing intervals, days	155.86	159.92	158.11	160.11	156.85	158.26	157.00	156.84	157.85	155.00
Farrowing rate, %	74.70	72.60	75.92	73.88	75.98	73.83	75.24	75.03	76.19	80.00
Pre-weaning mortality, %	10.03	11.29	9.90	11.61	10.36	9.71	11.52	8.80	9.24	<10.0
Mortality based on total population, %	2.54	3.21	2.87	3.54	3.46	3.60	4.02	3.58	3.57	<2.25
Adjusted 30-day weight, kg	6.97	6.86	6.94	6.85	7.09	7.34	6.96	7.28	7.38	7.50
Farrowing index	2.35	2.29	2.31	2.28	2.33	2.31	2.33	2.33	2.31	2.35
Pigs weaned per sow per year	19.28	18.02	19.03	18.42	19.08	18.75	18.77	19.12	19.36	20.08
Average daily gain, kg	0.467	0.459	0.474	0.480	0.477	0.482	0.464	0.475	0.485	0.475
Adjusted 180-day weight, kg	84.08	82.60	85.37	86.47	85.81	81.07	83.53	85.52	87.29	85.00
Farm efficiency	4.17	3.71	3.76	3.78	3.68	3.66	3.56	3.63	3.64	
Adjusted farm efficiency	3.93	3.82	3.75	3.75	3.72	3.69	3.65	3.59	3.63	3.75
Feed cost (Pesos)/kg of live animals sold,										
– Before adjustment	34.46	29.74	30.06	33.32	33.66	35.36	37.92	33.25	37.44	
– After adjustment	32.30	30.67	30.32	33.11	34.65	36.36	39.34	33.40	37.04	
Pigs produced per sow per year	15.99	14.47	15.39	14.47	15.58	15.01	15.63	16.11	15.77	
Price of regular slaughter hogs sold, Pesos	48.12	40.48	51.14	45.15	54.10	55.96	55.46	59.03	56.29	

Source: Argañosa et al. 2000.

entrepreneurs and creates employment, especially in rural areas where more than 75% of the total inventory is kept.

The preference of Filipino consumers for freshly slaughtered warm pork over frozen pork gives the local industry assurance of the market for its products. Likewise, the culinary recipes of Filipinos, which include pork either as a main course or a mere ingredient in the recipe, ensure the continuous demand and utilisation of pork. Moreover, with the disease outbreak of bovine spongiform encephalopathy (BSE) in Europe and chicken flu in China, the swine industry is gaining the benefits in terms of increased demand. With the continuing increase in the population and in per capita consumption, the swine industry needs to increase its yearly production simply to meet the country's demand, let alone to allow export to other countries.

Among smallholders, swine raising is being considered literally as a sideline or 'piggy bank', particularly among housewives. They often raise one or two head of pigs for very specific purposes, with the proceeds of the sale of pork being used for purposes such as tuition fees, food for special occasions, emergency needs, and travel, or as a secondary source of income.

The economic importance of the swine industry can also be gleaned from the fact that commercial investment and establishment of commercial farms continues to grow. In fact, large-scale (1,000 to 120,000 sows) pig farms integrated with commercial feed mills are now being established by foreign investors in the free port zone, using their own breeder stocks, technology, and other production inputs. This development means that there is indirect importation of pork into the country with zero or minimal tariff cost. As this form of development expands, it is likely to have quite adverse effects on commercial swine producers elsewhere in the country.

2. R&D INVESTMENT PRIORITIES FOR THE SMALLHOLD SWINE INDUSTRY

2.1 Priorities Within Disciplines

2.1.1 Genetics

Between 1980 and 1999, smallholder swine raisers comprised over 80% of the total swine inventory. However, it is a sad fact of life that at market time this dominant group of producers is mostly at the mercy of middlemen, butcher/retailers, and processors. The buyers often allege (with some justification) that the animals are finished poorly and reach market weight at

greater age than commercially raised pigs. Smallholders still use 'mixed breeds', obtaining their stocks from wherever they can, with low price being the main selection criterion. In smallholder swine operations with 1–5 sows, the acquisition and maintenance of a boar is not common. Breeding service is obtained through the use of 'boars-for-hire' within the community, with the decision on which boar to hire being made on the basis of recommendations from other raisers or through experience—a very inefficient system for genetic improvement.

Three possible approaches to genetic improvement are being studied in the Smallholder Swine Genetic Resources Improvement Program (SGRIP). Fastest improvement can be achieved by improving both male and female breeders at the same time. The second approach is by the improvement of the male line only, and the third one involving the female line only. All of these approaches are being studied to find the most suitable approach for a particular locality.

The government, through the Department of Agriculture's Livestock Program, also has a National Swine Development Plan. Its goal is to sustain the gains of the industry and explore the export market potential for swine. For production, the main objective is to sustain local hog production, in part by genetic improvement with the following principal activities:

- promoting accreditation of breeders;
- expanding the national swine performance testing program; and
- encouraging private sector involvement in delivering artificial insemination (AI) services for smallholder farms.

Although AI is a well-proven technology widely used in the commercial industry, it is not popular among smallholder swine raisers. One reason for this is that there are limited numbers of highly trained technicians. As a consequence, technicians or persons with limited skills and knowledge perform the procedure with unfavourable results. This leads to disappointment and a return to the boar-for-hire approach.

Another genetic improvement technology that was piloted by PCARRD–DOST is the 'triple-cross pig' approach for improving the productivity of pigs held by smallholder farmers. The technology was well accepted by the farmers, but sourcing growers proved to be a major challenge. The cost of procuring F1 crossbred (Landrace × Yorkshire) pigs from commercial breeder farms is still very high and deters potential smallholder breeders. The terminal sire of the triple cross is the Duroc—owned by commercial breeders but also used as boars-for-hire. Some farmers use the fast-growing

triple-cross as breeders—a purpose for which they were not intended.

Four possible R&D investment opportunities in genetics are:

- assessing the contribution of the boar-for-hire scheme to genetic improvement leading to improvement of the total productivity of smallholder pig production;
- facilitating the production of triple-cross pigs as market hogs among smallholder raisers (to overcome the problems noted above);
- improving the genotype of native or country pigs through continuous selection; and
- conserving examples of the native pig population.

2.1.2 Nutrition

It is still quite popular among smallholder swine raisers in the Philippines to use kitchen refuse as feed for their herd in combination with commercial feeds or with other available feed ingredients. Many farmers believe that the more one includes additional ingredients in the feeds, the faster the growth of the animals. However, lack of knowledge and inattention to the nutritional balance of the diet leads to long production cycles, low-quality produce, and lower prices in the marketplace. While the use of commercial feeds is generally well accepted and used by swine raisers, for cost reasons it is very common for smallholder raisers to ‘extend’ the commercial feed by adding corn grits and bran. This upsets the nutritional balance of the commercial feed and leads to poorer performance. Often, the ration is also cooked—with unknown effects on its nutritional value.

Although attention to swine nutrition has improved over the years, a major nutritional constraint is the increasing cost of feeds. Numerous factors contribute to the high feed cost—fluctuating availability of local feed ingredients, the need to import many feed ingredients (e.g. corn, soybean, fishmeal, feed additives), and fluctuations in the world price of imported ingredients and in exchange rates. Early research on the use of locally available feedstuffs as substitutes for commonly imported feed ingredients have been done and the results proved promising. However, most of these feedstuffs were never commercialised because of their variable quality and fluctuating availability.

2.1.3 Health

Disease outbreaks occur on many farms, mainly as a result of poor disease monitoring and surveillance, inadequate veterinary facilities, insufficient diagnostic laboratories, and lack of field veterinarians. Disease prevention and control, especially in farms located in

areas far from urban centres, is an ongoing problem due to limited availability and high costs of imported biologics and other medicaments. Smallholder production systems are particularly prone to disease outbreaks because the farms are often exposed to contamination and infection, and often adopt poor sanitation practices. For cost reasons, smallholders often seek veterinary help only from government livestock inspectors who are expected to be knowledgeable on everything. They even expect to receive free drugs and biologics from government officers!

The main objective of the Department of Agriculture’s National Swine Development Plan for Animal Health is to develop a Swine Disease Surveillance, Prevention, Control and Eradication Plan. Strategies in this Plan include:

- creating an inter-agency swine development committee;
- creating a technical working group composed of veterinarians from government, private sector and academia;
- organising a network of laboratories to examine swine samples;
- coordinating the efforts of government, the private sector, and academia in the conduct of disease surveillance and research; and
- establishing a swine health information system (SHIS) to collate and process data from all sources and disseminate it to all groups in the industry.

The above strategies are aimed at prevention using a cooperative approach with the different sectors of the industry. Smallholder farmers should take advantage of the programs, because they are often the first to be affected, and suffer the biggest consequences. Diseases can then spread to the commercial sector with adverse consequences for the industry as a whole. However, this does not always occur despite there being continuous dissemination of information on animal health through seminars, radio, television, publications etc., in an attempt to keep farmers informed.

R&D in animal health is mostly focused on vaccine development and diagnostics. Production of local vaccines for hog cholera and other economically important diseases are important R&D activities that need further investment, as does the development of field diagnostic kits for rapid confirmation of common swine diseases.

2.1.4 Housing and environment

Smallholder swine raisers generally recognise the necessity and importance of housing, but standards

vary significantly, depending on the household's available resources. The housing construction can be elaborate (concrete flooring and galvanised iron roofing), or modest (bamboo, wooden slabs and nipa shingles). For some, the animals are simply tied under the house or tethered to a nearby tree.

The popularity of backyard swine raising throughout the country indicates its importance as a smallholder enterprise and as source of income. This group of producers disposes of animal waste in one or more of the following methods:

- composting, or simply depositing in a nearby hole or depression;
- discharging to a river or any body of water;
- discharging to a septic tank; or
- leaving it where it falls in the tethering area or surroundings where the hogs spend their time.

In a study done by the Bureau of Animal Statistics, about 56% of smallholder swine raisers made use of hog waste as compost. This was practised by more than 80% of smallholder raisers in the provinces of Pangasinan and South Cotabato. Some 26% discharged pig waste to rivers or any body of water. This is more common in Negros Occidental, with over 50% reporting use of this method. Digging a hole into which to discharge animal waste was done by 4% of the smallholder swine raisers in eight provinces. Meanwhile, about 4% were just leaving it in the tethering area or surroundings, while another 4% used the septic tank for the daily disposal of animal waste (BAS 1999).

For environmental and sanitary reasons, swine raising is not allowed near residential areas, particularly in urban areas. The policy on land zoning, however, is not always well followed, particularly among smallholders in areas or villages where everybody raises swine. This is because environmental concerns receive a very low priority when compared with various family matters, food security, and even the survival of the household.

R&D on waste management was earlier focused on the development and use of biogas digesters and settlement lagoons. These technologies have not found widespread adoption by smallholders for reasons of cost, social appreciation of the technology, and availability of land. However, the use of lagoons on commercial farms is quite popular.

2.1.5 *Product development and quality*

Concerns about human health are driving the demand for pork and pork products in the local Philippine market towards lean produce. The advocacy of certain health groups against pork as a cause of high

cholesterol levels and heart diseases is thus taking its toll on the pig industry. The more affluent consumers are becoming more health conscious and either minimise their consumption of pork or choose leaner carcasses and cuts. As a consequence, swine raised on the controlled diets provided on commercial farms are generally more acceptable in the marketplace than those from smallholders. As mentioned earlier, smallholders have the tendency to overfeed their animals, particularly with high-energy rations, resulting in fatter pigs at market and lower prices from butchers and traders.

Smallholder swine raisers may be able to develop a lucrative market niche for 'organic pork', especially if they raise native or country pigs. Health-conscious consumers and organic food advocates are beginning to seek native pigs or animals from villages because of the greater likelihood that the animals have been grown organically with lower use of antibiotics, hormones, artificial amino acids etc. than those that have been raised on commercial farms.

Finally, further R&D on the development of low-cost and long-shelf life products is needed to add more value to pork and to benefit both the consumer and the industry as a whole.

2.1.6 *Reproduction*

Reproductive performance of smallholder swine remains a major challenge and is dependent on the quality of animals, and the farmer's access to support services, management skills, and overall resources. These constraints are part and parcel of the dynamics and interactions taking place within farm households.

In terms of support services, the important role of the government is to provide veterinary services and, if possible, AI, together with better information relating to other aspects of swine production. The other support services (e.g. stocks, stud service, drugs, and specific veterinary advice) are in general readily available from the private sector.

The government, in close cooperation with the private sector, is conscious of the need to improve the genetic potential and reproductive performance of Philippine pigs and is already conducting boar testing and accreditation of swine farm breeders. A novel intervention on trial is the boar-for-hire scheme that may represent an important means of disseminating superior genetics to smallholder pig producers. Another related intervention that could be further developed by cooperation between government and industry is AI. Despite all the negative information on the operation of AI systems, it is still the cheapest and most practical approach for infusing superior genetic material into smallholder swine. Problems of semen quality, semen

processing, and determination and timing of heat are the more common reasons for poor reproduction results and may respond to further R&D investment. Likewise, other aspects of reproduction (low conception rate, long farrowing interval, low litter size, and low reproductive performance in the third quarter of the year) are common concerns that need addressing by the R&D sector.

2.1.7 Socioeconomics and technology transfer

Many of the development-oriented programs that were initiated in the Philippines in recent decades failed because the implementers failed to understand the whole farming system (the farm, the family, the resources, the animals, the external forces, and many other factors). The focus has been mostly on the particular intervention involved, and the subject of the intervention—namely, the animals. In smallholder swine raising, important questions that need to be answered to fully understand the system include: why pigs are being raised, who does what, how much time is allocated, who are the participants in the whole system, and how does the existing system function? Answers to these questions will help determine whether smallholder swine raisers can ever fully participate in market-oriented livestock production, and what policies are needed to foster an environment that encourages and supports this involvement (Devendra 2001).

Although agricultural extension methods vary from place to place within a country and around the world, there are commonalities found in them. All aim to achieve their objectives through a change system, manned by change agents (Faylon and Villar 1996). The means of achieving change can be in the form of conventional technology transfer where particular information is made known to smallholders—for example, through seminars, radio and print media, technical demonstrations, STAR farmers, fora, and word-of-mouth. Where a community-based approach to technology transfer is required, however, participatory R&D processes may be more appropriate and have been found to be very promising.

In relation to the delivery and transfer of information and technology in the Philippines, a number of players are mandated at the national, provincial, regional, and municipal levels. The local government units (LGUs), through the mayors and governors under the Department of Interior and Local Government, are the primary movers of extension work. Agricultural technicians are all under the jurisdiction of the municipal mayors. Thus, all efforts to promote or extend information to the villages from the national and regional levels work through the mayor, especially if

they involve interpersonal or group interaction with the constituents.

Recent information coming from the national agencies like the Bureau of Animal Industry goes to the regional office of the Department of Agriculture and is then passed on to the LGUs. The Regional Department of Agriculture sees to it that the information is important enough to merit support of the LGUs. Apart from the LGUs, the state colleges and universities (SCUs) also have a role in extension but on a more limited level. For example, some SCUs have technicians or assistants who go to the field to promote particular technologies related to swine raising. The feed and veterinary suppliers also help in promoting and transferring technologies—usually in the form of seminars, field visits, demonstrations, and advertising in the media.

Another means of developing the capability of smallholder farmers is through particular programs and projects that sponsor training on specific technologies. The training can be in a form of technology training, or use of the participatory approach to technology transfer, participatory monitoring and evaluation, and so on. Commonly, part of the modality is the use of field visits to other successful farms. However, training on the vital topic of farmer entrepreneurship has been under-emphasised in the past and should be included in all future attempts to develop farmer capability. The recently concluded project on promoting the production of triple-cross pigs among farmers in Quirino was a mix of several different approaches to technology transfer (Villar et al. 2000). The project was able to demonstrate that, despite some problems, triple-cross pig production can be appropriate for smallholder farmers, not just for commercial producers.

2.2 Priorities Between Disciplines

Considering the realities affecting the total livestock industry, both in the domestic and global arena, some transformations in the agricultural sectors are considered inevitable. Despite the safety nets that may be in place, globalisation will immediately take its toll on the less-efficient agricultural groups and sectors. Smallholder pig producers are therefore highly vulnerable and will surely be the first-line casualties with global trading. This is because, in general, they are not organised, have limited resources, and are less efficient. In contrast, the commercial raisers will be more likely to meet the challenge because they are both technically- and resource-ready.

The disciplines of socioeconomics (including policy research and advocacy) and animal health are deemed higher priority in terms of R&D investment than other disciplines like nutrition, reproduction, management and housing which are already well studied. If, as

argued above, the smallholder swine raisers are likely to be disadvantaged under full trade liberalisation, it is likely that they will struggle to survive. Thus, an important policy question for government is whether it can assist smallholder swine raisers either directly or indirectly (e.g. by encouraging the commercial group to help and assume the 'big brother' role). The commercial sector (as 'big brothers') and the smallholder raisers should be able to develop joint production schemes or production and market modules (e.g. modified contract-growing schemes) that would both assure the supply of stock and feed to smallholders and provide them with appropriate marketing outlets for their products. On the other hand, the smallholders would need to be willing to avail themselves of credit and at the same time organise and cooperate among themselves.

The role of the government should rightly also be in policy advocacy on environmental matters, in the provision of support services, and in the consideration of the use of trade tariffs as a safety net. In relation to the environment, recent research has shown that smallholder swine raising has contributed to severe environmental problems due to the improper disposal of animal waste, causing river death and contamination of the watertable. Thus, policy on this issue is urgently needed. Another important policy matter related to R&D that was mentioned earlier is how to ensure the maximum participation of smallholder swine raisers in a market-oriented livestock production system.

In relation to animal health, improved availability of locally produced drugs, vaccines, and detection kits/ techniques are essential R&D outputs that would significantly alleviate the smallholder farmers' problem of diseases—a threat to which their systems are particularly vulnerable. Likewise, an integrated, community-based approach to disease prevention and control may need to be considered as a strategic intervention.

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SWINE INDUSTRY FARMS IN THAILAND

Thavajchai Sakpuaram, Suwicha Kasaemsuwan, and Preeyaphan Udomprasert

Faculty of Veterinary Medicine, Kasetsart University, 50 Thanon Phahon Yothin, Chatuchak, Bangkok 10900, Thailand

1 OVERVIEW OF PIG PRODUCTION IN THAILAND

1.1 Background

Since the early 1950s, pig raising in Thailand has been

steadily changing from smallholder production systems using kitchen scraps to commercial-scale production systems. Early in that period, the Department of Livestock Development (DLD) imported breeders for a breed selection program, seeking breeds that were adapted to Thai environmental conditions. At the same time, they tried to promote the imported breeds to farmers to replace the less productive native breeds, principally the Rad, Hainan, and Kwai breeds (Thongsiri et al. 1963).

During the first fifteen years (1954–69) of the pig farm development program (Yuthawisuth 1961), Yorkshire and Large White pigs were imported from Australia. Their production, however, was disappointing. DLD then imported a wide range of English breeds (Large Whites, Duroc Jerseys, Hampshires, Middle Whites, and Tamworth) for testing and comparison among breeds. Farmers found that the Large White and Duroc breeds best met their needs. Meanwhile, the native breeds were further developed for higher productivity by showing that they could produce better litter sizes and heavier weaners under better systems of management and nutrition (Yuthawisuth and Sukuntasup 1960; Thongsiri et al. 1963).

During the 1960s, the breed selection program continued to compare the production efficiency of the native and imported breeds. The results indicated that the Hampshire, Duroc, Large White, and Landrace breeds had higher productivity than the native breeds (Tintukatisiri et al. 1967). In 1970, it was concluded that, of these, the Large White and Duroc Jersey were the most productive breeds with fair to good consistency (Pannasiri 1970). As a consequence, these breeds were accepted broadly and native breeds gradually declined in popularity.

The next 20 years (1970–89) were a phase of research and development (R&D) of the imported breeds, and of pig nutrition. Efficiency studies of a wider range of imported pure breeds and cross breeds of Landrace, Large White, Duroc, Spot Large White, and Meisan, from Belgium, Canada, Denmark, England, Norway and the United States (Sritakoset et al. 1981; Pralomkajana et al. 1985; Indra 1992) revealed that the sources of the breeds had an influence on the heritability of pig production in Thailand. Dams derived from male Large White crossbred with female Landrace were shown to produce better litter sizes than dams from male Landrace and female Large White (Tumtavisootikul 1995). The main breeds finally adopted for crossbreeding in Thailand were locally adapted lines of European breeds; these are known as Thai Landrace, Thai Large White and Thai Duroc.

Close cooperation between the government and private sectors commenced in 1987. Its objective for the decade 1987–96 was to increase production and export by increasing litter size on the larger farms from an average of 17.6 to 23 weaners per sow per annum, through good farm management and proper nutrition and gilt pool management (Udomprasert et al. 1994, 1996). Pig numbers in Thailand during the period 1987–2000 (Table 1) grew steadily to about 17 million pigs in 1997 then declined, as a result of Thailand's economic crisis of that year, to the current level of about 15–16 million.

1.2 Production Systems

Pig production farms in Thailand can be categorised into four groups:

- *Nursery farms.* These farms import breeders for use as grandparent or great grandparent stock. The sizes of the farms vary from 500 to more than 1000 sows.
- *Farrow-to-finish farms.* These farms vary in size from 500 to more than 1000 sows. Some of the farms own modern slaughterhouses that can further process the output.

- *Contract farms.* These farms produce pigs using weaners from contracting companies. Some of them share in joint ventures with these companies.
 - *Fattening farms.* These farms buy weaners from many sources and raise them until they reach market weight. Farm size can vary between 50 and 1000 or more pigs.
- 90% of the pig farmers in Thailand are smallholders who produce about 20% of the pig products. The remaining 10% of farmers have medium to large farms and produce about 80% of the pig products. A 1995 DLD survey of pig populations in all 9 economic areas of Thailand (Table 2) indicated that more than 3 million pigs per hog cycle were produced on a total of 3,820 farms.

Table 1. Pig numbers in Thailand, 1987–2000.

Year	1st half of year (million pigs)	2nd half of year (million pigs)	Annual total (million pigs)	Consumption (million pigs)
1987	4.209	7.153	11.362	7.64
1988	4.685	7.567	12.252	7.58
1989	4.679	7.960	12.639	8.19
1990	4.762	8.088	12.850	8.60
1991	4.859	8.037	12.896	8.16
1992	4.655	8.666	13.321	8.36
1993	4.984	9.175	14.159	8.57
1994	4.833	9.288	14.121	9.85
1995	4.829	9.328	14.157	9.02
1996	6.128	10.226	16.354	9.46
1997	6.894	10.973	17.867	11.42
1998	6.446	9.492	15.938	10.01
1999	5.926	9.307	15.233	9.01
2000	6.217	9.734	15.951	9.55

Source: National Agricultural Information Centre, Office of Agricultural Economics.

Table 2. Number of pig producers and pigs in 1995, stratified by holding type and herd size.

Holding type	Smallholder	Peri-urban	Semi-commercial	Commercial	Total	Number of pigs per round
Herd size	10–50	51–100	101–200	> 200		
Number of holdings	371	966	653	1,830	3,820	3,144,740
Region 1	38	100	69	128	335	387,742
Region 2	99	245	220	641	1,205	923,182
Region 3	80	100	36	148	364	285,243
Region 4	29	34	29	60	152	44,387
Region 5	12	88	28	72	200	132,386
Region 6	42	79	27	53	201	70,865
Region 7	42	151	158	578	929	1,167,042
Region 8	16	91	47	87	241	67,305
Region 9	13	78	39	63	193	66,588
Trends	Increase	Growth	Rapid growth			

Source: Department of Livestock Development.

During 1996–97, market prices were very favourable and medium and small farms expanded their production capacity substantially. After 1998, however, fattening production by smallholders declined sharply and by the year 2000 survey (Table 3) had virtually ceased. At that time, 83% of the 5,602 fattening farms were of medium size (50–500 pigs) and located in peri-urban areas. The remaining 17% were semi-commercial or commercial, with pig numbers of between 500 and 20,000.

The numbers of breeding farms in 2000, as distinct from fattening farms, are shown in Table 4. In all, the 33,956 breeding farms produced over 2.3m pigs per round. Smallholders dominate the picture but their herd sizes are small (less than 50 pigs).

1.3 Marketing Arrangements

1.3.1 Domestic consumption

Up to 98% of Thai pig production is for domestic consumption. Consumption is affected by changes in the human population and in pork consumption per head. Total consumption increased by 2.9% per annum between 1992 and 1996 but decreased by 6.2% per annum between 1997 and 2000 as a result of the economic crisis (see Table 1). Thai prefer lean meat for their main dish, with the by-products being processed into other popular products that form an important part of Thai cuisine. These include sour preserved pork (Nam), steam minced pork (Mu-yow), chinese sausage, and sweet powder pork (Mu-yong). There is also an

Table 3. Number of pig fattening farms and pigs in Thailand in 2000, stratified by holding type and herd size.

Holding type	Smallholder	Peri-urban	Semi-commercial	Commercial	Total	Number of pigs per round
Herd size	10–50	51–500	501–1000	> 1000		
Total	–	4,643	476	483	5,602	3,227,298
Region 1	–	412	11	23	446	192,867
Region 2	–	914	181	168	1,263	986,694
Region 3	–	300	23	12	335	99,602
Region 4	–	220	3	10	235	77,651
Region 5	–	396	23	9	428	210,741
Region 6	–	440	16	7	463	104,636
Region 7	–	1,276	184	233	1,693	1,392,905
Region 8	–	369	24	16	409	101,161
Region 9	–	314	11	5	330	61,041

Source: Department of Livestock Development, Ministry of Agriculture and Cooperation.

Table 4. Numbers of pig breeding farms and pigs in Thailand in 2000, stratified by holding type and herd size.

Holding type	Small holder	Peri-urban	Semi-commercial	Commercial	Total	Number of pigs per round
Herd size	10–50	51–200	201–500	>500		
Total	30,325	2,330	724	577	33,956	2,317,099
Region 1	2,141	157	32	33	2,363	168,555
Region 2	1,076	407	251	154	1,888	357,880
Region 3	4,455	132	36	22	4,645	281,144
Region 4	3,818	152	19	10	3,999	121,064
Region 5	4,029	191	33	26	4,279	144,403
Region 6	4,241	274	32	9	4,556	128,821
Region 7	4,737	639	260	294	5,930	912,481
Region 8	3,157	212	33	18	3,420	110,364
Region 9	2,671	166	28	11	2,876	92,387

Source: Department of Livestock Development, Ministry of Agriculture and Cooperation.

increasing demand for western style products such as sausage, ham, and bacon. To meet this combined demand, many further processing plants have been established. In 1995, in Bangkok alone, there were 58 further processing plants producing nearly 10,000 tonnes per annum of products (Table 5).

Table 5. Number of pig meat processing plants in Bangkok in 1995, and their production capacity.

Product	Number of processing plants	Production capacity (tonnes per annum)
Total	58	9,715.26
Meat ball	20	2,737.8
Sausage	16	4,651.8
Ham	8	1,007.0
Powder pork, thin-sliced	7	174.6
crispy pork, steam minced pork		
Bacon Barona	5	861.0
Chinese sausage	1	183.0
Steam minced chicken	1	100.0

Source: Department of Industrial Work.

For the whole country, there were over 500 processing plants with a production capacity of 45,000 tonnes per annum (Table 6). Although the plants cannot support all the pig products available, they do play a vital role in reducing unemployment at the rural level. It has been estimated that they employ more than 10,000 people.

1.3.2 Export

Only a small proportion of Thai pig production is currently exported (Table 7), but it is hoped that this will increase substantially in the future in response to support from government, and cooperation with the private sector.

Table 6. Number of pig meat processing plants in Thailand in 1995, and their production capacity.

Product	Number of processing plants	Production capacity (tonnes per annum)
Total	501	44,970
<i>Traditional Thai products</i>		
Sour-preserved pork, cracker	43	10,340
Steam minced pork	44	350
<i>Modern pork products</i>		
Sausage	39	4,970
Ham	11	1,350
Bacon	6	1,210
<i>Cooking-pork products</i>		
Chinese sausage	66	1,120
Powder pork	60	650
Thin-sliced crispy pork	15	360
<i>Further processed meat products^a</i>		
Meat ball	217	24,620

^a Includes pork-meat balls and other meat balls

Source: Department of Industrial Work.

Table 7. Pigs and pig products exported from Thailand during the decade 1990–99.

Year	Breeders		Live pigs		Pig carcasses		Pig products	
	Number	Baht (million)	Number	Baht (million)	Weight (tonnes)	Baht (million)	Weight (tonnes)	Baht (million)
1990	38	0.3	–	–	1,424	71.6	–	–
1991	–	–	–	–	1,328	66.1	–	–
1992	40	0.3	–	–	288	15.5	272	34.2
1993	20	0.1	–	–	318	17.1	667	79.8
1994	45	0.4	220	0.1	205	11.5	666	92.5
1995	–	–	118	0.3	585	40.6	1,823	214.5
1996	561	4.9	71	0.1	142	10.6	1,279	143.3
1997	192	1.1	1,490	3.0	1,082	94.6	1,896	217.8
1998	347	3.2	1,915	2.2	2,184	189.3	2,445	281.6
1999	1,748	5.9	3,952	3.7	703	49.3	2,536	283.8

Source: Department of Customs.

Forecasts by the Swine Production and Process for Exportation Association are for exports to increase during 2002–06 as shown in Table 8. Controlling outbreaks of contagious diseases and improving the quality of the products will be crucial to achieving this growth.

1.3.3 Cost of production and profitability

The pig price at the farm gate is controlled by the principle of supply and demand. Since the margin between production cost and pig price is quite small (at least it has been during the last 2 years), only highly efficient farms remain in business. While large production farms continue to improve their production efficiency, smallholders tend to ignore the efficiency issue. As a result, the number of smallholder farms fattening pigs continues to decrease while the number of large commercial farms increases, and they become even more competitive.

1.4 Industry Services

Government sectors have for many years played a major role in research, development, promotion, and extension for the Thai pig industry, with a particular emphasis on small and medium size farms. (The bigger farms normally have the capacity to manage the health and production of their pigs by themselves.) In recent years, many pharmaceutical companies have also shared in the task of improving pig production systems

in order to produce better pork products for both domestic consumers and for export. Further details of the complete range of services available to the Thai pig industry are given in Table 9.

Table 8. Pork and pork products forecast to be exported from Thailand, 2002–06.

Year	Pork (tonnes)	Pig products (tonnes)
2002	4,889	1,869
2003	5,084	2,243
2004	5,288	2,692
2005	5,499	3,230
2006	5,719	3,876

Source: Swine Production and Process for Exportation Association.

Government sectors are currently following the Policy and Strategy Plans in the National Socio-economic Development Plan No. 8 (1997–2001). For pigs, these are:

Breeding. R&D is continuing with the aim of further reducing the importation of breeders—the research being performed cooperatively by researchers from universities and private companies. The target is to supply 25,000–50,000 breeders to the farmers involved. In addition, DLD has developed the artificial

Table 9. Pig industry services in Thailand.

Holding type	R&D	Extension	Source of stock	Health services	Health products	Feed
Smallholder	Universities	Provincial veterinarians	50% government 50% private	Government veterinary service	Locally and imported medications	Commercial feeds
	DLD, DIT, DCE	Provincial agriculturalists	companies	Private companies		
Peri-urban	Universities	Provincial veterinarians	50% government 50% private	Government veterinary service	Locally and imported medications	Commercial feeds
	DLD, DIT, DCE	Provincial agriculturalists	companies	Private cooperation		
Semi-commercial	Universities	Private Self	AI commercial sector Private	Government veterinary service	Locally and imported medications	Their own factories
	DLD, DIT, DCE			Private cooperation		
	Private companies					
Commercial	Private companies	Provincial veterinarians	Private Self	Private Self Universities	Locally and imported medications	Their own factories
	Universities	Provincial Agriculturalists Private Self				

Note: R&D = research and development; DLD = Department of Livestock Development; DIT = Department of Internal Trade; DCE = Department of Co-operation Extension; AI = artificial insemination.

insemination program with the target of establishing a pig breeding station and increasing the number of breeders by 5,000 per annum.

Disease Control. R&D is being conducted to improve the efficacy of disease control and/or eradication by: expanding vaccine production (target of 25 million doses per annum); implementing strict policies on the import and export of animals, carcasses, and animal products; establishing an Office International des Epizooties (OIE) and Food and Agriculture Organization of the United Nations (FAO) standard laboratory for the international quarantine units; establishing disease-free zones (especially for foot-and-mouth disease and hog cholera); developing a swine information centre for disease surveillance; developing regional diagnostic centres; and establishing a standards laboratory to certify the health of livestock.

Quality standards. Standards are being developed for production systems and pork products. This involves the development and standardisation of farm management systems, the promotion of standard slaughterhouses and processing plants, and the development of standardised systems to control and test pork and other pig products for domestic and foreign markets.

Health, and control of endemic diseases. R&D is being conducted on health problems and infectious diseases that affect pig production and pig products.

Nutrition. R&D is being conducted on ration formulation to reduce the costs of production, and produce products that are safe for human consumption.

Meat science. R&D is being conducted on pork product technologies in order to add value to the products and enhance exports.

Environmental management and biodiversity. R&D is being conducted on waste treatment systems and waste recycling to reduce pollutants from pig farms and slaughterhouses, and on the conservation of native pig breeds.

Economics. The negotiating strength of farmers is being improved by promoting the development of private cooperatives with sound administration and management systems.

Partly as a result of this broad range of R&D activities, the estimates for the industry for the next 5 years (2002–06) suggest that pig production, demand, and exports will continue to grow at a substantial rate (Table 10).

2 R&D PRIORITIES

2.1 Priorities Within Disciplines

2.1.1 Genetics

Feed conversion efficiency and carcass quality are the most desired traits for Thai pig producers, regardless of the size of their operation. With the cost of feed during the grow-finishing period (from 25 to 105 kilograms) comprising 55% of the production cost, improvement in feed conversion efficiency clearly has a highly significant impact on the profitability of the enterprise. Carcass quality is also extremely important and consumers and middlemen are demanding carcasses of steadily increasing quality. This marketing pressure has forced some Thai producers to depend on the illegal substance, β -agonist.

Table 10. Estimates of pig production, demand, and export for the years 2002–06.

Year	Production target (million pigs)	Domestic demand (million pigs)	Export (million pigs)
2002	11.575	11.454	0.121
2003	11.932	11.766	0.166
2004	12.314	12.085	0.229
2005	12.731	12.415	0.316
2006	13.169	12.734	0.435

Source: Department of Livestock Development.

Genetic improvement within Thailand is currently under-emphasised, and genetic stocks are still being imported from Europe and the United States. The fact that genetic costs comprise only 10% of the weaned pig cost or 2% of the finishing pig cost suggests that this situation is likely to continue.

2.1.2 Nutrition

Large commercial operators generally have a good understanding of current knowledge about pig nutrition. Smallholders may not have such a good understanding, but knowledge is readily accessible through university extension services and the customer service departments of pharmaceutical companies. Although smallholders generally use commercial feed, it would be very beneficial if they had a better understanding of feeding management.

There are three particular nutrition-related problems of importance to Thai pig production. Firstly, mycotoxin contamination of feed ingredients is a serious problem and a quick and accurate method to detect mycotoxin is needed. Secondly, the digestibility of protein and amino acids in local feed ingredients such as mungbean and palm kernel meal is not well known, so these

potential ingredients cannot be fully utilised. Thirdly, cassava is not well utilised despite it being widely available. Fermentation of cassava and its by-products in the hot-humid climate in Thailand may offer a way of enhancing its value as a feed for pigs.

2.1.3 Health

Knowledge, vaccines, and therapeutic products are readily available at reasonable prices, but there is a need to improve the national diagnostic capability in terms of scale and efficiency. Moreover, the budget of the University Extension Service limits its effectiveness. This has a greater impact on the smallholder sector than on the commercial sector which can more readily draw on its own resources, or seek assistance from pharmaceutical and feed companies.

2.1.4 Housing and environment

Environmental pollution is probably the most important issue that may eventually force smallholders out of business completely. Large commercial farms are now installing biogas plants for effluent control and water treatment, thereby also saving energy costs and generating income by selling surplus electricity. Smallholders, however, generally find that biogas plants are too expensive to install and maintain. Thus, technology to help smallholders treat effluent and water more economically is urgently needed.

2.1.5 Product development and quality

As mentioned previously, producers—particularly smallholders—need to be much more aware of, and responsive to, the changing needs of customers and consumers. Continuing to be insensitive to market needs in the next 5–10 years will almost certainly force them out of business. In contrast, large commercial operations recognise the changing needs of the consumer and are formulating marketing strategies including the establishment of their own slaughterhouses and meat packing plants. Some are developing their own branded products and advertising them extensively through the mass media. The only foreseeable hope for smallholders is to aggregate into cooperative societies and set up their own slaughterhouses, cooperative stores, and marketing systems.

2.1.6 Reproduction

Knowledge and technology to push the sow herd to its maximum efficiency is already available in Thailand, particularly through the Faculty of Veterinary Medicine, Kasetsart University. This is evidenced by the superb reproductive performance of large commercial herds that draw on this resource. The reproductive performance of small farms, however, is far below potential. While large commercial operations recognise superb reproductive performance as a vital

component of their business and try to adopt any technology available, smallholders generally do not. More manpower, particularly for an expansion of university extension activities, is required to raise their awareness that high reproductive performance is crucial to economic success.

2.1.7 Socioeconomics technology transfer

For smallholders, pig production is a way of life. Smallholders play an important part in the pig production system by distributing their products through village markets but, because of their lack of awareness of the overall market situation, they are also responsible at times for oversupplying the market. With limited financial backing, they are particularly vulnerable to low and unstable prices and can be forced out of the industry by profitability and cash flow problems. This leads in due course to increased migration to the major cities in search of work, and a host of associated social problems.

The policy of the government is to assist smallholders to become more productive—in order to achieve a balance in the local pork market between commercial producers and smallholders, to maintain the need for rural labour, and to support village incomes. Government sectors (the Departments of Livestock Development and Co-operative Extension), universities, and private companies have attempted to supply the required technologies and consultancy services to smallholders. However, this has met with only limited success. Farmers tend to want to make profits in the short term when pork prices are high, but lack long-term strategies for increased productivity and efficiency. They are also short of capital and/or reluctant to invest in improved infrastructure and technology.

2.2 Priorities Between Disciplines

There is general agreement among people working in the Thai pig industry that smallholders will cease to be pig producers in the near future. To prolong the involvement of smallholders in the industry, three actions need to be undertaken.

Nutrition is probably the first priority. R&D assistance is urgently required to assist smallholders to make up their own feeds from local ingredients rather than using the more expensive, purchased commercial feeds. Opportunities might also exist for improving the nutritive value of local ingredients or agricultural by-products.

Secondly, knowledge and technology needs to be extended to smallholders to raise their herds to maximum production efficiency.

Thirdly, knowledge and technology also need to be extended to smallholders to minimise the occurrence and impact of respiratory disease in finishing pigs. This can dramatically reduce feed conversion efficiency, the major determinant of production cost.

Although we consider that the long-term outlook for smallholder pig producers is gloomy, there may be a potential and profitable niche market for them in supplying organically raised pork to a small but growing market of middle-class consumers concerned about drugs and other chemicals used in the commercial and semi-commercial production systems. However, to capture this market would require greatly improved organisation and marketing activities.

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PIG PRODUCTION IN VIETNAM

La Van Kinh*, Le Thanh Hai*, Do Van Quang*, Nguyen Van Duc†

* Department of Animal Nutrition and Feedstuffs, Institute of Agricultural Science of South Vietnam, 121 Nguyen Binh Khiem, District 1, Hochiminh City, Vietnam.

† Animal Genetics and Breeding Department, National Institute of Animal Husbandry, Thuy Phuong, Chem, Tu liem, Hanoi Vietnam.

1 OVERVIEW OF PIG PRODUCTION

1.1 Pig Industry Statistics

Vietnam is dominantly an agricultural country and farmers have been heavily dependent on rice and pig production for a thousand years or more. Pigs play a vital role in the livestock industry, are the major source of animal protein for the population, and are highly competitive with other livestock species. According to the 1999 statistics (Table 1), the pig population of Vietnam was nearly 19 million, approximately 14% being sows and 86% fatteners. The average growth rate in pig numbers during the last ten years was just under 5%.

We consider that there are four broad types of holdings producing pigs. Smallholder systems are dominant and account for approximately 80% of the national pig population (Table 2). Within the smallholder systems, most farmers raise only one or two fattening pigs. The farmers are usually poorly educated and short of capital, so they purchase a few piglets at a time, as required, in the market or from their neighbours.

Most of the pigs raised on smallholder farms are local breeds with high fat and low lean meat percentages, although crossbreeds are more significant in the south.

The larger-scale farms, on the other hand, keep either crosses between local and exotic breeds or exotic pigs. In 2000, only about 15% of the country's pigs showed evidence of infusion of exotic genetic material as evidenced by lean meat percentages above 50%. Adoption of improved pig breeds is quite slow.

Table 1. Livestock numbers in Vietnam, 1990–99.

Livestock type	Number (million) 1999	Average annual change (%)		
		1990–95	1995–99	1990–99
Pigs	18.89	5.97	3.74	4.98
Poultry	179.32	5.84	6.01	5.91
– Chicken	135.76	6.28	5.90	6.11
– Others	43.56	5.28	6.42	5.79
Beef	7.02	2.03	1.55	1.82
– Cattle	4.06	3.16	2.80	3.00
– Buffaloes	2.96	0.76	–0.06	0.39

Source: Data obtained by the General Statistical Organisation (2001).

A recent survey found that, while 75% of pig producers had one or more crossbred pigs in the herd, only 20% had one or more exotic pigs, and only 18% had exotic pig adoption rates of 100%.

Table 2. Pig production holdings in Vietnam, classified by scale of production.

Holding type	Herd size	Trends	% of national herd	Number of pigs (million)	Breeds
Smallholder or backyard	1–10 pigs	Modest increase	80%	15.1	North: mostly local South: mostly cross with exotic
Small–medium	5–20 sows, or 30–100 fattening	Significant growth	10%	1.88	Cross and exotic
Medium	20–500 sows, or 100–4000 fattening	Rapid growth	5%	0.94	Exotic
Large	>500 sows, or >4000 fattening	Modest increase	5%	0.94	Exotic

The larger farms may keep either a mixture of sows and fattening pigs or specialise in fattening pigs only. Their hygiene and veterinary practices are of a higher standard than other holding types, and their labour costs are lower. Medium-and large-scale farmers are generally willing to apply new technologies and practise better overall management, with the result that they have substantially higher incomes than smallholders.

Carcass characteristics are important traits in assessing the quality of the breeding stock in different geographical zones (Table 3). In the South-East area, pigs are of good quality as shown by the high slaughter weights, long carcasses, good dressing-out percentages, and low backfat thickness. The area therefore produces good quality pig products, and pig production is intensively market-oriented. By contrast, pig breeds in the Mekong River Delta are mainly crosses between local (Thuoc Nhieu, Ba Xuyen) and exotic breeds. Farmers in this region keep pigs as a form of savings—so the length of the fattening periods is prolonged, and the resultant slaughter weights and backfat thickness are high. In the Red River Delta, Central North, and Central South Coast, pigs are mainly crossbreds (50–75% exotic blood) between Mong Cai breed and exotic breeds (Yorkshire and Landrace) and carcass quality characteristics are intermediate between the South-East and Mekong River production zones.

Table 3. Some carcass traits of pigs in some agro-ecological zones.

Zone	No.	Slaughter weight (kg)	Dressing -out (%)	Carcass length (cm)	Backfat (mm)
Red River Delta	70	82.1	69.8	70.0	32.3
North-Central Coast	33	83.3	70.5	68.5	36.3
Middle-Coast Area	78	79.1	72.4	70.6	33.4
South-East Area	79	86.8	71.7	79.9	21.4
Mekong River Delta	369	94.6	73.7	68.1	38.0

Source: Le Thanh Hai et al. 1998.

1.2 Market Arrangements

Almost all pig producers in Vietnam sell pigs at their farms as live animals. Most of the smallholder farmers sell pigs through middlemen, while the semi-commercial and commercial farms use a mixture of middlemen and marketing directly to slaughterhouses (Table 4). The price of pigs is heavily influenced by estimated or actual carcass quality at the slaughterhouse. Prices for over-fat carcasses are heavily discounted*

A survey conducted in 1999 by the Institute of Agricultural Science (IAS) and the Ministry of Agriculture and Rural Development (MARD) found that the price of pigs was characterised by strong fluctuations but lacked a clear trend. Prices were high, however, and quality generally low, so there is probably little scope to develop a major export market in pig meat at this time. Consumers generally prefer to eat fresh meat, so the solution to the rising demand for pig meat noted above is to increase local production rather than to import chilled or frozen meat. Factors limiting further expansion of pig meat consumption are the low incomes and low living standards experienced by much of the rural population, and the ready availability of other sources of animal protein (fish and marine products).

Table 4. Summary of marketing arrangements for pigs and pig products in Vietnam.

Holding type	Marketing system	Market sector	Market signals
Smallholder or backyard	Live animal	Local, some linkage with city	Middleman
Small-medium	Live animal	Local, some linkage with city	Slaughterhouse
Medium	Carcass payment	City	Slaughterhouse
Large	Carcass payment	City	Slaughterhouse

1.3 Industry Services

1.3.1 Research

In Vietnam, there are two different systems for agriculture—research and teaching. The role of the research institutes is primarily research but with some teaching (both high-level students and farmers). There are three institutions in this category—the National Animal Husbandry Institute (NIAH), the Institute of Agricultural Sciences of South Vietnam (IAS), and the Institute of Veterinary Medicine. The role of the universities, on the other hand, is primarily teaching but

with some research and extension. There are five agriculture-related universities—Hanoi Agricultural University, Thai Nguyen Agricultural College, Hue Agricultural College, Thu Duc Agricultural University, and Can Tho University.

In general, expenditure on agricultural research in Vietnam is very low. According to the official statistics, the funds for agricultural research in 1998 and 1999 were about \$US5.3m per annum—about 1.7% of the total budget for agriculture and about 0.08% of the agricultural gross domestic product (GDP). During that time, the investment for agricultural research in neighbouring countries as a percentage of agricultural GDP was as follows: China, 6%; Thailand, 10%; other Asian countries, 3%. In animal husbandry, the state investment for Animal Research Institutes accounted for about 14% of the total funds for agricultural research, of which 50–60% were used for the salaries of research staff. In 1999, the total government funding for basic and applied research in the animal and veterinary fields was about \$US0.8m—less than 1% of agricultural GDP.

1.3.2 Technology transfer

Extension is the responsibility of the Extension Department of MARD and the provincial and district level Extension Services. The Department for Animal Health and Veterinary Medicine within MARD provides animal health services and veterinary medicines. There are also private veterinary service providers at provincial, district, and village levels (see Table 5).

In addition to the above public sector services, government policy is to stimulate the participation of all sectors in the provision of animal health and genetic improvement services, and the manufacture and

distribution of feed. Thus, during the period 1989–2000, numerous feed mills were established. Most are privately owned and produce large quantities of formulated rations for both pigs and poultry.

In general, state funds expended on animal husbandry extension are very limited. During the period 1996–2000, the budget for agricultural extension in animal husbandry was between 17 and 22% of the total budget for agricultural extension. As a result of this, extension of information to farmers, particularly those living in remote areas, was seriously affected. Based on the survey of the International Food Policy Research Institute (IFPRI)–MARD (1999), the quality of the extension service was rated as only poor–adequate, not good. The average number of visits of extension officers to farms was 0.32 times per annum for smallholder farms and 1.0 times for larger farms. The fact that extension officers receive some payment for visits to the larger farms is perhaps significant in this regard.

1.4 Industry Significance

According to government statistics, pig meat accounts for about 77% of Vietnamese meat consumption, poultry about 15% and beef about 8%. The pig industry is the major source of income for many farmers and it is estimated that smallholder pig producers derive about 75% of their total income from pigs, medium farms 90% and large farms 95%. Pig raising also creates considerable employment in the countryside, especially for women. Moreover, it is an excellent way of adding value to, and disposing of, other agricultural by-products by using them as feed components. Thus, pig production plays an extremely important role in raising living standards and contributing to the rural and national economy.

Table 5. Services for the pig industry in Vietnam.

Holding type	R&D	Extension	Source of stock	Health services	Health products	Feed
Smallholder or backyard	Research institute and university	Provincial agricultural services	93% local, 5% govt, AI	Local	Natural products, locally produced medicine	Mainly crop by-products 2.5–16% commercial feed
Small–medium	Research institute and university	Provincial agricultural services	74% local, 16% govt, AI	Private, self	Local medicines, imported medications	Purchase by-products for making feed and 5–10% commercial feed
Medium		Private, self	Private, self			
Large	Self and as above					

Note: R&D = research and development; govt = government; AI = artificial insemination.

2 RESEARCH PRIORITIES

2.1 Priorities Within Disciplines

2.1.1 Genetics

The government's policy on livestock development is principally to improve the genetic quality of breeding animals in order to lift overall productivity. This is to be achieved by crossbreeding with high-quality exotic breeds, and by the use of overseas technology. Specific objectives for pigs are to increase live-weight production per capita from the 1999 level of 2.2 kg to 3.5 kg, and to increase the percentage of the total pig population with more than 50% lean meat from the current level of 15%, to 25% by 2005, and 30% by 2010. These objectives are to be achieved through improvements in average daily gain (ADG) and lean meat percentage in the carcass—characteristics that have medium to high heritability.

Accordingly, MARD's current research investment priorities for genetics are to:

- develop large-scale commercial/industrial pig production in concentrated areas (the Red River and Mekong deltas, and the South-East zones);
- establish the pyramid breeding system and do the selection in nucleus herds with a high intensity of selection; and
- preserve and exploit animal genetic resources through crossbreeding programs appropriate to each agro-ecological zone.

These priorities will be accomplished by:

- setting up breeding systems based on good breeding management of great grandparent, grandparent and parent stock in order to produce commercial pigs of high quality;
- building up the nuclear herd of pure breeds (Yorkshire and Landrace for the female lines and

Duroc and Pietrant for the male lines for exotic breeds, and Mong Cai as the female line for local breeds), selecting then multiplying them for production of pure breeds of grandparent stock and crossbreeds of parent stock;

- recovering and conserving local/native pig breeds;
- using crossbreeding and artificial insemination (AI) to rapidly transfer improved genetics to practical pig production; and
- applying biotechnology, as appropriate, to the selection and multiplication of breeding herds.

2.1.2 Nutrition

A survey by the IAS of smallholder farms in six provinces showed that the protein concentration of pig diets was often 20–30% lower than feeding standards. Reasons for this were lack of funds, transport difficulties, poor availability of protein concentrates, and an overall lack of knowledge of pig nutrition and feeding by farmers. 98% of smallholder farmers used local feedstuffs, especially rice bran (98% of farmers) and broken rice (88%), usually mixed with seafood or protein concentrate. However, the proportion of concentrates/complete feed in the ration was comparatively low, varying from 5–15% (see Table 6). In contrast to smallholders, most of the large- and medium-scale farms use high-quality products from state feed mills or joint venture/foreign capital companies.

Smallholder farmers used a high proportion of rice bran, corn, and cassava and only a low proportion of cheap complete feed in pig feeds when these ingredients were relatively cheap around harvesting time. Later in the year, however, when they were expensive, they used only cheap complete feeds costing only 15–20% more than rice bran. A small proportion of farmers used neither, and based their pig feeds on corn or cassava.

Table 6. Pig feeding systems in Vietnam.

Scale of production	100% complete feed	Concentrate + ingredient	Complete feed + ingredient	Ingredient + by-products
Large scale (>500 sows, >4000 fattening pigs)	+++			
Medium scale (20–500 sows, 100–4000 fattening pigs)	+++	++		
Small–medium scale (5–20 sows, 30–100 fattening pigs)	+++	+++		
Backyard (1–10 pigs)	0/+	+	++	+++

Key to symbols: 0 = not used; + = less popular; ++ = popular; +++ = very popular

There was also a tendency for farmers to supplement a rice bran diet with just one of these three ingredients.

Use of corn, seafood, and vegetables was regionally variable; many Ho Chi Minh zone and Central region

Pig production in Vietnam

farmers used all three. Beside the major ingredients, some feed additives such as vitamin–mineral premix, amino acids, and enzymes were popular.

Although large quantities of local feed ingredients are used, importation of feeds and feed ingredients is increasing rapidly (Table 7).

We believe that the priorities for R&D on pig nutrition in Vietnam are to:

- improve pig nutrition by appropriate formulation of diets and on-site education of smallholder farmers; and
- reduce the cost of feeds by utilising local feed sources more efficiently, thereby reducing dependence on importation.

2.1.3 Health

Government actions and regulations on animal health and disease management have benefited the smallholder sector. They include free vaccination programs for some dangerous diseases, controls on

hygiene on farms and in slaughterhouses, controls on the quality of animal feeds, and training of farmers in animal health matters. The government has also issued regulations on the import and export of veterinary drugs. In practice, however, poor control and bad management at various levels of administration mean that the effectiveness of the above controls and regulations is very variable, and disease is still a major factor affecting pig production. The major diseases and conditions affecting the smallholder sector are: diarrhoea, hog cholera, salmonella, pasteurella, and foot-and-mouth disease. Current drugs and vaccines for disease prevention or treatment are reasonably accessible by farmers and are widely used. Vaccine quality at the time of injection, however, is very variable and disease outbreaks have occurred. Estimates of the costs of livestock mortality are shown in Table 8.

We believe that the priority for R&D on pig health in Vietnam is to improve the efficiency of vaccines by improving their transport and storage, and the timing and methods of vaccination.

Table 7. Feed supplied and imported.

Feedstuff	Total dry matter available ('000 t)	Used for pig feed (%)	Proportion of ration (%)	Imported ('000 t)
Paddy rice	26,400	17	73.5	210
Maize	1,413	65	15.0	200
Soybean	132	5	1.1	500
Groundnut	339	2	1.1	100
Sweet potato	393	6	3.9	–
Cassava	499	4	3.9	–
Fishmeal	88	1	1.4	35
Total	29,264	100	100	1,045

Table 8. National cost of animal mortality.

Livestock species	Average direct mortality cost (% total animal sales)	National mortality cost	
		(VND million)	(\$US million)
Pigs	2.4	325,425	23.2
Chickens	10.2	408,970	29.2
Ducks	5.7	48,055	3.4
Cattle	1.8	15,505	1.1
Buffalo	3.0	10,845	0.8
Total		808,000	57.7

Source: International Food Policy Research Institute – Ministry of Agriculture and Rural Development (IFPRI–MARD) Survey 1999.

2.1.4 *Housing and environment*

Smallholder farmers generally have a poor understanding of the importance of housing on herd productivity, and provide pigs with a very low standard of housing. Education and training in the design of appropriate housing (including cages, flats, flooring, and cooling systems) and the use of local materials is urgently required.

Management of pig waste is becoming a very serious environmental issue affecting soil and water resources and the health of both animals and humans. Most smallholder farmers lack facilities for handling pig waste, although some sell dry manure for use as fertiliser in gardens. Only a few of the medium- and large-scale pig producers have biogas systems or tanks for collection and treatment of effluent. The rapidly accelerating trend towards larger-scale production, particularly in peri-urban areas, is exacerbating the problem. National policies, regulations, and programs relating to this serious environment issue are being developed. For example, the government has issued regulations on water and air standards that all farms have to follow, is encouraging farmers to improve their waste management, and is providing training for them on methods of waste management that are appropriate for their production systems.

We believe that the highest priorities for R&D on housing and environment in Vietnam are to support the thrust of the government's policies and programs by:

- developing alternative methods of waste management that are appropriate to conditions on smallholder farms, using locally available materials; and
- developing and providing improved training for farmers, and improved housing and environmentally friendly systems for disposal of pig waste.

2.1.5 *Product development and quality*

Pigs weighing 80–100 kg and with higher lean meat percentages in the carcass are readily accepted at abattoirs and sell for high prices. Pigs that do not meet these criteria bring lower prices or are un-saleable. The government's policies and programs to improve: the genetic quality of pigs in the smallholder sector; pig nutrition and the processing and storing of foodstuffs; and pig health, housing, and waste management; should, in time, all improve product quality. The priorities in product development and quality, therefore, are for further R&D that supports these policies and programs.

2.1.6 *Reproduction*

Reproductive performance in smallholder herds is often poor because of poor farmer understanding of selection and feeding of gilts, poor management of boars, problems with heat detection, and poor timing of insemination. Where AI is used, especially where the AI service is privately owned, there is often a lack of control of boar quality, and poor transport and storage of semen. In view of these problems, we believe that the highest priorities for R&D on reproduction in Vietnam are to:

- develop the government AI system in each province so that every smallholder has access to the service;
- strengthen the quality control of animals used for breeding, e.g. by establishing boar and sow record systems; and
- train smallholder farmers how to improve reproductive efficiency.

2.1.7 *Socioeconomics and technology transfer*

National policy is focused on improving the efficiency of production of smallholder farmers, since they account for about 80% of pig production. It aims to stimulate all sectors of the economy to participate in providing services to smallholders, and to improve the effectiveness of linkages between the research and extension agencies.

Information to bring about such changes used to be provided only by government extension workers at district and village level. With the recent development of free market approaches, however, many business agencies have been established to sell products and offer various services to the farmer. Both the district-level extension workers and the business agencies can and do provide ongoing training in particular fields of specialisation. In recent years, there have also been a number of attempts to use non-traditional methods of technology transfer of R&D results, including the provision of practical on-farm training for farmers in remote areas, and direct transfer of breeding animals from research centres to the farmer or to an AI unit of a nearby district extension station.

2.2 **Priorities Between the Disciplines**

From the above overview of research in the various disciplines, we think that the highest investment priorities for R&D should be given to the following topics, as these are most likely to provide the greatest benefit to smallholder farmers:

- nutrition research focusing on the use of local foodstuffs and new feed ingredients, on feed storage and processing, and feeding methods, and on new approaches to education, and on-farm demonstration and training in pig nutrition;

- the management of pig wastes using appropriate technology for each production system; and
- genetic research focusing on selection and establishment of nuclear herds of pure breeds so that the advantages of superior genetic material can flow rapidly through to the smallholder system.

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