

ECONOMIC THEORY, APPLICATIONS AND ISSUES

Working Paper No. 63

**The Competitiveness of Small Household Pig
Producers in Vietnam: Significant Research
and Policy Findings from an ACIAR-sponsored
Study and their Limitations**

by

Clem Tisdell

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* The draft of a contribution to the ACIAR-sponsored research project "Improving the Competitiveness of Pig Producers in an Adjusting Vietnam Market", Project number: LPS/2005/063, managed by ILRI. Note that this review does not cover all the findings from this research project.

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**The Competitiveness of Small Household Pig Producers in Vietnam:
Significant Research and Policy Findings from an
ACIAR-sponsored Study.**

ABSTRACT

The preamble to this paper highlights some of the major policy issues facing Vietnam as far as its supply of pork is concerned, in particular, the problem of its demand for pork rising at a faster rate than its supply. Some relevant background to this research project is provided by outlining selected features of Vietnam's pig industry. Then the main findings (in the view of the author) from this ACIAR-funded research are presented. These results include (1) natural protection given to Vietnam's pig producers from imports as a result of the nature of the preferences of Vietnamese consumers; (2) the importance of household labour, especially that provided by females, in the husbandry of pigs held by households; (3) the existence, or otherwise, of scale economies as a function of the number of pigs held by households and the economic efficiency of small producers, (4) the import dependence for pig food of Vietnam's pig industry and the way in which it varies with the number of pigs kept by households; (5) specialization in pig production, (6) regional differences in the economics of pig production; (7) economic discrimination in the supply of inputs to household producers of pigs and in their sale of pigs; (8) the size of pig-holdings and the use of professional services, such as veterinary services and extension services; and (9) findings about miscellaneous matters, such as the genetic composition of the pig stock. Scope for future research in relation to these aspects is also highlighted, and the need is raised for considering the economics of increasing quality standards and certifying the quality of pork. The economics of increasing the scale of pig producing units is given particular attention. Vietnam's policy options for improving the balance between its demand for pork and its supply are considered and the important role that household (small producers) have and can play in this regard are highlighted.

JEL Classification: Q1

Keywords: economic efficiency in pig production, economies of scale in pig production, gender and rural employment, household agricultural production, livestock development policy, natural trade protection, specialization in agricultural products, Vietnam's pig industry.

1. Preamble

Small household pig producers are the dominant suppliers of pork in Vietnam and currently account for about 90% of its pork supply and about the same share of its pig stock (Tisdell, 2009b). Although domestic pork supplies have more than doubled since Vietnam began its market reforms, this growing supply has been outpaced by the rising demand for pork in Vietnam. This has resulted in an escalation in the real price of pork because (as discovered in this ACIAR-sponsored research) Vietnamese have a very strong (and enduring) preference for fresh (warm) pork and therefore, avoid chilled, frozen and processed pork (CAP and ILRI, July 2010b; Lapar and Toan, 2010). Hence, they tend to avoid imported pork because of necessity, it must be chilled, frozen or be used in processed form. Consequently, any increased demand for pork in Vietnam must primarily be filled by domestic pig producers.

The strong preference of Vietnamese for fresh pork also seems to have many other consequences. It results in pigs being slaughtered in Vietnam close to the places where they are consumed rather than far away. Otherwise, the meat would need to be chilled or frozen for transport. Furthermore, Vietnamese are reluctant to buy pork in supermarkets and mostly buy it **frequently** from traditional market outlets which have fresher meat. The penchant of the Vietnamese for really fresh meat has many implications for the development of Vietnam's pig industry. These include a high degree of natural protection for its domestic pig industry and a concentration of pig-rearing close to its major cities, that is in peri-urban areas.

The escalation in the real price of pork (and other livestock products) is of concern to the Vietnamese government because of its magnitude and the importance of pork in the diet of the Vietnamese. The rapid rise in the price of pork is a reflection of the growing demand for pork in Vietnam as a result of its economic growth (rising levels of per capita income, a growing population and greater urbanization) and the inability of domestic pork production to increase at a comparable rate.

As a result, important policy issues have risen in relation to Vietnam's pig industry. For example, how can Vietnam further increase its domestic supply of pork in an economically efficient way? Is the main supply constraint in this supply 'shortage' the lack of competitiveness and lack of efficiency of small household pig producers, as suggested by some policy-makers? Therefore, should their competitiveness be improved or should government policy favour production by large commercial producers of pigs as is recommended in Vietnam's livestock development strategy (Ministry of Agriculture and Rural Development, 2010)? What particular measures should be adopted to further increase Vietnam's level of pork production? These issues have arisen mainly because Vietnam has been very successful in increasing and maintaining its economic growth since the start of its economic reforms – they are problems arising from Vietnam's economic success.

It will be argued in this paper that in its effort to boost its pork supply, Vietnam should not neglect the needs of household producers of pigs. This is because they supply the major proportion of Vietnam's pork and although their relative importance as pork suppliers is declining, they are likely to be the major suppliers of pork in Vietnam for some time to come. This hypothesis is reinforced by quantitative conclusions from the model of N. Minot and K. Rich. They conclude that the modern pig sector is likely to remain small over the next decade and beyond (Minot, 2010). Furthermore, at this stage of Vietnam's economic development, most household producers are cost-effective suppliers of pork. Furthermore, because pig food is the major cost incurred in raising pigs, ways should be explored to keep its costs down, increase its domestic supply and ensure that it is efficiently used. The high cost of pig food in Vietnam seems to be a significant barrier to the expansion of Vietnam's pork production.

2. Introduction

Interesting results have emerged from the ACIAR-sponsored project "Improving Competitiveness of pig producing in an Adjusting Vietnam Market," particularly as far as the economic status of holders of small stocks of pigs is concerned. Small pigholders account for the majority of Vietnam's stock of pigs. It is households (as

distinct from registered pig farms) that account for virtually all of Vietnam's small holdings of pigs. In 2006, for example, households having 5 pigs or less accounted for 83.4% of pig stocks held by Vietnamese households and households accounted for about 90% of pig stocks and registered farms the remainder (Tisdell, 2009b). This suggests that in 2006 household pig producers supplied about 90% of Vietnam's production of pork. It may have fallen since then to around about 85%. Thus households possessing small stocks of pigs continue to dominate Vietnam's pig industry, even though their relative share of total pig production is declining slowly (Tisdell, 2010a).

In the last few decades, economic mechanisms used to direct and allocate resource-use in Vietnam have undergone considerable change as a result of this increased adoption of market mechanisms and the greater openness of Vietnam to international trade. A programme, *Doi Moi* (Renovation), for the reform of Vietnam's economic system so as to make it more market-oriented was adopted by the Vietnamese Government in 1986. According to Son et al. (2006), "this was followed by a series of reforms that effectively ended the system of resource allocation by central planning by 1989. Reforms since 1990 have therefore, been aimed at adjusting the institutional and regulatory framework in order to ensure that markets can function well."

Pig producers have had to adjust to this economic transition which potentially could have reduced the relative competitiveness of small pigholders and the comparative international competitiveness of Vietnam's pork industry. Given these changes, how have smallholders of pigs managed to remain competitive and how generally has Vietnam's pig industry been able to cope? This study (which used sample surveys to examine the retail market for pork in Vietnam and to obtain information about the production situation facing household suppliers of pigs) throws considerable light on the above question and the economic status of small pigholders.

In discussing this matter, I'll first make a few observations on trends in pig production in Vietnam, outline factors that provide natural protection to Vietnam's pig producers (as discovered in this research by a survey of a sample of Vietnam's consumers) and highlight important results that have emerged from the sample survey of household pig producers in Vietnam. Differences in the nature of employment and in the use of local and home-produced pig food were observed between small holders and large

holders of pigs. Regional differences in specialization in stages of pig production were also observed. Comments will be made on these and other findings about the nature of pig production and subjects that need further research will be highlighted.

Box 1. Data sources and methods

The results reported in this part of the research output for the ACIAR-funded research project “Improving the Competitiveness of Pig Producers in an Adjusting Vietnam Market” are based on research reports prepared by CAP and ILRI in connection with this project, published data of the General Statistical Office of Vietnam, and other published materials (including those of the author) and analysis, including the use of concepts developed in economics.

3. Trends in Vietnam’s Pig Production and Consumption of Pork

In the period for which I have statistics (1996-2006), Vietnam’s volume of pork production showed a steady upward trend with a slight tapering off in growth in 2006. During this time the volume of Vietnam’s pork production **more than doubled** – it rose by 132% (Tisdell, 2009b). In this period, almost all of Vietnam’s supply of pork came from domestic producers and per capita consumption of pork in Vietnam almost doubled. How was this increase made possible? Both increased pig stocks and greater yields played a role, but a role that varied during this period. Before 2004, increases in pig numbers (with some increase in yields) explains the trend but from 2004 onwards increased yield is the dominant contributor to the expanded production of pork in Vietnam (Tisdell, 2009b). Vietnam’s pig population peaked at 29.4 million head in 2005 and in the period 2006-2008, remained fairly stationary at levels slightly below 27 million head (General Statistical Office of Vietnam, 2009, p.289). Hence, increasing pork production in Vietnam has become increasingly dependent on raising yields.

Given their relative importance, small producers must have contributed to a major part of the upward trend in Vietnam’s pork production. It can be inferred that this increased production required a substantial rise in the total amount of pig food utilised in Vietnam. Presumably, this was reflected in rising imports of grain and other food used for pigs as well as greater domestic inputs of pig food. This aspect has not yet been researched. The greater openness of Vietnam’s economy would have given more scope for its import of raw materials required for the production of pig food, and the

increased presence of multinational companies (integrators) in Vietnam involved in the milling and distribution of animal food would have facilitated this. It is likely that in the absence of greater import of grains required to produce pig food, the expansion in Vietnam's pork supply would have been restricted. A corollary is that Vietnam's pork production has become increasingly dependent on imports needed to supply pig food. These aspects are worthy of study, particularly constraints on increasing supply of domestically produced pig food. This pattern of Vietnam's development is not unlike that of China which has substantially increased its import of coarse grains in order to increase its supply of food for livestock (Huang et al., 2006).

4. Vietnam's Pork Supply is Growing more Slowly than Demand and Pork Prices are Escalating

Although Vietnam has more than doubled its pork supply since 1995, its rate of increase has slowed since 2005. The onset of this decline can be seen in Fig. 1 of Tisdell (Tisdell, 2009b). It is further evidenced by a decline in the rate of growth of index of the gross output of meat from domestic animals (excluding poultry) since 2005. The major component of this index is pork but it also includes beef and carabeef. The yearly rate of change in this index is shown in Table 1. It can be seen from this table that between 1995 and 2005 the annual growth rate of production of meat from domestic livestock tended to rise. It peaked in 2005, and since then, this growth rate has declined.

Table 1: The annual growth rate of the gross output of meat from domestic animals (pork, beef and carabeef mainly) at constant 1994 prices for Vietnam, 1995-2008.

| Year | %Change | Year | %Change |
|-------------|----------------|---------------|----------------|
| 1995 | 4.1 | 2002 | 8.3 |
| 1996 | 5.1 | 2003 | 8.3 |
| 1997 | 6.7 | 2004 | 11.9 |
| 1998 | 5.5 | 2005 (Max) | 15.1 |
| 1999 | 6.8 | 2006 | 8.5 |
| 2000 | 6.6 | 2007 | 3.7 |
| 2001 | 3.2 | 2008 (Prelim) | 4.1 |

Source: Based on Table 94, p.228, General Statistics Office of Vietnam (2009).

Despite the continual growth since 1995 in the volume of Vietnam's meat production (consisting mainly of pork), meat prices have increased at a rate that has escalated in recent years. This is evident from Table 2 which shows the values of Vietnam's producer's index of meat from domestic animals, excluding poultry. Given the rising value of this index, it can be concluded that the demand for meat in Vietnam has risen at a faster rate than its supply, and it can be inferred that this is so for pork. These trends are also highlighted by Figures 1 and 2 in Tisdell (2010a) which summarizes the broad trends.

Table 2: Vietnam’s producer’s price index for meat from domestic animals (excluding poultry) for selected years in the period 1995-2008 based on 1995 prices.

| Year | Index Value | % Rise from 1995 |
|-------------|--------------------|-------------------------|
| 1995 | 100 | - |
| 2000 | 110.5 | 10.5 |
| 2004 | 141.2 | 41.2 |
| 2005 | 145.6 | 45.2 |
| 2006 | 140.6 | 40.6 |
| 2007 | 161.1 | 61.1 |
| 2008 | 274.5 | 174.5 |

Source: Based on Table 218, p. 471, General Statistics Office of Vietnam (2009)

Note that producer’s price indices measure the real prices which producers receive for their products, taxes and levies being excluded. Between 1995 and 2008, the rise in real price of meat from domestic animals was greater than that for all other categories of agricultural products (see General Statistics Office of Vietnam, 2009, Table 218). Between 2000 and 2008, it increased at a much faster rate than Vietnam’s average consumer price index (compare Tables 218 and 216 of General Statistics Office of Vietnam, 2009).

What is the reason for this? Apart from the rapidly growing demand for meat in Vietnam due to its economic growth (mentioned above), the strong preference of Vietnamese households for fresh meat is a major factor. As a result, virtually all increased demand for meat has to be met from domestic supplies. This provides considerable natural market protection for Vietnam’s domestic pig industry.

5. Natural Market Protection of Vietnam’s Pig Producers Due to the Strong Preference of Vietnamese Households for Fresh Pork

Surveys of samples of representative consumers in Hanoi and Ho Chi Minh City (and rural areas) as part of this study revealed that Vietnamese consumers have a strong

preference for fresh pork which they prefer to buy from traditional market outlets (Lapar and Toan, 2010; Lapar *et al.*, 2009; Tisdell *et al.*, 2009). This helps to protect the Vietnamese pig industry from imports of pork which by necessity for preservation purposes are either chilled, frozen or processed. These types of meat are usually retailed in supermarkets or similar food outlets. These food habits of the Vietnamese have provided a significant level of protection to the local pig industry because chilled, frozen and processed pork from North America costs less than Vietnamese pork. This natural protection is important for the survival of Vietnam's pig industry because according to Son *et al.* (2006), it is internationally uncompetitive in view of its comparatively high cost of production.

The lack of development of supermarkets in Vietnam (Maruyama and Trung, 2007) has also partly been favourable to the survival of small holders of pigs. Supermarkets tend to favour a standardised product and want easy traceability of their product. This may comparatively favour larger pig producers. Although supermarkets would not deal directly with individual pig producers, middlemen will and would reflect the demand of supermarkets if they want to obtain sales to these.

It is worth considering some of the results from the CAP-ILRI survey (CAP and ILRI, July 2010b) of urban and rural households in Vietnam in relation to their preferences for different kinds of meat and their expenditure on these. These results have important implications for the development of Vietnam's pig industry and for the roles of household pig producers and larger commercial producers in it. Several results from the CAP-ILRI survey of households and their surveys in Vietnam are worth highlighting because of their important implications for the way in which Vietnam's pork market function.

The CAP-ILRI surveys of a sample of urban households in Hanoi and Ho Chi Minh City (HCMC) and a sample of rural households reveals that pork is the preferred type of meat for urban households, and one of the two most preferred types for rural households (see Table 4). This preference is persistent. There is evidence from these surveys that it existed at least a decade ago. Furthermore, on average, pork accounts for the largest proportion of expenditure on meat by households – more than a third in urban and rural areas (see Table 3). One important finding of the CAP-ILRI meat

consumer survey is that Vietnamese consumers have a strong preference for fresh pork, and an aversion to chilled, frozen and processed pork. As a result:

- Vietnamese consumers do not like to buy pork from supermarkets and prefer to buy it from traditional market outlets.
- They avoid imported pork because it is of necessity, chilled, frozen or used in processed pork products. Thus, most consumers demand domestic pork.
- They buy pork frequently and do not store it for long.
- These tastes probably result in pigs being slaughtered close to retail markets and the limited transport of pork from rural areas to large cities.

Table 3: Preferences of samples of Vietnamese households for pork in comparison to other types of meat (including fish and seafood)

| Type of Meat | Urban Households | | Rural Households | |
|--------------|---|-------|------------------|-------|
| | Rank | Score | Rank | Score |
| Pork | 1 | 8.83 | 2 | 8.04 |
| Chicken | 2 | 8.05 | 1 | 8.16 |
| Beef | 3 | 7.75 | 3 | 7.90 |
| Fish | 4 | 7.44 | 4 | 5.51 |
| Others | Except for seafood, have a much lower score | | | |

Source: CAP-ILRI consumer survey data

Note: The average preference score is out of 10.

Table 4: Percentage of household meat budget spent on different types of meat and rank

| Type of Meat` | Urban Households | | Rural Households | |
|-------------------|------------------|------|------------------|------|
| | Rank | % | Rank | % |
| Pork | 1 | 34.1 | 1 | 38.2 |
| Beef and Carabeef | 2 | 28.0 | 4 | 7.2 |
| Fish and Seafood | 3 | 20.0 | 3 | 27.2 |
| Poultry | 4 | 17.7 | 2 | 27.3 |
| TOTAL | | 100 | | 100 |

Source: CAP-ILRI consumer survey data

The above results imply that nearly all of Vietnam’s increased demand for pork has to be satisfied by its own producers of pork, and that imports of pork cannot be used to any significant extent to moderate price rises in its pork. Given the strong and growing demand of Vietnamese for pork, this is a recipe for escalating pork prices if the growth in Vietnam’s supply lags behind its rising demand for pork. Furthermore, because expenditure on pork is such a large component of expenditure by Vietnamese households on meat, the rising price of pork is of political concern.

Additionally, the above findings indicate that the slaughtering of pigs close to its end-markets is necessary if consumers are to be able to buy fresh meat. This results in a concentration in their slaughter in or close to large cities and is probably one of the factors making for a concentration of pig farms close to Hanoi and Ho Chi Minh City (Tisdell, 2009b). The other factor favouring this is the proximity of these cities to ports through which pig food is imported. This tends to lower the delivery cost of imported pig food to pig farms.

Given the above trends, the Government of Vietnam is searching for ways to moderate rises in the price of pork which in turn requires Vietnam’s production of pork to increase at a faster rate than recently. Some policy-makers believe that this might be best achieved by encouraging a greater share of pig production to be supplied by large-scale commercial pig producers (Ministry of Agriculture and Rural

Development, 2010). This could result in less state support for household producers to increase their supply of pigs. This is an important issue that requires particular consideration.

6. Some General Observations on the Economic Merits of Small versus Large-scale Pig Producers and Household versus Commercial (Registered) Pig Producers

This research project was not designed to determine the merit of pig production by households in Vietnam compared to that by large-scale commercial pig producers. However, indirectly it throws some light on the subject which has become important from a policy point of view as Vietnam searches for ways to increase its domestic supply of pork.

In discussing this matter, a problem has been lack of scientific evidence for and against the role of small household pig producers as pork suppliers in Vietnam. Furthermore, the matter has probably been complicated by special interests. For example, major integrators of processed livestock food are liable to favour larger scale pig production (including production by commercial farms) because these pig producers use greater quantities and proportions of processed food. This in turn results in greater sales for integrators and higher profits for them.

In addition, some individuals in developing countries are strongly in favour of ‘modernizing’ and believe that the best development strategy is to adopt production techniques in use in higher income countries. However, this is not always the most economic choice because the countries considered are at a different stage of economic development.

From the ACIAR-sponsored research, it seems that, at this stage of Vietnam’s economic development, most small pig-rearing households play a cost-effective role in Vietnam’s supply of pork. This is because:

- They employ labour (especially female labour) that otherwise is likely to be unemployed or under employed.

- They utilize pig food available from the household or locally that otherwise would not be utilized or used for lower valued alternatives.

In addition, they are less reliant on imported pig food than are larger commercial producers and the larger-sized household producers of pigs.

Overall, the study did not find strong evidence that economies of scale are substantial in household pig production, although some economies of scale could exist for those specializing in farrow-to-wean production. However, the numbers of very large scale pig producers in the sample are small and it is unlikely that the results would be applicable to large commercial pig producers because these producers probably adopt different techniques of production to household producers. As a result, it seems likely that their per unit costs of production would be higher at lower scales of production than that of households.

Consider the specific results from this research about female participation in pig production, rural employment generation by household pig husbandry and about scale economics and the economic efficiency of household pig production in Vietnam.

7. Employment: Gender and Other Aspects Revealed by the Survey of Producers

Samples of household producers of pigs (931 in total) in six provinces of Vietnam were surveyed. The aim was to use purposive sampling to obtain a reasonably representative sample of conditions facing pig producers in order to specify the economics of the pig production in Vietnam taking into account regional variations. While the full diversity of conditions was not captured, significant pig producing provinces were included in the sampling. The geographical extent of sampling was limited by the amount of resources available. It might have been interesting, for example, to have included a province in the North West region where pig numbers are low and yields are well below the national average.

From the sampling data, it was found that household pig producers mostly rely on family labour for the husbandry of their pigs and the degree of reliance on family

labour tends to increase as their holdings of pigs become smaller. Female contribute more labour hours to tending pigs than males and the relative dependence on female labour tends to increase as pig-holdings become smaller. Hired labour involves the payment of wages whereas family labour does not. Only holders of larger pig stock tend to hire labour. Son et al. (2006) reported that registered commercial farms in Vietnam hire more labour than household farmers. Nevertheless, even in their case, family labour is a large component of their labour and their hired labour tends to be for casual employment.

A number of economic inferences can be drawn from these results. Employing family members in the raising of pigs by households can be economically efficient if family members are unable to find paid employment elsewhere in the economy. This is often the case for rural women. This observation is supported by that of Son et al. (2006) who also point out that rural women are limited in their scope for accepting employment away from their household because of their child-rearing duties. This means that very often, the opportunity cost of employing family labour in household enterprises is much less than the going market wage rate for labour.

In addition, if employment off-farm is available, the transaction cost of that employment has to be taken into account. Taking advantage of off-farm employment usually involves transport costs and sometimes relocation costs (see Tisdell, in press). There are also likely to be opportunity costs in terms of lower on-farm income.

Furthermore, work on household farms may add to family security, ensuring them of at least a subsistence income in difficult economic times when job shedding may occur in market-dominated labour markets. Off-farm jobs may not be very secure, especially in an economy in transition.

In some circumstances (but not all), on-farm employment of household members helps to reduce poverty, assists the employment of women and provides economic security for families. The economic desirability of (or otherwise) on-farm employment requires the **overall state of an economy** to be taken into account. For example, one must consider the extent to which the manufacturing and service sectors grow and are able to absorb surplus labour from the agricultural sector and provide

those employees exiting agriculture with security of employment (see Son *et al.*, 2006; Tisdell, in press).

8. Scale Economies and Economic Efficiency

This study tried to throw light on how the costs of production for a representative (average) household pig producer might vary with its scale of operations. It was concluded that the **cost** data imply that there are economies of scale (in terms of the cost of production) in farrow-to-wean; diseconomies in farrow-to-finish and almost scale neutrality in grow-to-finish systems of production (see Table 5 later). The results, however, could be quite sensitive to how pig food is valued, especially household-produced food and local supplies which account for a larger proportion of the pig food used by small holders than large holders of pigs.

The largest component of the cost of raising pigs is pig food. For those specializing in the farrow-to-weaner stage of pig production or farrow-to-finish stages of pig production, feed costs exceed 70% of operating costs (excluding household labour costs) and those concentrating on grow-to-finish, these costs exceed 54% of operating costs, the imputed cost of household labour excluded (CAP and ILRI, July 2010a, p.63). It was found that those households holding fewer pigs rely much more on their own produce and local produce to feed their pigs, compared to larger producers who rely more on marketed produce supplied ultimately by animal food production mills. The economic cost of the latter is likely to be considerably higher than that of the former. The former should be costed at a much lower level than the latter. To determine this cost is not easy. When account is taken of such factors, production of pigs by smallholders may be more efficient than appears to be the case at first sight. In other words, small producers can be low-cost suppliers of pigs. However, this may not be so for those who specialize in farrow-to-weaner production because they rely heavily on purchased pig food. Nevertheless, as demand for pork increases, small-scale producers cannot efficiently supply the whole of the market for pork and their share in the market can be expected to decline for reasons outlined in Tisdell (Tisdell, 2010b).

In a transitional situation, a market combination of small household pig producers and larger suppliers is likely to be most economical. However, as the economy grows and household members have more opportunities to be employed off-farm, their opportunity costs of working on a household's farm increases. This can be expected, in due course, to reduce the number of smallholders of pigs (Tisdell, 2010b, in press).

8.1 Definition of Scale

Additional features of the producers' report prepared by CAP on scale economies in the production of pigs by households in Vietnam are worth commenting on (CAP and ILRI, July 2010a). First, the scale of production of all the households surveyed is fairly small and to some extent, the definition of what is small, medium and large scale is arbitrary, as can be gathered from Table 5. The division of household producers by scale is influenced by the fact that the scale of virtually all is quite small. Furthermore, producers were classified according whether their production was concentrated on farrow-to-wean, farrow-to-finish or on grow-to-finish.

Table 5: Definition of scale of production of household pig producers

| Concentration | Small-scale | Medium-scale | Large-scale |
|----------------------|--------------------|---------------------|--------------------|
| Farrow-to-wean | 1 sow | 2-3 sows | 4 sows or more |
| Farrow-to-finish | 1 sow | 2-3 sows | 4 sows or more |
| Grow-to-finish | Less than 15 head | From 16-40 head | More than 40 head |

Source: Producer's survey, Table 3.1.2

8.2 Cost economies and the level of pig production

Using these definitions of scale, CAP estimated the average variable cost per kg of weight gain of pigs by production system and scales. In this calculation, labour supplied by households themselves is excluded. Table 6 summarises the results. For those specializing in farrow-to-wean production, there is a tendency for average

variable cost to decline with scale but the differences are not statistically significant. Furthermore, there is not much decline in these costs once a household has more than two sows. In the farrow-to-finish specialization, there seem to be diseconomies of scale and the difference is statistically significant between small and large scale producers. On the other hand, those who are involved in grow-to-finish seem to experience virtual scale neutrality. Overall, it seems that household pig producers do not experience substantial cost economies of scale (based on variations in their average variable cost), except in the farrow-to-wean system.

Table 6: Variable cost per kg of the weight gain of pigs of household producers (on average) classified by production system and scale in ‘000 VND in 2007^(a)

| System | Scale | | |
|------------------|-------|--------|-------|
| | Small | Medium | Large |
| Farrow-to-wean | 31.9 | 19.6 | 17.0 |
| Grow-to-finish | 20.0 | 20.3 | 19.6 |
| Farrow-to-finish | 15.0 | 16.8 | 19.2 |

(a) Based on household producers calculation of self-produced pig food (Scenario 1)

Source: Extracted from Table 3.7.9 of the Producer Survey Report.

8.3 Profitability and the scale of pig production

The gross margin per kilogram of output of household pig production was also investigated by CAP. This was done by production system and by scale. This takes account of the fact that the price per kg received by growers was not the same for all scales of production (see Lapar *et al.*, 2010, Figure 5). The sample size was reduced to some extent by this because suitable data was not available for all the households surveyed. Furthermore, average variable cost was estimated for two alternative scenarios: (Scenario 1) acceptance of the values placed on self-produced pig food by households and (Scenario 2) half this value because it was thought possible that householders had overvalued this item. [Note that the problem of how this feed

should be valued from an economic point of view was not resolved in this research].

Tables 7 and 8 summarise the results for scenarios 1 and 2.

Table 7: Gross margin and variable cost per kg of pig output by production system and scale for scenario 1 in ‘000 VND

| System and variable | Scale | | |
|-------------------------|-------|--------|-------|
| | Small | Medium | Large |
| <i>Farrow-to-wean</i> | | | |
| Average cost | 23.4 | 19.6 | 14.0 |
| Profit margin | 6.8 | 10.3 | 14.5 |
| <i>Grow-to-finish</i> | | | |
| Average cost | 19.8 | 20.3 | 19.6 |
| Profit margin | 4.3 | 4.8 | 5.6 |
| <i>Farrow-to-finish</i> | | | |
| Average cost | 15.0 | 15.7 | 19.2 |
| Profit margin | 8.8 | 9.1 | 7.2 |

Source: Extracted from Table 3.7.10 of the Producers Report

Table 8: Gross margin and variable cost per kg of pig output by production system and scale for scenario 2 in ‘000 VND

| System and variable | Scale | | |
|-------------------------|-------|--------|-------|
| | Small | Medium | Large |
| <i>Farrow-to-wean</i> | | | |
| Average cost | 22.2 | 18.8 | 14.0 |
| Profit margin | 8.0 | 11.1 | 14.6 |
| <i>Grow-to-finish</i> | | | |
| Average cost | 19.0 | 19.9 | 19.4 |
| Profit margin | 5.1 | 5.2 | 5.7 |
| <i>Farrow-to-finish</i> | | | |
| Average cost | 14.6 | 15.3 | 19.1 |
| Profit margin | 9.2 | 9.5 | 7.3 |

Source: Extracted from Table 3.7.10 of the Producers Report

These results suggest that economies of scale (for profitability) exist in the farrow-to-wean specialization in pig production. There is no evidence of substantial economies of scale (in profitability) in grow-to-finish and in farrow-to-finish. In fact, diseconomies of scale (in profitability) appear to exist in the latter case.

8.4 Distribution of sampled producers by scale

The results raise some queries. The main one is if there are profitable economies of scale, why are these not reflected in the distribution of the sizes of the pig holdings of the households sampled? If they are not reflected, does this mean that households are irrational in their economic choices or is this because some factors (not considered in the survey) constrain their decisions?

Table 9 specifies the distribution of households by production system and scale for the sample on which Table 6 is based. Table 10 does this for the sample used to derive

Tables 7 and 8. It can be seen from Table 9 that the distributions by scale are highly slanted towards low scale for farrow-to-wean and for grow-to-finish and towards large scale for farrow-to-finish. This is the opposite to what might be expected from Tables 6-8 if maximizing average profit per unit of output was thought to be desirable. This is because both Tables 6 (as well as 7 and 8) indicate economies of scale in profitability for farrow-to-wean and diseconomies to farrow-to-finish. One might, therefore, expect those households specializing in farrow-to-wean to cluster towards higher scale and those involved in farrow-to-finish to cluster towards smaller scale if they aimed to maximize profit per unit of output.

Table 9: Distribution of households by scale for different production systems for the sample used to derive Table 5

| Production system | Scale | | | | | | | |
|-------------------|-------|------|--------|------|-------|------|-----|-----|
| | Small | | Medium | | Large | | All | |
| | n | % | n | % | n | % | n | % |
| Farrow-to-wean | 116 | 66.3 | 51 | 29.1 | 8 | 4.6 | 175 | 100 |
| Grow-to-finish | 207 | 65.3 | 75 | 23.7 | 35 | 11.0 | 317 | 100 |
| Farrow-to-finish | 114 | 26.0 | 64 | 14.6 | 261 | 59.5 | 439 | 100 |

Table 10: Distribution of households by scale for different production systems for the sample used to derive Tables 6 and 7

| Production system | Scale | | | | | | | |
|-------------------|-------|------|--------|------|-------|------|-----|-----|
| | Small | | Medium | | Large | | All | |
| | n | % | n | % | n | % | n | % |
| Farrow-to-wean | 112 | 65.9 | 51 | 30 | 7 | 4.1 | 170 | 100 |
| Grow-to-finish | 194 | 63.8 | 75 | 24.7 | 35 | 11.5 | 304 | 100 |
| Farrow-to-finish | 114 | 56.2 | 63 | 31.0 | 26 | 12.8 | 203 | 100 |

It should be noted that there is a problem in comparing the results in Tables 8 and 9 because over half the sampled households were ‘discarded’ in Table 9 for the farrow-to-finish production system. Nevertheless, the observed distribution of the sampled households by scale do not accord with the distribution suggested to be desirable. It should not, however, be concluded that the majority of sampled households are irrational in their choices. More investigation is needed of the producers’ decisions and factors that constrain these.

Observe also that costs and returns in the above analysis are based on the averages for pig producers. There may be, however, considerable deviations of individual households from the average. Nevertheless, pig production by households is found to be profitable on average at all scales and for all production systems. An additional issue is that a firm’s profit is usually not maximised by maximising its profit per unit of output.

8.5 Further important observations on the relationship between average profitability and total profit

As explained in Appendix A, a producer’s maximum level of total profit usually occurs for a level of output for which profit per unit of output is declining. This is because maximum profit requires marginal profit to be zero. It is therefore, possible that the 59.5% of producers involved in farrow-to-finish system and operating at large-scale could be maximizing their profit even though that profit margin per unit of output is lower than for producers of smaller scale.

However, given the mathematical relationship explained in Appendix A, those involved in the farrow-to-wean system or in the grow-to-finish system could not be maximizing profit if they operated at less than large scale if all happened to have homogeneity in their profit functions and no constraints stopping them from maximizing profit. Unfortunately, there seems little likelihood that the conditions just mentioned will be satisfied in practice. Considerable **heterogeneity** is likely to exist in the conditions facing small household pig producers in Vietnam. Therefore, drawing policy conclusions for these empirical results based on the average situation is risky. Nevertheless, there is independent empirical evidence that increasing scale in

pig production is becoming more profitable on average for household pig producers because available secondary statistical data show that pig producers in Vietnam are slowly increasing their scale of pig holdings.

8.6 Empirical evidence that the scale of household pig production is slowly rising in Vietnam

It seems likely that many Vietnamese household pig producers find some increase in their previous scales of pig production to be profitable because the number of pigs held on average by pigholding households is slowly increasing as is revealed by differences between the results from Vietnam’s Agricultural Census of 2001 and of 2006. While in both censuses, the majority of households still had the equivalent of two pigs or fewer, this proportion had declined in 2006 and pig herds of larger size had become more common in 2006 (for example, having five or more pigs) as is illustrated by Figure 1.

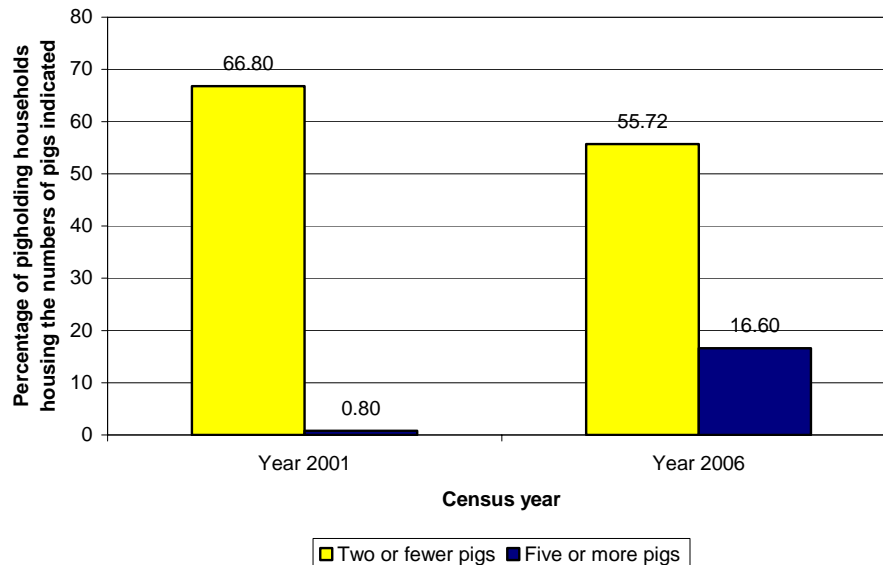


Figure 1: Most Vietnamese pigholding households keep very few pigs but on average the size of their herds is slowly rising, as is illustrated. Although not shown, the percentage of pigholding households with 21 pigs or more rose from 0.3% in 2001 to 1.75% in 2006. (Source: Based on results from Vietnam’s Agricultural Censuses for 2001 and 2006).

It needs to be emphasised that the data in Table 3.7.10 of the Producers Report (CAP and ILRI, July 2010a) (Table 6 and 7 above) are insufficient to determine the profit-maximizing level of output of a representative household pig producer. There are several reasons for this. One is that this table reports average profitability of output rather than marginal values of it. A second reason is that the ranges of the measures of scale differ and they are based on the size of the producers' stock of pigs rather than on the level of their (added) output. It is known, however, if average profit per unit of output is declining with scale, that increasing scale must increase profit. Therefore, for the average producer, the largest scale is likely to give the highest level of profit for farrow-to-wean and probably does so for grow-to-finish systems, given that results in Table 3.7.10 are accurate and profit levels are the only relevant consideration in determining scale. In relation to the farrow-to-finish system, it is possible that the largest scale also results in the highest level of attainable profit but it is impossible to determine that without taking into account changes in the marginal level of profit as a function of output. The technical details are explained in Appendix A of this paper. Note further that even if household pig producers do not operate at profit-maximizing scale, that they still might make a cost-effective contribution to Vietnam's pork production by utilizing home-produced and locally accessed pig food that otherwise would be wasted or used for lower-valued purposes.

8.7 Heterogeneity of production and market conditions in pig supply in Vietnam

Given the geographical diversity of Vietnam, it seems likely that pig producers in the sample face varying production and market conditions (see Tisdell, 2009b). Consequently, the cost and profitability relationships based on the average situation of all may fail to take adequate account of this heterogeneity. In other words, 'one shoe is unlikely to fit all'. It could, for example, be the case that pig producers close to large urban areas or cities find it more profitable to operate at a larger scale than those further away from such cities. They may, for example, receive a higher price for their product and find it more profitable to engage in industrial-type pig production. Cost curves may also differ between regions and within the same region depending on food availability and cost. This strongly suggests that Vietnam's livestock policy needs to be designed to take adequate account of such heterogeneity.

If the intention of policy-makers in Vietnam is to encourage the adoption of best practices in pig husbandry, one needs to define the criteria to be used to determine best practice. If the aim is to foster the most economic pattern of pig production (one criterion for best practice) then it should be born in mind that most profitable practices are unlikely to be the same for all pig holders. Adequate attention should be paid to heterogeneity of conditions faced by pig holders in Vietnam.

9. Observations on the Import Dependence of Pig Production in Vietnam and Its Variation with the Size of Pig-Holdings

It was mentioned earlier that increased pork production in Vietnam was facilitated by its rising imports of pig food. This pattern of dependence may continue. An investigation of constraints on the supply of pig food domestically is needed to throw more light on this matter.

The study found that smallholders of pigs make comparatively greater use of their own produce and local produce in rearing pigs than larger holders do. If this pattern persists and the structure of Vietnam's pig industry changes from one in which there are fewer small producers and more large-sized producers, this can be expected to result in rising imports of pig food by Vietnam and add to pressures on its balance of payments. Further, examination of import trends and relationships of relevance to Vietnam's pig industry could be worthwhile.

It might be noted that Vietnam is responding to its rapidly rising demand for livestock products (both meat and non-meat) in two different ways. Like China, it has increased its imports of coarse grains and other types of raw materials used to produce foodstuffs for livestock. It has relied primarily on this strategy to boost its domestic pig production. The second response has been to increase imports of the products concerned. This has been the main response of Vietnam to its increased demand for dairy products (Tisdell, in press). However, not all imported dairy products are finished products. For example, milk powder is imported and then processed into end products. The second type of strategy is not currently an option for meat products in Vietnam given the very strong preference of Vietnamese for fresh meat.

10. Specialization in Pig Production

In Western economies, it has been found that there has been a long-term tendency towards more specialization in agricultural production and in favour of a greater scale of production on individual farms (Skolrud et al., 2009). This process has evolved over a considerable period of time. One should not expect this pattern of development to occur **quickly** in transitional economies, although it could occur at a faster rate than that experienced in Western economies. A major restriction on the process in transitional economies could be restrictions on farm sizes and on the transferability of property rights in these.

This research project investigated some aspects of specialization in pig production in Vietnam, namely the extent to which pig producers specialize in different stages of pig production. Greater specialization in different stages of pig production was observed in the sample of producers from the Red River Delta region than in the south of Vietnam. However, the reasons for these differences in specialization are not known. This would be worthy of investigation. More research could be done on examining the economics of specialization by farmers in different stages of pig production. Comparisons with Western practice in this regard would also be interesting.

There was little investigation of the extent to which householders specialize in pigs compared to other forms of agricultural production. Nevertheless, some attention was given to the revenue obtained by the rural households surveyed from different types of livestock. How diversified by products produced are farming households rearing pigs? What are the economic advantages and disadvantages of such diversification? To what extent is increased pig production on individual farms likely to be at the expense of their diversity in production? Increased scale of production of pigs by households would most likely be accompanied by less product diversification. In turn, this would result in greater dependence on markets to supply pig food, much of which is imported. Diversification issues are worthy of more research.

There is some evidence from the producers' survey of the extent to which household pig producers specialize in the different phases of pig production in the regions sampled. Just over a half of those sampled specialized in farrow-to-wean or in the

grow-to-finish phase of pig production (see Table 10) and nearly a half of those sampled did not specialize but raised pigs for the whole of the production cycle. But as mentioned, the degree of specialization tended to be higher in Red River Delta than in the south of Vietnam. Regional differences exist in specialization by pig producers.

Table 10: The distribution of the sampled Vietnamese households rearing pigs based on their specialization by system of pig production.

| System | n | % |
|------------------|------------|--------------|
| Farrow-to-wean | 175 | 18.8 |
| Grow-to-finish | 317 | 34.0 |
| Sub total | 492 | 52.8 |
| Farrow-to-finish | 439 | 47.2 |
| TOTAL | 931 | 100.0 |

Source: Derived from Table 3.7.9 of the Producers Report

11. Regional Differences in the Economics of Pig Production

Geographically, Vietnam is a very diverse country and consequently, the economics of pig production can display considerable variation. Not only do the number of pigs present vary considerably between regions but there is also substantial variation in pig yields (Tisdell, 2009b) For example, in 2006, the highest pork yields were estimated to have been obtained in the Mekong River Delta (123kgs per pig in the stock) and the lowest in the North West region (39kgs per pig in the stock). Hence, on average pork yields per pig in the regional stock were over three times higher in the Red River Delta than in the North West. What explains such differences? Are they justified on economic grounds? These issues could be investigated. In general, regional differences in Vietnam's pig industry would warrant further research.

Also the way in which regional differences in pig production in different regions of Vietnam have changed and how they can be expected to alter as Vietnam's economy develops further would be worthy of research. For example, as Vietnam's transport

infrastructure improves more interprovincial trade in pigs and pork is likely to occur. How will this change the pattern of pig production in Vietnam?

A problem at present seems to be that there is little available data on interprovincial trade in pigs and pork. More information about this trade would be useful.

12. Economic Discrimination in the Supply of Inputs to Household Producers of Pigs and in their Sale of Pigs

This research collected evidence about whether smallholders of pigs were being discriminated against in their purchase of inputs and in their availability of credit. Differences in the terms and conditions for the purchase of inputs were found but they do not appear to be the result of discrimination. It was possible in most cases to explain variations in these conditions, by differences in market transaction costs. Furthermore, it was discovered that larger producers received a higher price per kg of pork than smaller producers (Lapar *et al.*, 2010). This seems to reflect differences in market transaction costs as well as possibly, quality differences. Market transaction costs per unit of sales tend to be higher for smallholders of pigs than for those with a larger number of pigs.

It also appears that smallholders obtained fewer loans than larger holders of pigs. However, it seems that the former had less demand for such loans.

On the whole, differences in market transaction costs tend to favour households that hold large stocks of pigs and disfavour those with smaller stocks. There is no obvious way in which smallholders can avoid this disadvantage.

13. Size of Pig-Holdings and Use of Professional Services such as Veterinary Services and Extension Services

Perhaps surprisingly, the study found that smallholders of pigs were more likely to use veterinary services than large holders. One possible reason was that large holders are more experienced in diagnosing maladies in pigs and treating them themselves.

Whether this is so is not known. Another possible factor could be the smallholders more frequently encounter veterinary problems in raising their pigs but once again, there is no concrete evidence for this. We cannot be sure that risk of disease outbreaks in pigs is greater in the case of smallholders than for those holding larger number of pigs.

The study found that most households having pigs made little use of extension services. This does not appear to be due only to their limited availability but also may reflect the fact that in most cases, the extra economic value perceived by households to be provided by these services was less than the added cost required to access them.

Observe that health risks encountered by households in rearing pigs probably depend on whether they raise pigs for the whole of the production cycle or whether they specialize in grow-to-finish. Those who specialize in grow-to-finish may be vulnerable to transmission of disease carried by purchased stock. As discussed below, they may also find it difficult to determine the quality of purchased stock

14. Miscellaneous Matters

Other interesting information also emerged from the survey of producers undertaken as a part of this project. It emerged that the most popular type of pig was that involving a cross of Large Whites and Mong Cai. However, since the provinces included in the producer survey were not amongst the most marginal producers of pigs in Vietnam, different compositions of pig varieties may be present in more outlying provinces; for example in provinces in the North West which experience harsh weather conditions such as severe cold snaps at times.

Household producers surveyed perceived several constraints on the supply of pig stocks and breeds. Many complained of the high price and inadequate supply of high quality genetic stock. These constraints seem, however, to be a result of market conditions. In the longer term, the market should adjust the supply and composition of stock to reflect demand. A more serious problem is the absence of the guaranteed genetic composition of purchased stock. This seems to be a particular problem in Ha Tay province where pig producers are relatively specialized in different stages of pig

production. They, therefore, have to trade more frequently in pig stocks than pig producers in most other provinces. It is well known that when buyers are uncertain about the quality of a product to be purchased that this results in economic losses (see, for example, Akerlof, 1970). However, it is not clear whether it would be economic to introduce a government-sponsored certification scheme to rectify this problem. In some countries, certification schemes are in place for seeds intended for planting crops for example, the variety and the germination rate are sometimes guaranteed.

Also another interesting result from the survey is that holders of large stocks of pigs are more likely to complain about market conditions than those with small stocks of pigs. For example, large holders of pigs more frequently complained about rises in the price of pig food. This is not surprising because this food involves a major cost outlay for them.

15. Notes on Some Emerging Issues Involving Pork Quality Standards

Of course, the pig industry in Vietnam will not remain stationary. To some extent, its future depends on the development of the whole of the Vietnamese economy because most industries and different markets are interdependent.

One major development that could have a significant impact on Vietnam's pig industry is improvements in Vietnam's transport infrastructure. This improvement is liable to facilitate interprovincial trade and may make it more economical for provinces that are more distant from Hanoi and Ho Chi Minh City to supply these markets with pork. This could result in some changes in the regional supply of pigs and pork in Vietnam. The possibility of this occurring could be a subject for research. Furthermore, as the food chain lengthens quality and health standards can assume growing importance. For example, pork sold through supermarkets usually takes longer to reach the consumer than that sold in traditional markets and, other things constant, is more prone to growth in bacterial and similar contamination. Therefore, greater attention needs to be paid to hygiene in this case. This aspect is underlined by field results reported by Grace (2010). She found from samples taken in Hanoi and Ha Tay in Vietnam that pork in supermarkets was less likely to meet health standards

than that sold in traditional meat markets. This raises the issue of quality standards for pork and the desirable degree of their uniformity throughout Vietnam.

While in principle, higher quality standards are desirable, it needs to be borne in mind that ensuring such standards is not costless. Therefore, it is necessary to compare their extra benefits with the additional costs and different consumers may have different levels of demand for the government imposition of higher standards.

Suppose that inspections are to be made and/or conditions are to be imposed to ensure that pork meets a particular health standard. The question then arises about the extent to which it is economical to see that this standard is satisfied. This can be assessed by reference to Figure 2. Assume that pork which meets the standard is certified as doing so. The demand of consumers for certification might be as shown by relationship ABCD. The per unit cost of certification of pork might be like line EBF. This is assumed to be of this simple form for illustrative purposes. Given this relationship, it is only economical to ensure that X_1 of the supply of pork satisfies this standard. If X_2 is the total supply of pork, requiring all pork to meet the standard would result in disbenefit to buyers equal to the area of quadrilateral BCDF, which has been cross hatched, it being assumed that consumers pay for the higher standard. However, in practice, the incidence of the cost of the higher standard will normally fall partly on consumers and partly on producers. The main point however, is that enforcing the same standards on all pork supplies is unlikely to be economic.

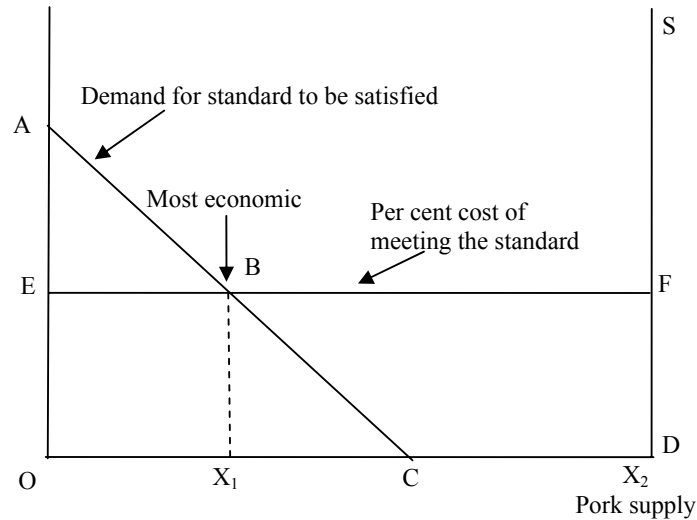


Figure 2: The introduction of quality standards for pork involves economic considerations. It may not be economic to ensure that all pork supplies meet a targeted standard. If that is done in the case illustrated, an economic loss equivalent to the hatched area occurs.

The demand for high quality standards is likely to be related to income levels. As income levels rise, the demand curve shown in Figure 2 is liable to shift upward. Higher income groups in cities may have a strong demand for higher quality standards but it would not be economically desirable to impose these standards on all consumers.

The above model involves several simplifications. However, its main purpose is to show that the adoption of food standards has economic implications. For one thing, the model assumes that consumers are knowledgeable about food standards and food quality. However, as research by Delia Grace from ILRI indicates, this is frequently not so. For example, consumers of milk in Assam were found to be poor judges of milk quality (Grace et al., 2007).

An alternative economic approach to deciding on appropriate food standards would be to apply health economic models to the problem. In principle, cost-benefit models of the type applied to controlling environmental health problems are relevant (see, for example, Tisdell, 2009a, Ch. 13). These models can be expected to indicate that higher food quality standards tend to become more economic as incomes rise. Conversely, they are less economic, the lower are incomes in a society.

Note that if economies of scale exist in compliance with food standards, imposing standards for a food item will tend to become more economic as the size of market for the food item subject to a standard increases. Thus both scale economies and higher incomes make it more economic to adopt higher food standards.

16. Is Increasing the Size of Vietnam's Pig Producing Units the Way to Make its Pig Industry More Competitive Internationally?

Many policy-makers in Vietnam seem to believe that by increasing the scale of production of its pig-producing units, Vietnam's pig industry will become more competitive internationally and that this will also improve quality standards in the industry. An FAO report (Son et al., 2006) also states that increased scale of production by individual agricultural units in Vietnam will lower per unit costs of Vietnam's agricultural production. However, it does not provide concrete evidence about these economies.

There is little available evidence that larger scale production units for livestock in Vietnam will **substantially** lower Vietnam's average cost of livestock production given the current stage of its economic transition.

In fact, large production units may experience higher costs of production than smaller units and they are likely to be more dependent on commercial food purchases and imports of commodities for feeding livestock. However, even if they do have high per unit costs, Vietnam may need supplies from such units to help meet its increasing demand for livestock products, as I have argued elsewhere (Tisdell, 2010b).

The following question also arises: If large scale livestock units are more profitable (economic) than small-scale units, why do they not evolve naturally at a desirable pace? Is it because such units require a greater land area than that which is available to households and is the required amount of land difficult to secure? If this is so, why is it difficult to secure? Have the land reforms in Vietnam (Son et al., 2006) proved to be inadequate in freeing up the market in land and if so, why? Are there still too many constraints on transfers of agricultural land and if so, what are they? Or is it

that households are very reluctant to transfer their land? These are all questions to which it is worthwhile seeking answers.

Despite continuing uncertainty about the magnitude of economies of scale in household pig production in Vietnam, there has been a trend toward larger scale of production by households, even though their scales still remain relatively small. This suggests that on the whole, households are finding larger scales of production to be more economic. At the same time as this has been happening, the number of household producers of pigs has declined.

17. Policy Choices

There appear to be two main policy issues facing Vietnam's Government as far as its pig industry is concerned:

1. the cost of production of pork in Vietnam remains relatively high by international standards; and
2. Vietnamese pork prices are rising rapidly because Vietnamese households rely on domestic pig producers to satisfy their demand for pork (because of their strong preference for fresh pork) and with Vietnam's rapid economic growth, its increased demand for pork has outstripped its growing supply of pork. The result has been an escalation in the price of pork. This is also influenced to some extent by intensified demand for low fat pork.

How might these problems be addressed? One option is for the government to do nothing and leave it to market system to bring about adjustment. This might not happen quickly and could result in pork prices continuing to rise and remaining at high levels for some time. Furthermore, given the importance of pork in the Vietnamese diet, some Vietnamese could criticize the government for doing nothing.

Secondly, the government could intervene on the supply side and adopt measures aimed at stimulating supply. Measures that improve economic efficiency in the pig industry would be the most desirable way of doing this. These measures should be

considered for producers of all sizes. Ways to reduce the cost of pig food deserve particular attention because the largest expenditure item in pig production is for pig food. Special attention could be given to the cost and utilization of domestically produced pig food taking into account agro-ecological variations in Vietnam and the fact that many of its crops differ from those utilized in Western countries.

Supply might also be increased by subsidizing pig production but that will not necessarily increase economic efficiency and the supply response rates are not known. If the subsidy is given only to large commercial pig producers, it may be that this supply response rate would be greater than if given to households. However, their response would need to be much greater because registered commercial pig producers produce less than 15% of the pork output of household suppliers.

A third policy option would be to try to convince Vietnamese consumers to be more favourable to the consumption of chilled, frozen or processed pork. This may be difficult to do. An important step in designing such a policy would be to discover why Vietnamese have such a strong preference for fresh pork in comparison to chilled, frozen or processed pork. Is it because they believe fresh pork is safer from a health point of view? Is it because they can judge the quality of fresh pork more easily? Is it because fresh pork is found to be tastier? If the problem is to do with the safety of pork then this might be addressed by improving or imposing health standards to be satisfied by fresh and chilled pork. If these alternatives to fresh pork can be made more acceptable to Vietnamese consumers, then imports will become more acceptable and this will help to cap pork prices. It may also result in more slaughtering of pigs away from major urban areas in Vietnam.

A number of the above mentioned policies could be adopted in conjunction. The choice depends in the end on political considerations.

18. Conclusions

In my view, several important findings have emerged from this research project. They include the following:

- (1) Because of the strong preference of Vietnamese consumers for fresh pork purchased from traditional market outlets, Vietnamese pig producers enjoy substantial market protection from pork imports. The slow growth of supermarkets in Vietnam reinforces this protection. The continuation of this trade protection depends on Vietnamese lifestyles not altering radically.
- (2) Household pig producers rely mostly on family labour and women tend to spend more time than men in tending pigs. Given lack of alternative employment opportunities (and other considerations), household pig production seems to be economically desirable given the current state of Vietnam's development and economic transition.
- (3) Findings about economies of scale in relation to size of the number of pigs held by producing units have, in my view, been inconclusive on the whole. Nevertheless, the study did indicate that the presence of economies of scale could be different for different stages of pig production. In any case, given the level of demand for pork in Vietnam, producers with different levels of costs are able to survive in the market, that is both some higher cost producers and some with lower costs can survive. This is normal. The fact that the scale of production by household producers is increasing suggests that larger scale is becoming more economic from their point of view.
- (4) It was found that those units with smaller pig stocks were less dependent on imported pig food than those with larger pig stocks. Smaller producers relied more on their own produce and locally produced pig food. However, small producers are unable to meet all of Vietnam's demand for pork because the availability of domestically supplied pig food is limited.
- (5) In the sample survey of household producers of pigs, it was discovered that pig producers in the Red River Delta specialize to a greater extent in different stages in pig production compared to those in the south of Vietnam. Reasons for this difference have yet to be explored. Also the extent to which holders of pigs diversified their agricultural production and why were not examined.
- (6) While some information about regional differences in pig production systems was gathered (for example, about differences in specialization by different stages of pig productions), there is scope for further study of these differences such as reasons for large variations in regional pig yields and the economics of these differences.

- (7) Research was conducted to find out if small holders of pigs are disadvantaged by economic discrimination in relation to supply of inputs and their sale of pigs. While small holders suffered economic disadvantage to some extent in accessing input markets, these are largely explained by the higher per unit market transaction costs arising from small market exchanges. Economic discrimination does not seem to be a major problem.
- (8) The survey results revealed that small holders of pigs are more likely to access veterinary services than larger holders. This result seems to be contrary to popular opinion. The reasons for this relationship are not completely known but one reason given was that those with a large number of pigs are more knowledgeable about pig husbandry and, therefore, do not require as much veterinary assistance. Most holders of pigs were found to make little use of extension services.
- (9) The majority of pigs held by the households surveyed were crosses of Large Whites and Mong Cai.
- (10) Households holding larger stocks of pigs complained most frequently about price variations, particularly the rising price of pig food. This is not surprising because they are more market dependent than smallholders as revealed by this research.
- (11) In view of the fact that pig food is a major cost in pig production, attention should be given to possible ways to reduce this cost and improve the utilization of available pig food.

Significant results have emerged from this research and a number of areas have been identified that would benefit from future research. These matters include the domestic supply of pig food versus imports of this food, further consideration of supply chains for pig food, inter-provincial trade in pigs, pork and pig food, the extent and economic reasons for specialization (diversification) by those holding pigs, and the likely changes in the pattern of regional pig production. More attention could be given to regional differences in systems of pig production and variations in the economics of this production. Another significant issue is the economics of enforcing higher standards and quality control in the industry and the certification of the quality of pork. It could be claimed that one of the contributions of this project has been to identify issues in Vietnam's pig industry that would benefit from future research. It was

observed that the per cost costs of production of larger sized pig producing units do not have to be lower than for small holders for them to be able to market their produce in Vietnam.

Finally, let me emphasize that small-scale pig producers have responded well to changed market conditions in Vietnam. They have increased pork yields and pig numbers in Vietnam since 1995 and this has resulted in more than a doubling of Vietnam's production of pork. While large-scale commercial producers are increasing in relative importance as suppliers of pork in Vietnam, they are not yet the major suppliers of pork. Therefore, in policies designed to increase Vietnam's pork supply and reduce the cost of this supply, it is important not to neglect the contribution that can be made by households rearing pigs.

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Appendix A: A Technical Note on Costs, Profitability and Scale

A1 Introduction

It was mentioned in the text that it is usually most profitable for a business which is a price-taker to operate beyond the scale of production that minimizes its per unit cost of production, that is beyond the scale that is sometimes described in textbooks as the minimum efficient scale. This implies that farmers who are price-takers and operating at greater than minimum efficient scale could be maximizing their profit. This appendix illustrates this point.

The second purpose of this appendix is to show that a farm which is maximizing its profit per unit of output is unlikely to be maximizing its profit. As a rule, profit maximization will occur for an output greater than that which maximizes profit per unit of output.

The third objective of this appendix is to consider the implications for a firm's profit maximization strategy when the price it receives for its product rises with its volume of sales. This case was reported in the text. Even though it was found that the price per kg obtained by pig producers for their pigs rose with their quantity of sales, they still were price-takers.

A2 Firms that are Price-Takers usually Maximize their Profit by Producing at Greater than Minimum Efficient Scale

In cases where firms are price-takers, their profit is usually maximized by producing a quantity of output greater than their level of output which minimizes their per unit cost of production. This is illustrated in Figure 3 for a case where the per unit costs of production by a firm are assumed to be U-shaped. U-shaped per unit cost curves are considered to be normal for agriculture. There the curve marked AC represents the firm's average cost of production and that marked MC is its marginal cost of production. If the price for its product is equal to the minimum of its AC curve, P_1 , the

firm will maximize its profit by producing x_1 of its product per unit of time. If the price for its product is below this, it will pay the firm not to produce at all. If the price for its product is higher than P_1 , say P_2 , (equals in this case its marginal revenue) the firm maximizes its profit by producing beyond x_1 at a level that raises its per unit cost of production. In the case illustrated, it maximizes its profit by supplying x_2 of the product when its product's price is P_2 and its per unit costs of production increase from P_1 to OB compared to a situation in which it produces x_1 , the output corresponding to its minimum average cost of production. For an output of x_2 , the firm's profit is maximized because its marginal cost of production equals its marginal revenue and its marginal cost is increasing. Note that if a firm produces an output in the range where its average cost is declining, it is not minimizing its per unit cost of production and it cannot be maximizing its profit. However, producing beyond the minimum efficient scale of production is often the most profitable strategy for a price-taker.

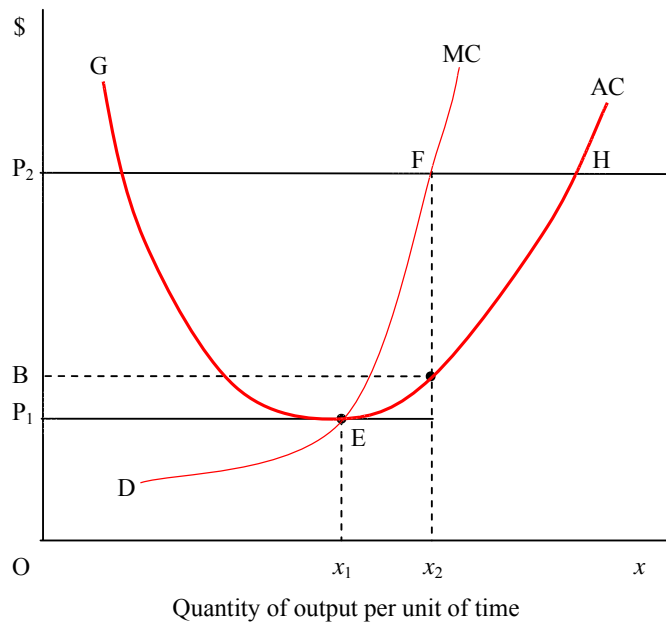


Figure 3: In most cases, businesses that are price-takers maximize their profit by operating beyond the scale that minimizes their per unit cost of production.

A3 Maximizing Profit Per Unit of Output Does not Maximize Profit

An additional point is that variations in profit per unit of output are of limited value in determining a business' most profitable level of output. In order to maximize profit as a function of a firm's output, it is necessary to produce a level of output such that marginal profit is zero and declining. As a result, a business will normally find it most profitable to produce an output which is greater than that which maximizes its profit per unit of output.

This is illustrated in Figure 4. There the curve marked AII represents the profit per unit of output of the business and that marked MII is that for its marginal profit as a function of its level of output. From mathematics, it is known that when an average value is rising the marginal value must exceed it. When the average value declines,

the marginal value must be below it. Hence, the type of relationship shown in Figure 4 applies. It follows that a business cannot be maximizing its profit in the situation illustrated if it produces an output less than that maximizing its profit per unit of output (x_1 , in this instance). Usually, its profit will be maximized when it produces an output greater than that which maximizes its profit per unit of output. This occurs in the case illustrated, when it produces x_2 of its product. It makes a profit of OA per unit of its output which is lower than its maximum profit per unit of output, OB .

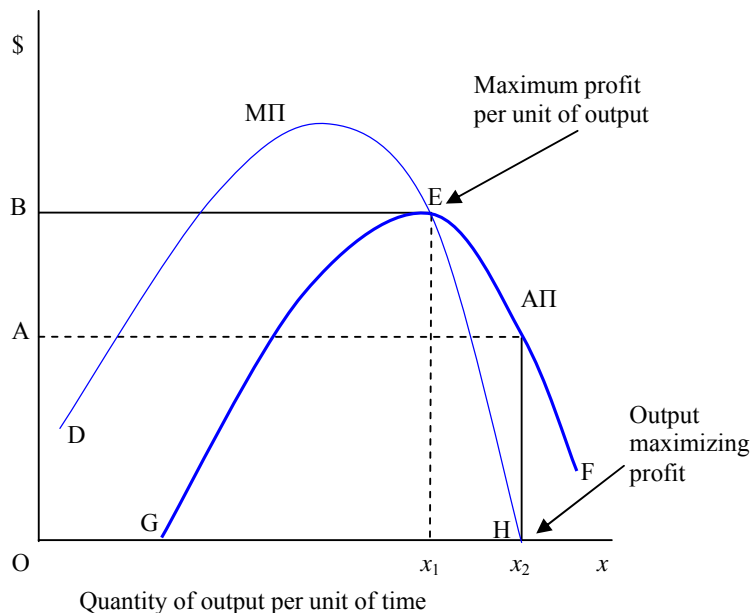


Figure 4: In most cases, the most profitable level of output for a business is a level of output greater than that which maximizes its profit per unit output, as in the case illustrated below.

A4 A Case in which Suppliers Find that the Price they Receive for their Product Rises with the Value of their Sales

It is well known that firms may achieve falling per unit costs with great volume of output for engineering and technical reasons or because they obtain discounts when buying larger volumes of inputs. Some evidence that this occurs for pig producers in Vietnam was found as a result of this project. In addition, it was found that pig

producers selling a larger volume of pigs tend to be paid a higher price per kg for these. This might be a reflection of lower market transaction costs being associated with a larger volume of sales. It might also be that the pigs of large holders are considered to be of better quality.

The effect of this upward-rising average revenue curve is a function of the volume of sales so as to make production on a larger scale more profitable for pig producers. In fact, in this situation it always pays pig producers to produce beyond minimum efficient scales if their average cost of production function is U-shaped.

A microeconomic example of this type of situation is illustrated in Figure 5. There the line DEF represents the average revenue curve for a farm (a pig producer) and line AGH is its corresponding marginal revenue relationship. The U-shaped curve identified by AC is the farm's average cost curve and that marked MC is its corresponding marginal revenue curve. The condition for profit maximization is satisfied at point H and for an output of x_2 . At point H, marginal cost equals marginal revenue and marginal cost is rising more quickly than marginal revenue. The farm's profit-maximizing level of production occurs beyond that corresponding to its minimum efficient scale, x_1 . The size of the firm is limited by increasing marginal costs but the rising average cost curve tends to make it more economic for the firm to operate at a higher level of production than otherwise.

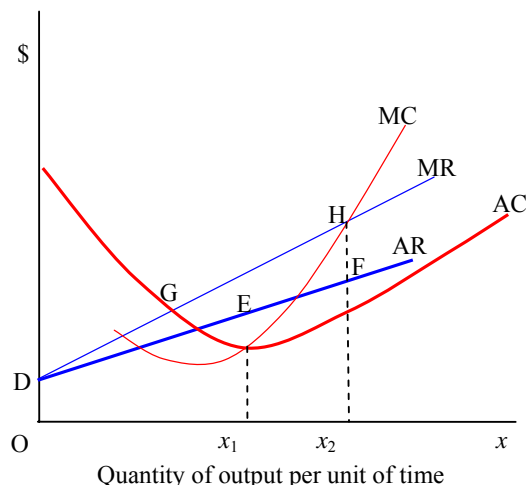


Figure 5: An illustration of profit maximization in the case where a producer receives a higher price per unit of sales as his/her sales volume increases.

A5 Concluding Comments

The technical illustrations in this appendix underscore the need to be careful in drawing policy recommendations from the empirical results of this ACIAR-sponsored research about the optimal scale of pig production by individual pig producers. This is so even if it is agreed that the cost and profit relationships obtained are representative of those for Vietnamese household pig producers. It is, however, doubtful whether they are sufficiently representative to provide firm policy recommendations because they do not take account of the diversity of conditions facing pig producers in Vietnam in different parts of the country.

An interesting result from the research is that pig producers selling larger volumes of pigs tend to get a higher price per kg for their pigs. As shown, this provides an economic incentive for pig producers to produce beyond their minimum efficient scale. By doing so, they will maximize their profit. It should also be clear from this analysis that to operate at minimum efficient scale usually does not maximize the profit of a pig producer. Furthermore, maximizing profit per-unit of output does not maximize profit because this occurs when the rate of change of profit (marginal profit is zero.

Appendix B: The Growing Shortfall in Vietnam's Domestic Supply of Pork – Draft Project Brief

Project Brief

The growing shortfall in Vietnam's domestic supply of pork: Significance and policy implications

Clem Tisdell, School of Economics, The University of Queensland. 8 September, 2010
Email: c.tisdell@economics.uq.edu.au

B1 Key points

- Pork is an important component of the Vietnamese diet. Since its market reforms, Vietnam's domestic production and consumption of pork have risen substantially.
- Nevertheless, in recent years, Vietnamese demand for pork has grown at a faster rate than its domestic supply. This (and the fact that most Vietnamese do not want to purchase imported pork because of their strong preference for fresh (warm) pork) has resulted in a steep rise in Vietnam's pork prices.
- This concerns the Government of Vietnam which is searching for ways to increase the domestic supply of pork.
- Households keeping few pigs are the main source of Vietnam's pork supply. Some policy-makers believe that they are inefficient and an obstacle to expanding Vietnam's pork supply.
- These policy-makers argue that the government should favour larger commercial pig producers on various efficiency grounds and that these producers can fill the shortfall in the domestic supply of pork.
- While small household pig producers have limited capacity to increase their supply, they are often low cost producers because they utilize inputs that would otherwise be unused or under utilized. They are less reliant on imports of pig food than are large producers.
- A combination of small household producers and large pig producers is most efficient for Vietnam at this stage of its development. Efforts should be made to increase the economic efficiency of both small and large producers.
- More attention could be paid to constraints on the supply of domestically produced pig food and improving its utilization because pig food is the major cost in pig production in Vietnam.

B2 Introduction

Following Vietnam's market reforms, its domestic production of pork and its per capita consumption of pork have risen substantially¹. Vietnamese demand for pork has risen due to higher incomes, an increasing population and growing urbanization. Vietnam's increased pork supply occurred as a result of an increase in its stock of pigs and greater pork yields, the relative importance of which has varied². However, at least since 2000, Vietnam's domestic supply of pork has grown more slowly than its demand for pork and there has been a substantial rise in the real price of pork. This has happened because Vietnamese consumers have strong and persistent preference for fresh (warm) pork³ and therefore, most avoid imported pork. There are natural barriers to pork imports and so the rise in pork prices had not been moderated by imports⁴.

Given the importance of pork in the diet of Vietnamese, this trend is of concern to Vietnam's Government. Some policy-makers think that the main problem is the inefficiency of small household suppliers of pigs and believe the answer to the problem is to expand production by larger-sized commercial producers⁵. However, at this stage in Vietnam's development, small household producers still make an important contribution to Vietnam's supply of pork – they account for about 90% of supply. In many cases, their costs of production are lower than can be achieved by larger commercial producers because they utilize inputs that otherwise may be unused or under utilized. They are also much less reliant on imported pig food than large commercial producers.

In the current situation, ways should be explored to reduce the cost of production for both household and non-household producers. Attention should be given for example, to increasing the supply and reducing the cost of domestically produced pig food and utilizing available supplies more efficiently.

Box 1: The steep rise in Vietnamese pork prices

The real price of pork in Vietnam has risen rapidly in recent years. According to data in the Statistical Yearbook of Vietnam 2008 (p.471) the producer's prices index for products from domestic animals (mainly pigs and cattle) have increased at a faster rate than that for all other categories of agricultural products, and this increase has accelerated. Between 1995 and 2008, this index increased by 174% and between 2000 and 2008 it rose by 148.5%. That means it more than doubled in these periods. The producer's price index for agricultural products gives a measure of the real prices (excluding taxes and levies) which farmers received for their products when they sold them to consumers. Also note that the producer's index for agricultural products has risen in recent years at a faster rate than the general price index. Therefore, agricultural goods have become more expensive in relation to other goods.

Box 2: Data sources and methods

The results reported in this part of the research output for the ACIAR-funded research project "Improving the Competitiveness of Pig Producers in an Adjusting Vietnam Market" are based on research reports prepared by CAP and ILRI in connection with this project, published data of the General Statistical Office of Vietnam, and other published

materials (including those of the author) and analysis, including the use of concepts developed in economics.

B3 Results

The persistent strong preference of Vietnamese consumers for fresh (warm) pork

The CAP-ILRI survey of urban households in Hanoi and Ho Chi Minh City (HCMC) and a sample of rural households reveals that pork is the preferred type of meat for urban households, and one of the two most preferred types for rural households (see Table 1). This preference is persistent and there is evidence that it existed at least a decade ago. Furthermore, on average, pork accounts for the largest proportion of expenditure on meat by households – more than a third in urban and rural areas (see Table 2). One important finding of the CAP-ILRI meat consumer survey is that Vietnamese consumers have a strong preference for fresh pork, and an aversion to chilled, frozen and processed pork. As a result:

- Vietnamese consumers do not like to buy pork from supermarkets and prefer to buy it from traditional market outlets⁶.
- They avoid imported pork because it is of necessity, chilled, frozen or used in processed pork products. Thus, most consumers demand domestic pork.
- They buy pork frequently and do not store it for long.
- These tastes probably result in pigs being slaughtered close to retail markets and limited transport of pork from rural areas to large cities.

Table 1: Preferences of samples of Vietnamese households for pork in comparison to other types of meat (including fish and seafood)

| Type of Meat | Urban Households | | Rural Households | |
|--------------|---|-------|------------------|-------|
| | Rank | Score | Rank | Score |
| Pork | 1 | 8.83 | 2 | 8.04 |
| Chicken | 2 | 8.05 | 1 | 8.16 |
| Beef | 3 | 7.75 | 3 | 7.90 |
| Fish | 4 | 7.44 | 4 | 5.51 |
| Others | Except for Seafood, have a much lower score | | | |

Source: CAP-ILRI consumer survey data

Table 2: Percentage of household meat budget spent on different types of meat and rank

| Type of Meat | Urban Households | | Rural Households | |
|-------------------|------------------|------|------------------|------|
| | Rank | % | Rank | % |
| Pork | 1 | 34.1 | 1 | 38.2 |
| Beef and Carabeef | 2 | 28.0 | 4 | 7.2 |
| Fish and Seafood | 3 | 20.0 | 3 | 27.2 |
| Poultry | 4 | 17.7 | 2 | 27.3 |

Source: CAP-ILRI consumer survey data

Vietnam's supply of pork is growing more slowly than the demand and pork prices are accelerating

Vietnam has more than doubled its volume of production of pork since 1995. This has been due to an increase in its stock of pigs and increased pork yields. However, Vietnam's population of pigs peaked in 2005 and was reduced in the period 2006-2008⁷.

The following trends can be noted:

- Annual output of pork, beef and carabeef combined grew at 6.1% p.a. in the period 95-00, accelerated to 9.7% p.a. in the period 00-05, and fell back to 4.8% p.a. in the period 05-08 (see Fig 1). Thus the growth rate of production is no longer being maintained.
- The increase in the real price of pork, beef and carabeef combined has accelerated. It rose by 10.5% in the five-year period to 2000, by 35.1% in the next five-year period and by 88.2% in the three-year period to 2008 (see Fig.1). This indicates that the increased supply of pork has failed to keep pace with rising demand.

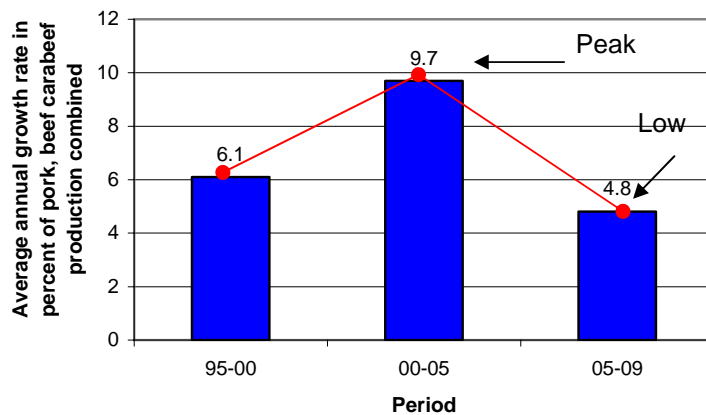


Figure 1: Percentage increase in the index of the volume of production of pork, beef and carabeef combined in Vietnam for period between 1995 and 2002.

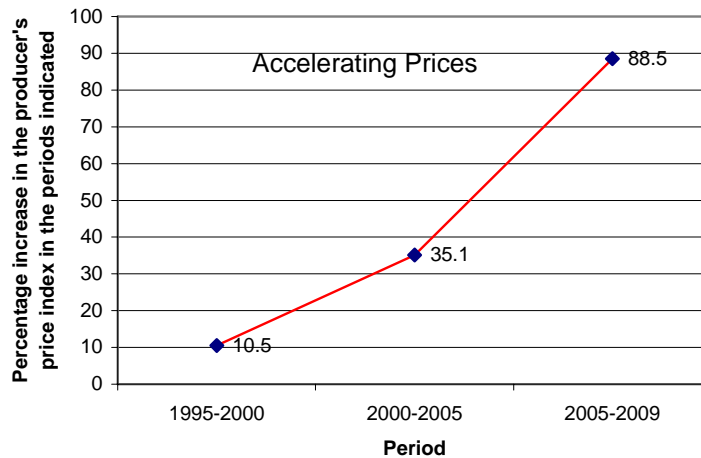


Figure 2: The accelerating increase in the real price of pork, beef and carabeef combined based on the producer's price index in the Statistical Year Book of Vietnam, 2008 (p.471). There is a failure of increased supply of these meats to match rising demand.

Small household producers are important suppliers of pork and efficient producers

Small households rearing pigs are a major source of pork supply in Vietnam and on the whole, they make an efficient contribution to Vietnam's pork production given its present stage of development⁸. That is not to say that the efficiency of their production cannot be increased.

- Household pig producers still supply about 90% of Vietnam's pork and account for around 90% of its pig stock⁹.
- The number of household producers is declining, their proportionate contribution to pork supply is slowly falling¹⁰ and the average size of household pig herds is rising (see Fig. 3).
- In comparison to larger producers, most households raising pigs in Vietnam play a cost-effective role in the supply of pork because:
 - They employ household labour (especially female labour) that otherwise is likely to be unemployed or under employed.
 - They utilize pig food available from the household or locally¹¹ that otherwise may not be utilized or be used for lower value alternatives.
 - They are less reliant on imported pig food than larger commercial producers.
- The number of household producers of pigs can be expected to continue to decline with Vietnam's economic growth but for some time, they will be an important source of pork supply for Vietnam¹². They should be neglected in policies designed to increase Vietnam's level of pork production¹³.

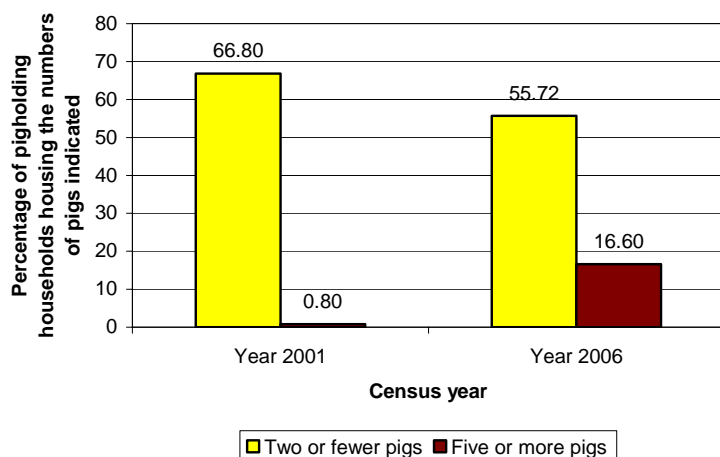


Figure 3: Most Vietnamese pigholding households keep very few pigs but on average the size of their herds is slowly rising, as is illustrated. Although not shown, the percentage of pigholding households with 21 pigs or more rose from 0.3% in 2001 to 1.75% in 2006.

B4 Conclusions

The following are the main conclusions that can be drawn:

- As a result of Vietnam’s economic growth and the strong preference of Vietnamese for fresh pork, the rising demand for pork has outstripped its increasing supply. The result has been an upward trend in the real price of pork which has started to accelerate at a worrying rate.
- Given the importance of pork in the diet of Vietnamese and their strong preference for it, the trend is a policy concern. However the view that household pig producers are to blame for the situation because they are inefficient seems to be misplaced at this stage of Vietnam’s development. It should also be borne in mind that household pig producers have made a substantial contribution to increasing the level of Vietnam’s pork production in recent decades.

B5 Implications for policy and interventions

Policy implications

- A combination of household and large commercial producers of pigs is likely to be efficient in meeting Vietnam’s demand for pork in the present stage of its development¹⁴.
- The major cost for pig producers is pig food and its rising price seems to be a major restriction on expanding pork supply. Particular attention should be paid to increasing Vietnam’s supply of pig food, reducing its costs of production, and better utilizing Vietnam’s available supplies of pig food, including self produced food and locally available food.

Investment implication

- The government should invest in R and D and extension services to improve the efficiency of pig producers of all sizes, especially households, because they are still the major pork suppliers.

B6 Notes

1. These more than doubled in the period 1996-2006. See Tisdell, C.A. 2009 Trends in Vietnam's pork supply and structural features of its pig sector. *The Open Area Studies Journal*, 2, 52-71.
2. This is detailed in the reference given in Note 1.
3. Lapar, M.L.A., Toan, N.N., Que, N.N., Jabbar, M., Tisdell, C.A. and Staal, S. 2009. 'Market outlet choices in the context of changing demand for fresh meat: Implications for smallholder inclusion in the pork supply chain in Vietnam'. Paper presented at the 27th Conference of the International Association of Agriculture Economists held in Beijing, 16-22 August, 2009.
4. Tisdell, C.A., Lapar, M.L.A., Staal, S. and Que, N.N. (2010) "Natural protection from international competition in the livestock industry: Analysis, examples and Vietnam's pork market as a case". In T.H. Lee (ed.) *Agricultural Economics: New Research*. Nova Science Publishers, New York.
5. Ministry of Agriculture and Rural Development, Department of Livestock Production, 2010. *Livestock Development Strategy to 2020 (Revised)*. Publishing House for Science and Technology, Hanoi.
6. See Project Brief, Demand for pork by Vietnamese consumers: Implications for pro-poor livestock policy and development agenda in Vietnam. October, 2010. ILRI, Hanoi.
7. General Statistical Office of Vietnam, 2009. *Statistical Yearbook of Vietnam*, 2008, p.289. Statistical Publishing House, Hanoi.
8. The reasons why this is so are outlined in Tisdell, C.A. 2010. The survival of small-scale agriculture producers in Asia, particularly Vietnam: General issues illustrated by Vietnam's agricultural sectors especially its pig production. In A. Salazar and I. Riva (eds.) *Sustainable Agriculture: Technology, Planning and Management*. Nova Science Publishers, New York.
9. See reference in Note 1.
10. See reference in Note 8 and Tisdell C.A. (In press) Economic growth and transition in Vietnam and China and its consequences for their agricultural sectors: Policy and agricultural adjustment issues. *Regional Development Studies*.
11. See Project Brief, Competitiveness of smallholder pig producers in Vietnam, October, 2010. ILRI, Hanoi.
12. The reasons are outlined in the references mentioned in notes 8 and 10.
13. Also of relevance is the conclusion in the Project Brief. Future scenarios for pig sector development in Vietnam: Results from a policy simulation model, October 2010, ILRI, Hanoi, that "The modern pig sector is likely to remain small over the next decade and beyond".
14. The reasons for this are detailed in the reference given in Note 8.

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