The Impact of Crossbred Cattle (Red Sindhi×Yellow Local) on Smallholder Households in the Mountainous and Lowland Zones of Quang Ngai, Vietnam

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ABSTRACT : This research investigates the use of crossbreed cattle (Red Sindhi×Yellow Local cattle) at household level in the lowland and mountainous zones in Quang Ngai province, Vietnam. The internal and external inputs and outputs of mixed farming systems were analysed to quantify the productivity and efficiency of the use of the crossbred and yellow local cattle. In the mountainous zone, households with crossbred cattle had a lower crop and farm efficiency rate than households without crossbred cattle, but in terms of crop, livestock and farm productivity they did not differ. In the lowland zone, households with crossbred cattle had a higher crop, livestock and farm productivity and crop efficiency rate than households without crossbred cattle, but did not differ in terms of farm efficiency rate. The lowland zone had higher off-farm income, crop and household productivity, but lower livestock productivity, livestock and farm efficiency rate than the mountainous zone. Households with crossbred cattle had lower off-farm income than households without crossbred cattle. The results suggest that interactions between zone and kind of household occur at the households and show that the yellow local cattle is a better breed in the mountainous zone and more or less comparable with crossbred cattle in the lowland zone. The extrapolation of the use of crossbred cattle should be carefully considered in line with feeding practice and management. ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16, No. 9 : 1390-1396)***

Key Words : Yellow Cattle, Crossbred, Households, Productivity, Efficiency, Vietnam

INTRODUCTION

For over a decade Red Sindhi (Zebu) crossbreeds (Red Sindhi×Yellow local) have been introduced in mixed farming systems in all agro-ecological zones of Quang Ngai and other provinces in Vietnam. The cattle crossbreeding program has been considered a major livestock development activity of Quang Ngai Provincial Department of Agricultural Extension and Rural Development (PDAERD). From an evaluation on the crossbreeding program, one of the conclusions was: “The program was most welcome by all the farmers in the project area. Crossbreeding of cattle resulted in improving production and the total income of the farmers involved in this program” (Lich, 1997). However, this was not established by detailed and quantitative information on the productivity and efficiency of crop and livestock production of households. In addition the effects of the crossbreeding program depend on the conditions of the production systems. Phung (2001) reports genotype and environment (G×E) interactions on productive and reproductive traits of the crossbred cattle in Quang Ngai resulting in one most favourable breed for a specific zone. The G×E interaction on animal level probably affects the productivity and efficiency of households’ production. Therefore, the objective of this investigation is to compare the production of two types of smallholder households (with and without crossbreeds) in two zones (mountainous and lowland zone). The knowledge obtained is important for policy makers, for animal breeders and especially for farmers for selecting the appropriate and most profitable cattle breed for a specific zone.

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MATERIAL AND METHODS

Research location

Quang Ngai province is located in the south central coast of Vietnam with an area of about 58,497 square kilometres. Population size is around 1.2 million people. Climate is tropical monsoon. The area can be classified into four zones (mountainous, highland, lowland, and coastal). The research was conducted in the mountainous and the lowland zones. The mountainous zone (M) has an area of about 391,192 hectares, occupying nearly 2/3 of the total area of the province. The level of the M zone is about 300-1,600 m above sea level. The lowland zone (L) is about 150,678 ha with a more ecological diversification than the M zone.

Data were collected over one year (August 2000 to July 2001) from 210 randomly selected cattle rearing households with crossbreeding cattle (C) and with yellow local cattle (Y). Fifteen villages of three communes of Bato, Badong, Bacung, represent the M zone and 12 villages of two communes of Nghiadung and Hanhthinh, represent the L zone. All households involved in mixed farming, had land, labour and were involved in the crossbreeding program of

Table 1. Parameter calculation and interpretation of the effects of zone and kind of household for model with (model [2]) and without interaction (model [3])

Effects	Parameters		Calculated as
	No interaction	Interaction	
L zone	α	α	$\frac{1}{4}\left(\overline{Y}_{LC}+\overline{Y}_{LY}-\overline{Y}_{MC}-\overline{Y}_{MY}\right)$
M zone	-α	-α	$-\frac{1}{4}\left(\overline{Y}_{LC}+\overline{Y}_{LY}-\overline{Y}_{MC}-\overline{Y}_{MY}\right)$
C household in the L zone		$\beta(\alpha_1)$	$\frac{1}{2}(\overline{Y}_{LC}-\overline{Y}_{LY})$
Y household in the L zone		$-\beta(\alpha_1)$	$-\frac{1}{2}(\overline{Y}_{LC}-\overline{Y}_{LY})$
C household in the M zone		$\beta(\alpha_2)$	$\frac{1}{2}(\overline{Y}_{MC}-\overline{Y}_{MY})$
Y household in the M zone		$-\beta(\alpha_2)$	$-\frac{1}{2}(\overline{Y}_{MC}-\overline{Y}_{MY})$
C household	β		$\frac{1}{4}\left(\overline{Y}_{LC}-\overline{Y}_{LY}+\overline{Y}_{MC}-\overline{Y}_{MY}\right)$
Y household	-β		$-\frac{1}{4}\left(\overline{Y}_{LC}-\overline{Y}_{LY}+\overline{Y}_{MC}-\overline{Y}_{MY}\right)$

PDAERD and kept cattle for more than four years. Survey questionnaires were used to collect the information.

Variables

The data was collected on family background, farm resources and production activities. The information included the inputs and outputs of the production activities, which were quantified at actual farm gate prices, expressed in Vietnamese Dong (1$=15,500 VND). Gross margins, productivity and efficiency measures were derived to investigate the effects of the crossbreeding program in the households, which were calculated as:

Total gross margin=crop gross margin+livestock gross margin,
Gross margin=Gross income earned-variable costs,
Farm income=Total gross margin-fixed costs.

Both researched production systems, however, are low input systems, therefore fixed costs were not quantified in this research and farm income was considered equal to total gross margin.

Productivity : Farm, crop and livestock productivity per unit of land (m^2), per labour and per person was estimated for farm income, crop and livestock gross margin

Efficiency : Farm, crop and livestock efficiency was estimated, which was cash output/cash input for farm, crop and livestock.

Statistical model

The General Linear Model procedure from the SPSS package (Version 10.0) was used to analyse the ANOVA. Effects of zone and kind of household on farm resources, productivity and efficiency were analysed by model [1]

$$Y_{ijk}=\mu+\alpha_i+\beta_j+\gamma_{ij}+e_{ijk} \quad [1]$$

Y_{ijk} is the measurement of household k within zone i and kind of household j, μ is the overall mean, α_I is the effect of zone i (i=1 for L zone; i=2 for M zone), β_j is the effect of kind of household j (j=1 for C household; j=2 for Y household), γ_{ij} is the interaction between zone i and kind of household j and e_{ijk} is the random term for animal k within zone i and kind of household j.

If the interaction between zone and type of household was significant ($p<0.05$), the model [1] was changed in to a nested model:

$$Y_{ijk}=\mu+\alpha_i+\beta_j(\alpha_i)+e_{ijk} \quad [2]$$

where $\beta_j(\alpha_i)$ is the effect of kind of household j within zone i and other parameters and variables are the same as in [1].

The parameters in model [2] were estimated by the method of Angela and Daniel (1999) using the sum restriction $\sum\alpha=0$ and $\sum\beta=0$ so that μ expresses the overall mean.

If the interaction between zone i and kind of household j was not significant ($p>0.05$) the model [1] was changed into a model without interaction:

$$Y_{ijk}=\mu+\alpha_i+\beta_j+e_{ijk} \quad [3]$$

where all parameters and variables are the same as in [1]. The parameters in this model were also estimated by the method of Angela and Daniel, (1999). The estimation

Table 2. Variables describing the production systems at L and M agricultural zones for households with and without crossbreed cattle in Quang Ngai, Vietnam in terms of degrees of freedom (df), mean, model parameters (see Table 1) and residual deviation (RSD).

Variables	df	Mean	α	β (α_1)	β (α_2)	β	RSD
Number of household members	207	5.89	0.18			0.05	1.73
Total family crop labour (d y^{-1})	207	228.4	93.7***			16.9*	113.1
Total family livestock labour (d y^{-1})	207	179.5	-55.9***			6.2	88.2
Total off farm work (d y^{-1})	206	397.8	201.1***	-110.4*	-6.2		357.9
Number of large ruminants	207	2.98	-0.66***			-0.02	1.72
Number of pigs	207	3.2	-1.2***			-0.41	3.37
Number of poultry	207	21.7	-6.2*			-1.62	34.9
Number of cows	207	1.3	-0.4***			-0.13*	0.9
Number of calves	207	1.3	-0.49***			-0.09	1.0
Number of buffaloes	207	0.04	-0.01			0.02	0.35
Number of bullocks	206	0.05	-0.05*	0	0.10*		0.30
Number of beeves	206	0.3	0.25***	0.26**	-0.01		0.58
Cultivated land (m^2)	207	3,301	-502.9**			205.3	1,846
Grass land (m^2 h h^{-1})	207	192.1	192.1***			12.9	283.7
Cut & carried green grass (kg y^{-1})	207	5,311	3,078***			555**	2,829
Cattle concentrate (kg y^{-1})	206	86.9	54.8***	69.2***	12.3		131.6
Grazing time (h d^{-1})	206	4.3	-2.49***	-0.97***	-0.12		1.68
Grazing days (d y^{-1})	206	198.9	-94.3***	-63.8***	-9.0		74.1

procedure for the parameters of model [2] and [3] is in Table 1.

RESULTS

System description

Table 2 presents some variables describing the production systems in M and L zones sub-divided into households with and without crossbred cattle. Zones and kinds of household did not differ in number of household members ($p>0.05$). Zones and kinds of household differed for total family crop labor, respectively, with 93.7 and 16.9 days/year, which means the L households and the C households employed significantly higher total family crop labor than their counterparts ($p<0.001$). Zones differed for total family livestock labor ($p<0.001$) with the magnitude of -55.9 days/year, but this was not the case for kinds of household ($p>0.05$).

Zones differed for total off-farm work ($p<0.001$). Kinds of household in each zone differed for total off-farm work that were, respectively, -110.4 days ($p<0.05$) and -6.2 days ($p>0.05$) for the L and the M zones. The difference in off-farm workdays between zones was due to that zone L had advantages in access to the city, where off-farm work was available. The higher RSD of off-farm work reflected that not all households had equal chances of getting off-farm work.

An interesting output is that the M households used 41.5% of their labor employed for livestock related activities, but it was 11.9% in the L households. In contrast, the M households used 34.7% of their labor force for off-farm activities, but it was 57.3% in the L households. In addition, the difference in % labor used for crop production between L and M households was small, about 7% (23.8 vs. 30.7%). The data show that in the M zone labor was mainly used for agricultural production, but in the L zone it was off-farm work.

Zones and kinds of household differed in the ownership of number large ruminants, number pigs, and number poultry. The L zone had significantly lower number cattle hh^{-1} than the M zone (Table 2). As a result, number cows, number calves, and number bullocks of the L households were also lower than those for the M households ($p<0.001$). In the L households number beeves, however, was significantly higher than that for the M households. Buffaloes made up 1.3% of the large ruminant herd and there were no differences in number buffaloes between zones and kinds of households ($p>0.05$). Bullocks occupied 1.6% of the large ruminants, even in the L zone where the farmers did not keep bullocks. The low percentages of buffaloes and bullocks were explained by the process of mechanization in agriculture, in which small tractors replaced buffaloes and bullocks, which were previously used to provide draught power for crop production. Zones differed in number pigs and number poultry (-1.2 vs. -6.2). It was, however, not the case for kinds of household ($p>0.05$).

Kinds of household did not differ in cultivated land. However, zones significantly differed on cultivated land (-502.9 m^2). Besides cultivated land, households in the M zone can access a large area of forest and hill lands where cattle can graze all the year around. Therefore, under the consideration of land resource for cattle production the M households had more advantages than their counterparts in the L zone. In the same zone, there were no differences in land cultivated between the two kinds of households.

Table 3. Gross margins, off-farm income and household income (all in VND y^{-1}) of households with and without crossbred cattle in the L and M zones in Quang Ngai,Vietnam

Criteria	df	Mean	α	β (α1)	β (α2)	β	RSD
Crop GM	206	3,141,926	1,128,009***	994,757**	-139,164		2,815,425
Livestock GM	206	3,320,944	-490,665***	618,942***	-186,625		1,774,148
Total GM	206	6,462,870	637,344*	1,613,699***	-325,789		3,514,459
Off-farm income	207	8,351,936	3,324,072***			-1,494,472**	20,339,862
Household income	207	14,727,059	4,283,509***			-827,547	11,262,803

In the L zone the amount of cut and carried grasses (kg y^{-1}) was 8,389 kg/year. In the M zone it was significantly lower (p<0.001), 2,233 kg/year. The difference was probably due to the following reasons: cut and carried grasses in the L zone were mainly planted grasses and were from the home garden or rice field or both and a very small part from communal grassland. Nevertheless, in the M zone 100% were natural grasses and were from communal grassland on roadsides, hills and forest-sides, which were highly seasonal dependence. With grassland (m^2 h h^{-1}), only the L households used their unfertile or unused land for grass plantation with an average of 384.2 m^2 h h^{-1}, which was an interesting proof for the first reason. The C households had higher cut and carried grasses than the Y households (p<0.01).

The mountainous zone had a large area of communal grassland, which was able to provide enough grass for cattle. Therefore cattle in the M zone had grazing time and grazing days higher than those of the L zone (p<0.001). In the L zone a small area of communal grassland was available and a huge amount of planted, cut and carried grasses was used instead of natural grasses leading to less grazing days and grazing time of cattle. This feeding practice, once again, explains why the L households had a significantly higher amount of cut and carried grasses than their counterparts in the M zone. The amount of concentrates used for cattle in the L households was higher than that in the M households (p<0.001), which more or less explains why the level of investment on cattle production in the L zone was higher than in the M zone. However, the RSD for concentrates provided was very high, 131.6, which means households were not homogenous in concentrates investment.

An interaction between zone and kind of household occurred on the criteria of grazing time (h d^{-1}), grazing days (d y^{-1}) and cattle concentrates (kg y^{-1}), which means the effects of kind of household were different per zone. Cattle of the C households in the L zone had 0.84 h of grazing time d^{-1}; 40.8 grazing days y^{-1} and 210.9 kg of concentrates y^{--1}. They had less grazing time and grazing days, but higher concentrates (p<0.001) than those of the Y cattle, which reflects that in the L zone the C cattle ate more cut and carried grasses and concentrates and grazed less than the Y cattle. However in the M zone there were no significant differences between the C and Y households within zone for these traits (p>0.05).

Crop and livestock gross margin and off-farm income

It can be seen from Table 3 that crop, livestock and total gross margin show interactions between zone and kind of household, but they were not the case for off-farm income and household income. The effects of zone on crop, livestock and total gross margin, respectively, were about 1.1, -0.5 and 0.6 million VND so the higher total GM of the L households was the result of higher crop GM. Livestock production in the L zone contributed 21.7% of total household income, which was 14.7% lower than the M households. The effects of kind of household was different per zone. C households in the L zone had higher crop, livestock and total GM than the Y households (p<0.01). However, there were no differences of crop, livestock and total gross margin between the C and Y households in the M zone (p>0.05).

Zone affected both off-farm income and household income, respectively, about 3.3 and 4.3 million VND (p<0.001). Kind of household did not show any effects on household income but on off-farm income, about -1.5 million VND (p<0.01). Off-farm income of the Y households occupied a higher percentage in total household income than the C households (about 57% vs. 49%). The RSD of off-farm income was about 2.4 times larger than its mean, which meant off-farm income of households was not homogenous between the households.

Productivity and efficiency

Gross margin is not the only criterion to compare kinds of household in the two zones. The GM estimates per m^2, per main labor or per person (productivity) and total money output per money input (efficiency rate) are widely used for comparative analyses between farms and between zones.

Table 4 reveals a comparative analysis of productivity and efficiency of the two kinds of household in both zones. It can be seen from the table that zone had a significant effect on crop productivity (p<0.001), which was about 200,000 crop GM per person; 400,000 per main labor and 500 VND per m^2. However, it had significantly negative effect on livestock productivity (p<0.001) which were about -270 and 100 thousand VND respectively for livestock GM per main labor and per person.

The effects of kind of household were different per zone, which in the L zone the kind of household had a significantly positive effect on both crop and livestock

Table 4. Productivity and efficiency of crop and livestock production of the C and Y households in the M and L zones in Quang Ngai, Vietnam

Criteria	df	Mean	α	β (α1)	β (α2)	β	RSD
Crop GM/person (VND y^{-1})	206	566,596	205,744***	207,677***	-22,769		544,154
Crop GM/ main labor (VND y^{-1})	206	1,334,663	430,530***	644,398**	-36,827		1,432,022
Crop GM/m^2 (VND y^{-1})	206	1,058	497***	315**	-77*		900
Li.stk. GM/main labor (VND y^{-1})	206	1,431,774	-271,592***	388,305***	-72,144		974,725
Li.stk. GM/person (VND y^{-1})	206	602,319	-102,524***	119,141***	-57,657		350,519
Farm income/main labor (VND y^{-1})	206	2,766,437	158,938	1,032,702***	-108,970		2,020,328
Farm income/m^2 (VND y^{-1})	206	2,254	453***	510***	-174		1,268
Farm income/person (VND y^{-1})	206	1,168,916	103,219*	326,818***	-80,426		690,252
Farm efficiency rate	206	3.16	-0.36***	0.16	-0.4***		1.2
Livestock efficiency rate	207	3.64	-0.98***			-0.11	2
Crop efficiency rate	206	3.04	0.12	0.4*	-0.4**		1.6

productivity. It means crop and livestock productivity of the C households in the L zone was higher than that of the Y households. In the M zone, however, no significant effects of the kind of household on productivity were found, except a significant effect on crop GM/m^2 ($p<0.05$).

Zone had an effect on farm income per m^2 and per person but not on farm income/main labor. The effect of the kind of household on farm productivity was different per zone, which it was significant in the L zone ($p<0.001$) and not significant in the M zone ($p>0.05$).

Zone had no effect on crop efficiency rate ($p>0.05$) but a significant effect on livestock and farm efficiency rates ($p<0.001$). Livestock efficiency rates of the L and M households, respectively, were 2.66 and 4.62. The significant difference of farm efficiency rate of the L and M households (2.8 vs. 3.5) was due to the significant difference in livestock efficiency. It was interesting that the kind of household had no effect on livestock efficiency, but it had an effect on crop efficiency in the L zone (about 0.4) and on both crop and farm efficiency in the M zone (about -0.4 and -0.38 respectively).

DISCUSSION

Livestock in general and cattle in particular are an integral part of the mixed farming system in Quang Ngai. Traditionally, farmers raise cattle for long-term savings, utilizing agricultural by-products and natural grasses for draught power, manure and meat. Cattle are multi-purpose animals. Since the Opening Policy, the living standard of people was improved remarkably, which created demands for a higher amount and better quality of beef (Edson, 1996). However the Y cattle are smaller in mature size and grow more slowly (Noi and Ly, 1995; Duong et al., 1995; Thuong, 1995). In that situation one of the common ways to improve beef production and create a genetic resource for milk production in the future is through the so-called cattle improvement program by importing Red Sindhi (Zebu), and other Zebu breeds as well, for crossbreeding with the native breeds. Later on the exotic breeds such as Charolaise and Hereford for beef production and others like Holstein Frisian for milk production will be imported.

However, an important issue in crossbreeding, genotype ×environment interaction is much open for further research (Khan, 1994, Chasan, 1998). The level of G×E interaction depends on zone, production system+weather and climate (Holmes et al., 1992, Vercoe and Frish, 1992; Chaudhry et al., 1994 and Richard, 1997). G×E interaction is less clear, if the crossbreeding experiments are conducted at stations or at farms, where feeding practices and management are conditioned. These conditions seem to be far over the reach of most of Quang Ngai's farmers.

Therefore, the literature gave evidence for G×E interactions on productive and reproductive traits of the crossbred cattle, which has an indirect effect on the productivity and efficiency of the livestock and crop production of cattle-keeping households. Thus, the main objective of this research was to study the effects of the crossbreeding program at household level in the M and L zones.

It is interesting that two production systems were rather different in production technology for livestock production. The level of technology was reflected in resources used and inputs and outputs.

Use of land: From free access to natural pasture on the hills and forest edges in the M zone to the cultivation of grasses on households' land in the L zone; 0 and 384 m^2 grass land h h^{-1} respectively. Land resource has shaped the cattle management and feeding practices of cattle production in both zones. Grazing was the main feeding practice of cattle in the M zone, while it was stall fed in the L zone. The difference in land resource was also the reason for a higher cattle density in the M zone than in the L zone.

Use of external inputs: From negligible in the M zone to moderate investment on concentrates and breed in the L zone; from supplying concentrates in time of calving in the M zone to all the year around in the L zone; from self-creating breed by using progeny calves or sharing-management for progeny calves in the M zone to buying calves or young beef from outside.

The cattle production systems were not only shaped by zone but also by kind of household. However the latter was not as strong as the former. The differences in production system of the two kinds of household were clear in the L zone but was not the case in the M zone. The use of technology indicates that the L production system was rather intensive and the M production system was extensive. In these conditions, with the same cattle breed, the interaction between zone and kind of household was expected.

The lowland zone households had higher crop GM, lower livestock GM and higher farm income than those of the M households. However, we could not conclude that keeping the C cattle was the cause of the differences, because the production systems at the two zones were different from land resources, livestock density, and crops planting. The combination of the L zone and C cattle had higher livestock GM than that of the L zone and Y cattle, which was expected because at the animal level, in the L zone the C cattle showed better growth and equal reproductive viability as the Y cattle (Phung, 2001). In addition, the monetary value of the C cattle was higher than of the for Y cattle. Therefore we can safely conclude that the higher livestock GM and farm income of the C households in the L zone was partly due to the use of the C cattle.

However, in the M zone, livestock, crop GM and farm income of C households were lower than those of the Y households. Although they were not significant, we can conclude that the differences were also due to the use of the C cattle, because two kinds of household were similar in resources, livestock density, and crop growing.

The study also found that the L households had about 2.6 times higher off-farm income than the M households. The data reflects the advantage of the L zone in access to the city, where off-farm jobs were available. The L households had limited cultivated land, but had the same family size as M households, which was also the reason to push the L people to the city for off-farm earning. The off-farm income of the Y households was about 1.43 times higher than that of the C households. This probably points to a compensation for their lower farm income.

The results of crop and livestock productivity were consistent with those of gross margin, for which the L households had higher crop GM/person, labor, and m^2, but lower livestock GM/labor and person. In the L zone the C household had higher crop and livestock productivity, but it was not the case in the M zone. The differences in the livestock GM can be safely concluded to be due to the use of the C cattle as a result of G x E interaction at the animal level. The differences in the crop GM were due to crop growing, while the L households planted vegetables and cash crops for the markets of the town or city nearby, which had higher value than rice as it was planted in the M households.

Farm and livestock efficiencies of the M households were higher than for the L households. The difference in farm efficiency was the result of differences in the livestock efficiency, because no difference in crop efficiency between the M and L households existed. The lower efficiency of livestock production in the L zone was probably the result of higher investment in concentrates, drug and dry feed, while in the M zone cattle production was based on the local resources such as green feed from communal land and abundant labour from family. In the L zone the C and Y households had similar farm efficiency, but in the M zone the C households had lower farm efficiency, which was probably due to the effect of livestock efficiency as a result of G×E interactions at the animal level.

Our findings on economic analysis of keeping the C cattle were not comparable with that of Alam et al. (1992) in Bangladesh, Kalra et al. (1995), Tashi (1997) in Bhutan and Patil and Udo (1997) in India, where keeping the C cattle had higher economic return than the local cattle. Their research was more or less related to daily milk products, in which genetically productive potential was important in deciding the productivity, as environments were improved a little bit already, which means G×E interaction was more or less reduced. In addition, in India and Bangladesh, milk is a traditional source of protein for humans, which greatly affects the productivity and efficiency of cattle keeping. As a result, the expectation is a higher economic return of the C cattle than the local cattle. No research on the effects of the use of the C cattle on economic return in the production systems, where progeny calves, meat, draught and manure are all interests, is found. However, if any, the results probably are in agreement with ours due to G×E interactions.

REFERENCES

Alam, J., M. Akteruzzaman, A. Rahman and Z. Ahmed. 1992. Comparative performance of local and crossbred cows in Bangladesh. Indian J. Dairy Sci. 4:112-117.

Angela, D. and V. Daniel. 1999. Design and Analysis of Experiments. Springer-Verlag NY, Inc.

Bourdon, M. R. 1997. Understanding Animal Breeding. Prentice Hall Upper Saddle River, NJ 07458. Colorado, America.

Chasan, C. 1998. Role of exotic breeds in dairy and beef improvement in Asia. Kasetsart University, Chathuchack, Bangkok 10900, Thailand (In press).

Chaudhry, M. Z., M. J. Tahir and M. Rafique. 1994. Production performance and milk producing efficiency in different filial groups of H. Friesian×Sahiwal half-breds. Asian-Aust. J. Anim. Sci. 7:383-387.

Duong, N. K., N. X. Ba and H. M. Quan. 1995. Cattle production in Central Vietnam. In: ACIAR proceeding No.68 -Exploring approaches to research in the animal sciences in Vietnam, Hue university, Vietnam 31 Jul-3 August. pp. 93-96.

Edson, D. P. 1996. Beef cattle production in Vietnam. http://www.salerscattle.com/cidarep.dpf. Accessed on February 25th, 2001.

Holmes, J. H. G., M. J. McKinmon., G. W. Seifert, J. H. Schottler, A. Bannick and R. Malik. 1992. Reproduction and calf growth in Brahman crossbred and South East Asian cattle in Papua New Guinea. Asian-Aust. J. Anim. Sci. 5:427-433.

Kalra, K. K., S. Rajvir and C. Anil. 1995. Economic analysis of milk production and disposal in rural areas of Haryana. Indian J. Dairy Sci. 48:546-550.

Khan, U. N., 1994. Genetic improvement of native cattle through crossbreeding and introduction of exotic dairy cattle in Pakistan. Pakistan Science Foundation, Islamabad.

Lich, N. B. 1997. Livestock production in Vietnam and development orientation. In: International workshop on animal recording for small holders in developing countries, Icar technical series No 1:115-127.

Noi, V. V. and L. V. Ly. 1995. Cattle production and research in the central region of Vietnam. In: ACIAR proceeding No.68-Exploring approaches to research in the animal sciences in Vietnam, Hue university, Vietnam 31 Jul-3 August. pp 200-203.

Patil, B. R. and H. M. J. Udo. 1997. The impact of crossbred cows at farm level in mixed farming systems in Gujarat, India. Asian-Aust. J. Anim. Sci. 10:621-628.

Phung, L. D. 2001. A system analysis of the use of Yellow Local and Red Sindhi crossbred (Red Sindhi×Yellow Local) cattle at the households in the mountainous and lowland zones, Quang Ngai, Vietnam. Msc thesis. University of Wageningen, Wageningen.

Samdup, T. 1997. The performance of Brown Swiss crossbred cattle types and the impact of crossbreeding at farm level Bunthang, Bhutan. MSc thesis, University of Wageningen, Wageningen.

Thuong, N. V. 1995. Some results of study of beef and dairy cattle in Vietnam. In: ACIAR proceeding No.68-Exploring approaches to research in the animal sciences in Vietnam, Hue university, Vietnam 31 Jul-3 August. pp. 45-49.

Udo, H. M. J., J. Meijer, F. Dawood and A. A. Dijkhuizen. 1992. The benefits of cattle in mixed farm systems in Pabna, Bangladesh. Asian-Aust. J. Anim. Sci. 5:495-503.

Vercoe, J. E. and J. E. Frish. 1992. Genotype (breed) and environment interaction with particular reference to cattle in the tropics. Asian-Aust. J. Anim. Sci. 5:401.