Table 3. Animal population, estimated power supply and cultivated land, 1984–86.

	1984	1985	1986	Trend (%/year)
		'000 head		
Population target[a]	9284	9390	9497	1.1
Actual population[b]	11488	12356	12929	5.1
DA population[c]	5955	6428	6733	6.1
Cultivable land	14888	16070	16833	6.1
Total harvested area	17192	16626	17640	1.3

Source: Direktorat Bina Program 1988; Biro Perencanaan 1988.
[a] Population target in Pelita V is 13.7 million head by 1989.
[b] Cattle and buffalo.
[c] DA population estimated as 52% of total population.

Table 4. Targets for meat consumption and production in Pelita V, 1989–93.

	1989		1993	Trend (%/year)
		kg/year		
Meat consumption per capita				
- cattle and buffalo meat	1.87		1.88	0.13
- other meats	3.47		4.07	3.99
		1000 t		
Total domestic consumption				
- cattle and buffalo meat	332		363	2.23
- other meats	618		783	5.92
Total production				
- cattle and buffalo meat	347		419	4.71
- other meats	689		928	7.42

Source: Ditjen Peternakan 1987.

production is only sufficient to meet 16.07% of manure requirement of farms.

By the end of the Fifth Five-Year Development Program (1993) the draught animal population is projected to reach 4.75 million head, sufficient to prepare 24.4 million ha of land. The manure production should reach 98 million t, or about 69.5% of the total manure production. The manure production should be sufficient to meet the requirement of 5.2 million ha of agricultural land.

Meat Production and Consumption

National meat production has always been dominated by the ruminant livestock, especially cows. The actual beef production during the 1984–86 period reached 28.5% of the total meat production. For future development policies, the role of broilers and other animals is becoming increasingly important. The present policy seemed to be quite successful during the Fourth Five-Year Development Program.

In the present Fifth Five-Year Development Program, the role of animals other than cows and buffaloes in meat production is expected to be even more important. This is shown in Table 4, where the target meat consumption per capita for broilers, other animals and other poultry is set lower than for cows and buffaloes. The policies to substitute draught animal meat consumption with other sources will be beneficial for future draught animal development. Similar information on the targeted production and consumption of various animals during the Fifth Five-Year Development Program is presented in Table 4.

Draught Livestock Intensification Policy

To promote draught livestock development the government has decided to launch the Draught Animal Intensification Program (INTEK) through the Minister of Agriculture Decree No. 9, 1984.

The target and achievements of the INTEK program since its inception (1985–86) until 1987–88 are presented in Table 5. The achievements through the credit INTEK Program were low compared with the self-financed INTEK program or INTEK Swadana (1.5% vs 130%). The rate decreased over time through the self-financed INTEK, whereas the rate through the Credit INTEK increased from 0.57% in 1985–86 to 4.2% in 1987–88. The INTEK actual in 1987–88 was only 45% of the targeted

Table 5. Targets and achievements for INTEK program, 1985-86, 1987-88.

	Credit animals		Other activities[a]	
	Target	Actual	Target	Actual
	head		*head*	
1985-86	8400	48	60600	123624
1986-87	9500	103	22000	31680
1987-88	4550	192	51070	18385

Source: Direktorat Bina Program 1988.
[a] Other Activities includes extension contacts with livestock farmers and marketing services.
N.B. The major distribution of draught animals falls within the transmigration program. Approximately 58000 head are distributed annually to these areas, accounting for 90% of total distribution.

Table 6. Interregional trade matrix of large ruminants, 1987 ('000s head).

	Importing regions					
Exporting region	Sumatera	Jakarta	West Java	Kalimantan	East Indonesia	Total
Central Java	-	68.5	99.3	-	-	167.8 (34.2)
East Java	4.3	126.5	34.8	12.0	-	177.3 (36.2)
Bali	-	22.0	-	-	-	22.0 (4.5)
West Nusa Tenggara	0.5	16.5	2.5	-	-	19.5 (4.0)
East Nusa Tenggara	-	40.5	-	-	4.0	44.5 (9.1)
Sulawesi	0.5	28.7	-	28.3	1.4	59.0 (12.1)

Source: Directorate of General Livestock Service, Jakarta.

270 810 farm households distributed in 14 provinces.

In the beginning of the Fifth Five-Year Development Program (1989) the INTEK target was 4750 packages, which is increased by 4.5% annually. The credit INTEK acceleration is placed second highest after the credit for pork. By the end of the Fifth Five-Year Development Program (1993), the credit INTEK is projected to reach 5700 packages, that is 1.9% of the total packages in the livestock subsector. If we look at the Credit INTEK Program achievements during the Fourth Development Program, the actuals during the Fifth Five-Year Development Program would not change very much, unless the government is able to make significant improvement in field implementation.

Livestock Trade Policies

The draught animal (cow) interisland trade is regulated by the Director General of Livestock, which further translates into local government regulations. This interisland trade quota will partly determine the draught animal development in producing centres. This interisland trade allocation is largely intended to meet the meat demand for Jakarta (61.8%) and West Java (27.9%). The meat demand in the two main consuming regions is mainly supplied from East Java (36.2%) and Central Java (34.2%). The major surplus regions outside Java are Sulawesi (12.1%) and East Nusa Tenggara (9.1%) (see Table 6). No export of large livestock is permitted.

Conclusions

The livestock subsector has received a relatively higher budgetary allocation than food crops and the estate subsectors. The main problem is to create an appropriate development environment, using the budget effectively and increasing the contributions of the livestock subsector to GDP, to achieve better results.

The main factor which affects agricultural mechanisation in Indonesia is the increasing scarcity of human labour and animal power at peak periods of land preparation. This is due to the adoption of modern technologies in food production, including rapid developments in synchronised irrigation. Nevertheless, since agricultural mechanisation is selective in application there remains great potential for draught animal development, especially in areas where tractors cannot operate. A further option is to increase DAP research in high-intensity land-use areas, to determine whether more draught animals can be reared by means which are profitable to the farmer and provide draught work at a rental rate that is competitive with tractors.

In the Fourth Five-Year Development Plan (1984–88) the increase in draught animal population exceeded the target set. However, increase in animal numbers has not been sufficient to match the increase in cropping area. In the Fifth Five-Year Development Plan (1989–93), distribution of draught animals to the transmigration areas is the main policy priority. Continuous monitoring and evaluation of these animals' utilisation in the new settlement areas is essential. The other problem of livestock development in the future is meeting the domestic and export demands for meat.

In general, the first 3 years (1985–86/1987–88) of the Draught Animal Intensification Program (INTEK) have been quite successful. Results from the associated Credit INTEK have been less encouraging. It is important to conduct an evaluation of the Credit INTEK program to determine why farmers did not use the program as expected.

There is growing argument that the quota system for some producing regions such as East Nusa Tenggara should be reconsidered to enhance draught livestock development in other regions. Cows are not widely used for labour source in East Nusa Tenggara, whereas in other regions it is an important source of labour for land preparation.

References

Biro Perencanaan. 1988. Rancangan Repelita V Pertanian. Buku I. Departemen Pertanian, Jakarta.

Direktorat Bina Program. 1988. Evaluasi Pelaksanaan Pembangunan Sub Sektor Peternakan Pelita IV Sampai Dengan 1987. Direktorat Jenderal Peternakan, Jakarta.

Ditjen Peternakan. 1987. Kebijakan Operational Pembangunan Peternakan Dalam Pelita V. Departemen Pertanian, Jakarta.

Kasryno, Faisal. 1984. Prospek pembangunan ekonomi pedesaan Indonesia. Yayasan Obor Indonesia, Jakarta.

Technical Efficiency and the Significance of Draught Animal Power for Rice Production in Indonesian Villages

N.M. Esparon*

Abstract

Eleven Indonesian villages in which a significant number of farmers employ draught animal power in their cultivation processes were analysed using econometric techniques, to determine whether they were (a) technically efficient in their rice production processes, and (b) whether draught animal power was an important significant input in the production of rice.

Introduction

IN this paper findings are reported from an investigation into whether rice farmers who use draught animals from a range of areas in Indonesia are technically efficient in their production of rice.† The major species of draught animals in Indonesia are cattle and buffaloes, and it is generally acknowledged that as well as providing draught power these animals serve many important purposes on the farm, such as providing a relatively liquid form of capital, acting as a store of wealth and the production of meat. Draught animal power (DAP) was one of the inputs to rice production included in the analysis.

The central question of the study was the hypothesis that 'within their physical and economic environments and the existing technologies of crop production and animal husbandry, rice farmers in the areas studied are technically efficient in the use of their resources, including draught animals.' The hypothesis was tested by estimating production functions from cross-sectional data derived from farm surveys in West Java, East Java and Lombok Island of Indonesia and was accepted as being true. Such knowledge about the technical efficiency of rice producers in Indonesia is valuable because it can indicate to policymakers whether future increases in production will be achievable through greater emphasis being placed on: (a) research to shift the production function upwards; or (b) from increasing extension to inform farmers how to increase their efficiency with the current technology.

Economic efficiency is composed of two components, namely, technical efficiency and allocative efficiency. Allocative efficiency refers to the extent to which a farmer combines inputs to achieve the greatest financial gain. Technical efficiency is concerned with the efficiency of the transformation of inputs to physical output. That is, for efficient production farm output should lie on the envelope curve, or production function, which traces out the maximum quantities of output from varying quantities of inputs under a given technology. When technical efficiency is defined in terms of maximum output from a given bundle of measured inputs, it means that only those farmers who are technically efficient will operate on the production function. Farms whose input-output peformance falls below that of farms on the production function are classed as being technically inefficient.

* Agricultural Economics, School of Agriculture and Forestry, University of Melbourne, Parkville, Vic 3052, Australia.

† The findings discussed in this paper come out of a larger study 'Technical Efficiency of Rice Production in Selected Villages of Indonesia' N.M. Esparon 1989, unpublished master's thesis, The University of Melbourne.

Table 1. Village profiles.

Source	*Desa*	*Kabupaten*	*Kecamatan*	DAP Input	DAP Marginal Product (hours/ha/crop)	
No 9 W.J. PATANAS	Pagelaran	Pagelaran	Cianjur	46	24	(9.4)
No 11 W.J. PATANAS	Nagrak	Banjaran	Bandung	109	11	(4)
No 14 W.J. PATANAS	Pamoyanan	Ciawi	Tasikmalaya	13	ns	
No 15 W.J. PATANAS	Cipanas	Tanjungkerta	Sumedang	96	ns	
No 7 E.J. PATANAS	Malingmati	Tambakrejo	Bojonegoro	132	-4	(2)
No 11 E.J. PATANAS	Prayungan	Sumberrejo	Bojonegoro	53	ns	
No 12 E.J. PATANAS	Sumberkalong	Kalisat	Jember	90	ns	
No 24 E.J. PATANAS	Sumberrejo	Gondang	Nganjuk	81	2	(1)
W.J. DAP Survey	Padamulya	Pagaden	Subang	152	9.7	(7)
W.J. DAP Survey	Tanjungwangi	Subang	Subang	118	15	(9)
LOMBOK Survey	Jontlak	Central Lombok	Lombok	293	ns	

Standard errors in parentheses.
Source: Esparon (1989).

The difficulty in testing for technical efficiency is to estimate production functions which accord with the above theoretical definition. Regression methods which use ordinary least squares (OLS) with the assumption of a normally distributed disturbance do not usually provide such functions. Recent advances in the theory and practice of estimating stochastic 'frontier functions' have brought empirical estimates of production functions much closer to their theoretical definition of envelope curves or frontiers. In this study of technical efficiency the reasoning of Farrell (1957) is followed. According to Farrell (1957) technical inefficiency arises when more than the least bundle of inputs are used to produce one unit of output. Estimation of the frontier production function in this study is based on the model proposed by Aigner et al. (1977).

Important determinants of rice production in Indonesia are land area, the form of power (e.g. labour power, tractor power or DAP), fertilisers and seasonal effects (Soekartawi and MacAulay 1982; Nehen 1983; Kasryno 1985; Siregar 1987). To date, studies by Soekartawi and MacAulay (1982), Nehen (1983), and Kasryno (1985) have considered DAP as a determinant of rice production in Indonesia. These studies have all shown that DAP is a significant variable, although in one case cited by Kasryno (1985) DAP was not significant. However, little attention has been given to the question of technical efficiency in Indonesian rice production, as indicated by the paucity of studies in the area. The only study to consider technical efficiency in Indonesia in a framework similar to that used in this study is that of Siregar (1987), though DAP was not included in this estimated function for rice production.

The Data

This study used cross-sectional survey data of farms from eleven *desa* (villages) of Indonesia. Eight *desa* were surveyed by the West and East Java National Panel of Farmers Study (*Penelitian Panel Petani Nasional* or PATANAS) surveys, information from two *desa* was collected by the DAP Project survey, and information from one *desa* in Lombok Island, Indonesia, was gathered by Sarwono referred to in this paper as the LOMBOK Survey.* The eleven *desa* selected for analysis are given in Table 1.

The measurable inputs to the production of rice were:

1. Area, measured in hectares;
2. Preharvest labour, measured in hours or days. This included all classes of labour without differentiating by sex or age used in land preparation, planting, weeding and fertilising. Harvesting labour was included for PATANAS West Java;

* The PATANAS data were provided by the Center for Agro-Economic Research, Bogor, Indonesia. I would like to thank Dr F. Kasryno and all his staff (especially Mr Stanley Wood and Mr Sjaiful Bahri (Asep)) for their considerable help.
DAP Project was sponsored by ACIAR to study the multidisciplinary roles of DAP in Indonesia. Two villages in Subang were selected and daily information about their farm activities were closely monitored.
The LOMBOK Survey was undertaken by Mr Djoko Sarwono in 1987 in *desa* Jontlak.

3. Urea measured in kilograms;
4. TSP (triple superphosphate) measured in kilograms;
5. Fertilisers applied which was recorded in Rupiah;
6. Pesticides applied which was recorded in Rupiah. The pesticides were mostly Hopsin, Furadan and Diazinon.
7. DAP:

   West and East Java PATANAS — animal power was measured in hours. It was not possible to distinguish between the sources of animal power, that is, whether buffaloes or cattle were used. Buffaloes are by far the most likely source of animal power in West Java, whilst cattle are more common than buffaloes in the four *desa* analysed in East Java.

   DAP Survey — animal power was measured in days. Buffaloes and cattle were used either in pairs or singles. In *desa* Padamulya and *desa* Tanjungwangi 55% and 73% respectively of the sampled farmers used animal power.

   LOMBOK Survey — animal power was measured in hours. There were two methods of using draught animal power. The first type used pairs of cattle to pull draught implements and the other method used a group of buffaloes to trample over the *sawah* plots.

Methodology

The stochastic frontier as proposed by Aigner et al. (1977) can be expressed as: $\ln Y = f(\ln X) + \epsilon_i$ where the error term, ϵ_i, in these models is composed of two components, ν and μ. The symmetric component ν accounts for purely random variation of the frontier across farms due to effects of measurement error, other statistical 'noise,' and/or random shocks outside the control of the farm. Thus the frontier itself can vary randomly across farms, or over time for the same farm. The other one-sided component μ is truncated at zero and captures the effects of technical inefficiency relative to the stochastic frontier. That is, μ_i pushes the farm below its stochastic production frontier. This nonpositive disturbance μ_i means that each farm's output can only lie on or below the frontier. Any such deviation is under the farmer's control, and this is attributable to technical inefficiency.

According to Aigner et al. (1977), the variances of ν_i and μ_i can be estimated, to give evidence of their relative size (where $\lambda = \sigma_\mu / \sigma_\nu$ given that $\sigma^2 = \sigma^2_\mu + \sigma^2_\nu$). From the value of λ it can be decided whether the disturbances are due to the symmetric or nonpositive errors. For example, when $\lambda^2 - 0$ it implies that either $\sigma^2_\nu \rightarrow \infty$ and/or $\sigma^2_\mu \rightarrow 0$. In this case the symmetric error dominates in determining of value of ϵ_i. When this occurs the conclusion is that farmers are technically efficient in their use of this particular bundle of inputs, and any differences in their level of production are due solely to the symmetric random errors. When $\lambda \rightarrow \infty$ the nonpositive errors become the dominant source of the disturbance and the density function of ϵ then takes the form of a negative half-normal (Aigner et al. 1977, p. 26), and the conclusion is that farmers are technically inefficient. In this study the stochastic maximum likelihood estimates (MLE) production frontier model of Aigner et al. (1977) was estimated using LIMDEP, the statistical package of Greene (1986). The parameters estimated in the LIMDEP frontier regression model are β, λ and σ^2.

A linear model was used for estimating the production functions for rice. This model was chosen partly because zero levels of inputs for some farms precluded the use of the Cobb-Douglas model. Further, a model without an intercept was preferred to a model with an intercept because no inputs in agriculture results in no production.

Empirical Results

The OLS rice production functions for all eleven *desa* are summarised in Tables 2 and 3.

Lombok Survey In *desa* Jontlak rice farmers use two different techniques of land preparation. One technique uses buffaloes for trampling, and the other technique uses buffaloes for pulling ploughs. Two linear production functions were estimated (Table 4): with case I the two different land preparation techniques were regressed as independent variables; and with case II a dummy variable was used to distinguish between the two different techniques of land preparation. For case I the only positive significant variable affecting rice production between these *sawah* plots was land area. Results from case II showed that the dummy variable for the different techniques of land preparation was not significant. This implies that there were no significant yield differences achieved between the trampling or ploughing techniques of land preparation.

Production functions for pooled data Three linear OLS production functions (referred to as cases I, II, III) were applied to the pooled information of *desa* 9, 11 and 14 of West Java

Table 2. Levels of significance of variable inputs.

	Area (ha)	Lab	DAP	Urea	TSP	Pest	Fert	Season
Desa 9 West Java	ns	ns	**+	**+	ns	–	–	–
Desa 11 West Java	**+	ns	**+	**+	ns	–	–	–
Desa 14 West Java	**+	ns	ns	ns	ns	–	–	–
Desa 15 West Java	**+	**+	ns	**+	**+	–	–	–
Desa 7 East Java	**+	**+	**–	**+	**–	–	–	–
Desa 11 East Java	**+	ns	ns	ns	ns	–	–	ns
Desa 12 East Java	**+	ns	ns	**+	ns	–	–	ns
Desa 24 East Java	*+	ns	*+	**+	ns	–	–	ns
Desa Padamulya	*+	**+	ns	*–	**+	ns	–	ns
Desa Tanjungwangi	ns	ns	*+	**+	ns	ns	–	–
Desa Jontlak	**+	ns	ns	–	–	ns	ns	–
No. of time sign.	9/11	3/11	5/11	8/10	3/10	0/3	0/1	0/4
Pooled information 9,11,14 West Java	**	ns	**	**	ns	–	–	–

**+ significant and positive at the 5% level.
*+ significant and positive at the 10% level.
**– significant and negative at the 5% level.
*– significant and negative at the 10% level.

Table 3. Marginal products for all *Desa*.

	Area (ha)	Lab	DAP	Urea	TSP	Pest	Fert	Season
Desa 9 West Java	ns	ns	24	10	ns	n	n	n
standard error			9.4	4.4				
Desa 11 West Java	3995	ns	11	6	#	n	n	n
standard error	1281		4	3				
Desa 14 West Java	7315	ns	ns	ns	ns	n	n	n
standard error	1416							
Desa 15 West Java	3743	0.4	ns	2	3	n	n	n
standard error	836	0.1		0.7	1			
Desa 7 East Java	1236	0.8	–4	7	–4	n	n	n
standard error	334	0.3	2	1	2			
Desa 11 East Java	4721	ns	ns	ns	ns	n	n	ns
standard error	801							
Desa 12 East Java	2730	ns	ns	3	n	n	n	ns
standard error	401			1				
Desa 24 East Java	1430	##	2	5	ns	n	n	ns
standard error	402		1	1				
Desa Padamulya	1678	11	9.7	–3	6	–0.01	n	–201
standard error	886	5	7	1	2	0.01		241
Desa Tanjungwangi	ns	ns	15	6	ns	ns	n	n
standard error			9	2				
Desa Jontlak	7041	ns	ns	n	n	ns	ns	n
standard error	1501							
Pooled information	2764	ns	12	8	4	n	n	n
9,11,14 West Java	856		3	3	3			
standard error								

ns Not significant variables.
n Variable not used in the input matrix.
TSP was dropped because it was highly correlated with urea.
Labour was dropped because it was highly correlated with area.

Table 4. OLS linear production functions of sampled *sawah* plots in *Desa* Jontlak, Lombok 1987–88.

	Case I	Case II
Dummy for land preparation D1 = 1 for ploughing	–	–181.17 (186.8)
Area (ha)	5989.61** (1509)	7200.5** (1625)
Preharvest labour (hours)	0.17 (2.98)	–2.24 (2.81)
Ploughing animal (hours)	–7.7 (8.2)	–
Trampling animal (hours)	0.99 (4.5)	–
Fertilisers (Rp)	–0.046 (0.029)	–0.05* (0.026)
Pesticides (Rp)	0.03 (0.11)	0.069 (0.124)
adj R^2	0.83	0.72
F statistic	15.03**	14.18**
Durbin-Watson Test	1.86	1.65
Breusch-Pagan 'Q'	9.48	8.34
Critical value $\chi^2_{0.05}(p-1)$	12.59	9.49
Sample size	21	21

Standard errors in parentheses.
** Significant at the 5% level.
* Significant at the 10% level.

The quantity Q = ESS/2 is, under the null hypothesis, asymptotically distributed as χ^2 (p–1). Thus if Q > $\chi^2_{0.05}$ (p–1) one would reject the null hypothesis of homoscedasticity at the 5% level (Breusch and Pagan 1979).

Table 5. Pooled OLS linear production functions for sample rice farmers from West Java (*Desa* 9, 11 and 14).

	Case I	Case II	Case III
Dummy for *desa* 11	–706.12** (220.3)	–612.66** (302.6)	–698.16** (249.2)
Dummy for *Desa* 14	289.62* (160.6)	–0.511 (177.9)	178.72 (241.0)
Dummy for DAP Users	–	–114.3 (209.9)	–
Area (ha)	3173.63** (723.8)	5549.24** (633.4)	2764.35** (865.0)
Total labour (hours)	0.132 (0.106)	0.305** (0.115)	0.114 (0.121)
DAP (hours)	10.75** (2.14)	–	11.89** (2.65)
Urea (kg)	7.87** (2.09)	7.96** (2.41)	7.78** (2.58)
TSP (kg)	2.53 (2.67)	–2.15 (3.15)	3.81 (3.37)
adj R^2	0.97	0.96	0.97
F-Test	413.53**	310.27**	305.97**
Durbin-Watson Test	2.49	2.17	2.49
Sample size	85	85	62

** Significant at the 5% level.
* Significant at the 10% level.
Standard errors in parentheses.

(Table 5). For case I animal services was used as one of the regressors, whilst the regression equation of case II contained a dummy variable for farmers that used animal power. Case III was a regression for production only by those farmers that used DAP. From case I significant variables to rice production were the coefficients for land area, animal services and urea application. From case II it was shown that users of animals were not significantly different in their technical efficiency of the production of rice compared to those farmers that did not use animal power to cultivate their land. From case III the marginal product (MP) of extra animal power at current levels of usage was obtained.

MLE frontier production functions Using the LIMDEP software package of Greene (1986), stochastic frontier functions were estimated, using MLE, for all eleven *desa* separately, and also for the pooled information of *desa* 9, 11 and 14 of West Java. Results from the stochastic frontiers indicated that all farmers studied in each of the eleven *desa* were technically efficient in their rice production, i.e. farmers were technically efficient when compared with each other in the same *desa.*

Discussion

The main point to note is the extent to which the significance and marginal productivity of inputs to rice production varied, *desa* by *desa.* There are few widely applicable general conclusions, which means that detailed case by case approaches to specific questions about rice production efficiency in specific areas and farms is required as an adjunct to approaches such as this one.

The significance of variables and their marginal productivity are summarised in Tables 2 and 3 respectively. Land area was a significant, positive variable for rice production in nine of the eleven *desa.* For eight out of the eleven *desa* some form of fertiliser was shown to be a significant input. In some cases the other variable inputs were significant determinants of rice production, but these varied greatly among different *desa.* The results illustrate the different responses received in rice yields under the conditions of production in each *desa.* Manual labour measured in this study included labour for land preparation, and crop husbandry, and for the West Java survey this also included harvesting labour. Labour was a significant and positive contributor to rice production for only three of the eleven *desa* analysed. The presence of significant, positive MP for labour could be due to labour being limiting for certain times, or could be due to labour having an opportunity cost higher than the value of the extra production, or could be due to the impact of risk, e.g. unanticipated extra output due to favourable seasonal variation.

Land cultivation in the surveyed *desa* was done by manual labour, DAP and tractors. DAP was a significant, positive variable for rice production for four out of the eleven *desa*, and was significant and negative for rice production in one *desa*. The MP of rice for DAP for the pooled information of *desa* 9, 11 and 14 of West Java PATANAS was significant and positive at a value of 12 kg of rice for one extra hour of animal power. The most notable aspect of the MP of DAP is the difference between the results for East and West Java. In East Java the MP for DAP were either insignificant or small (-4, 2 kg of rice). From the PATANAS survey in West Java, DAP had significant MPs of 24 and 11 kg of rice in two out of the four *desa* analysed. The DAP Survey in West Java revealed significant DAP MPs of 10 and 15 kg of rice for *desa* Padamulya and *desa* Tanjungwangi, respectively. These MPs from the West Java PATANAS and DAP surveys are moderately similar. More importantly, in East Java, which has a much higher density of draught animals (including cattle) than does West Java, the MPs for DAP were much less than in West Java. The higher MP findings for the West Java areas imply that the supply of DAP is a limiting factor or constraint in the West Javanese farming systems. In East Java, which had a higher density of animals, the MPs were close to zero. This suggests the supply of DAP services was much less of a constraint on production in rice production systems in East Java.

For the pooled sample of West Java, results showed that the dummy variable for animal users was not significant. This means that rice yields did not differ significantly irrespective of the techniques of land preparation used. Empirical results from *desa* Jontlak indicated that there were no statistical differences in the rice yields obtained by ploughing or by trampling. Research by Nehen (1983) showed that for the dry season tractor cultivation achieved higher yields than did animal power, which in turn outperformed manual cultivation. For the wet season, Nehen (1983) found rice yields using animal power were higher than output achieved using tractor power, which was in turn superior to manual cultivation.

If the different land preparation techniques in practice were to be pure technical substitutes (which Nehen 1983 disputes) then the price of renting animal power would be determined by the supply of buffaloes as well as the supply of alternative sources of power. This has important significance if true, as the implication for the future of DAP in Indonesia would be that if the supply of draught animals grows relatively slowly (and does not become relatively cheaper) then their use in the longer term may (depending on relative prices) be most important in areas where mechanisation is not possible and where there are shortages of labour for land preparation.

Conclusion

The main finding from this study is that all farmers in these eleven *desa* are achieving high levels of technical efficiency. Given the techniques they are using, the rice farmers studied are technically efficient. Or, within their environment and given their level of technology, these Indonesian rice farmers are using their technology efficiently.

The finding of technical efficiency has some implications for *both* research and extension. If these farmers are as technically efficient with their current technology as is practically possible, this would mean that there will be: (a) no need to inform these farmers of ways to increase their production using the *same* technology; and (b) future gains in productivity will have to come from shifts in the production function. This would involve new technologies being introduced to the production of rice, which would imply that there is a significant need for technical research into such things as reducing the effects of limiting factors, and increasing the potential output through improved varieties. This finding does *not* deny that extension services need to be done. After all, it may be that higher technical efficiency is possible with currently known, but not used, technology. If this is so then extension effort would be needed to inform rice farmers of such findings.

Land area was the most significant determinant of rice production in Indonesia. But, given the limited availability of land for rice production, productivity changes will have to come from the nonland inputs. Other significant inputs to rice production varied across *desa*, with urea, DAP and labour featuring as significant in various *desa*. The significance of DAP varied considerably among the different *desa*. DAP was a significant, positive variable for four of the eleven *desa* analysed, and a significant negative input in one *desa*. Interestingly extra output derived from extra DAP in rice production was markedly higher in West Java than East Java which could mean that there may be demand for greater DAP use in West Java if the animals were available, depending on price of course.

Finally, the differences in the importance of various inputs to rice production in different *desa* throughout Indonesia is indicative of the sometimes subtle but always significant technical, economic and human 'uniqueness' of rice production in particular areas on particular farms. The validity of findings from general surveys to particular farms has to be assessed for each case. Thus assessments of technical and economic efficiency by well-trained people at the farm level will remain an important and valuable task.

Acknowledgments

This study was funded by the Australian Centre for International Agricultural Research. I would like to thank Mr Neil Sturgess who has been very closely involved with all aspects of this work.

References

Aigner, D., Lovell, C.A., and Schmidt, P. 1977. Formulation and estimation of stochastic frontier production function models. Journal of Econometrics, 6, 21–37.

Breusch, T.S., and Pagan, A.R. 1979. A simple test for heteroscedasticity and random coefficient variation. Econometrica, 47(5), 1287–1294.

Esparon, N.M. 1989. Technical efficiency of rice production in selected villages of Indonesia. Unpublished Master's Thesis, The University of Melbourne, Australia.

Greene, W.H. 1986. LIMDEP, Econometric Software, Brooklyn, New York.

Kasryno, F. 1985. Efficiency analysis of rice farming in Java 1977–1983. Unpublished paper, Center for Agro-Economic Research, Agency for Agricultural Research and Development, Bogor, Indonesia.

Nehen, I.K. 1983. Choice of technique in land preparation, West Java, Indonesia. Unpublished Doctoral Thesis, Monash University, Australia.

Siregar, M. 1987. Effects of some selected variables on rice-farmers technical efficiency. Journal Agro Ekonomi, 6, 94–102.

Soekartawi, and MacAulay, T.G. 1982. Aspects of small-farmer productivity in four villages in East Java, Indonesia. Paper presented at the Annual Conference of the Australian Agricultural Economics Society, Melbourne, Australia.

Indonesian Smallholder Cattle Development Project: Description of the Credit Component

Bambang Soejoto and Michael G. McEvoy*

Abstract

A project to assist smallholders in the outer islands of Indonesia to increase food crop production through the provision of draught animals began in 1981, supported by the International Fund for Agricultural Development. The project is intended to improve the long-term domestic supply of livestock to the Indonesian Islands (other than Java), through a credit program to strengthen the Directorate General of Livestock Services (DGLS) and increase forage production and develop a forage seed production credit component to be implemented through smallholders in the poorer areas of the Eastern Islands.

The concept for the project to assist transmigrant livestock and food crop development in Indonesia was the outcome of a World Bank Cooperative Program Livestock Sector Survey in 1977. The project (Phase I) proposed the procurement of 45 000 Bali cattle in East Java (Madura cattle) and South Sulawesi, and NTT for distribution in Sumatera. The major objectives are to: (a) increase overall productivity and employment and to raise the incomes of the project farmers; (b) increase food crop production by increasing the area under cultivation and yields; (c) provide draught animal support to (a) and (b) above and introduce credit for the draught animal distribution program, and the forage seed production component; and (d) provide a package of technical services, forage seed and forage programs to farmers, including credit collection. The project has been particularly successful in implementation in both physical and financial aspects, due to the administrative structure and management systems instituted at project start-up.

Introduction

THE Transmigration Program in Indonesia, while providing a house, seeds, food support, etc. to transmigrants, was not making credit available until the implementation of this project. The outer islands, traditionally less fertile than Java, and the transmigrants being mainly young families, lacked the resources to develop the land, especially land cultivation.

This project was designed primarily to give the transmigrant access to credit to purchase a draught animal, plough and to receive the necessary technical support (e.g. forage development, animal health, etc.). An important long-term objective was to make the transmigrant aware of credit use and responsibility. Phase I of the project began in 1981-82 and was completed in 1986-87. It was funded by the International Fund for Agricultural Development (IFAD) (US$26 million) with counterpart funds from the Government of Indonesia — US$14 million. Phase II began in 1986-87 with funding from the World Bank (US$32 million), IFAD (US$12 million) and the Government of Indonesia (US$22 million).

The Phase II Smallholder Cattle Development Project Credit Scheme is an example of a project designed to provide credit. Some results of the scheme after 7 years of operation are presented in this paper.

* Project Director and Consultant Team Leader and Advisor to the Project Director, respectively, Ministry of Agriculture, Directorate General of Livestock Services, Jalan Salemba Raya 16, Jakarta, Indonesia.

Objectives

Cattle play an important role in the development of agricultural production in Indonesia, traditionally as the primary source of draught power, but are increasingly important as a capital reserve and a source of cash income. Development in the Outer Islands, especially in transmigration areas, has been constrained by undercropping due to inadequate farm labour or lack of draught power. The project was designed to increase agricultural production by overcoming the constraints of draught animal power.

The major components of the project as it was designed were:

(a) Cattle procurement and distribution in Phase I provided for procurement of 45 000 head phased over 6 years from overstocked areas in the Eastern Islands and distributed mainly to transmigration areas in five provinces in Sumatera; in Phase II 84 500 head will be distributed over 6 years.

(b) Infrastructure for cattle transfer: quality control centres, quarantine stations and holding yards in the procurement areas; improved port facilities; and of receiving stations at the distribution points.

(c) Forage improvement: improved forage production on farms, introduction of adapted pasture legumes, seed production.

(d) Institutional development: creation of project management office in DGLS and development of services at the district and village level.

(e) Program support: consulting services, monitoring and evaluation and cattle disease research.

Organisation

The success of the project, especially credit collection (averaging 81% in year 6) is due mainly to the manner in which the management structure was designed, so that authority was delegated with the corresponding accountability.

The project is managed at the national level through the Project Management Office (PMO) whose prime functions are to: ensure project policy is implemented; ensure that budgets are obtained from government and reimbursements from loan funds are on schedule; contract and implement major contracts; and monitor the project continuously for physical and financial performance and measure impact.

At the provincial level the project is managed by a Project Management Unit (PMU) which provides support to field staff in: coordination of overall activities within the project locations; coordination with provincial authorities involved in transmigration; local financial matters; and technical guidance to field staff.

At the location level the field staff (Satgas) are responsible for: distributing the original animals and necessary documentation (e.g. Credit Notes); collecting credits by redistributing animals and selling surplus males and culls; ensuring the farmers establish forage and utilise it; animal health, both routine and emergency; monthly reports on animal performance (e.g. births, deaths, credit repayments); and coordination at field level between all entities concerned (e.g. transmigration, Bank Rakyat Indonesia, etc.).

The Credit Scheme

Draught Animal Credit Component

The Credit Concept

The concept of credit in this project varied from existing Government of Indonesia Credit Programs, in that the package: provided one draught animal per farmer plus a noncredit technical services package consisting of forage development, animal health, and field staff being on site; monitored the value of the animals returned as payment and if the local market value was greater than the original CIF value plus interest the farmer was refunded the cash value; required the animals collected as credit to be redistributed within the same village until all farmers had received one animal; ensured that credit flow was clearly defined through a series of agreements: loan agreement between the COI and IFAD; financing agreement between the Ministry of Finance and Bank Rakyat Indonesia (BRI); subfinancing agreement between BRI and the DGLS; credit agreement between the BRI and recipient farmer.

Credit collection was the responsibility of the project itself with the field staff actually collecting in-kind and redistributing and/or selling the surplus/cull animals.

A key factor in the implementation of this credit was ensuring prior to implementation all levels of Project management and recipients fully understood the procedures for obtaining the credit, the system of processing the credit and the repayment of the credit. It was made very clear at all levels where, why and how much responsibility lay in the credit process, especially collection.

To implement the concept extensive training was carried out. Satgas and farmers are trained extensively prior to cattle distribution in the credit systems. Emphasis was placed on the public meetings between key farmers, farmers and Satgas to explain and demonstrate with diagrams the actual credit documents and how the process operates. If an area was detected as developing some weakness a special 'task force' from PMO Jakarta visited the area.

Guidelines and Regulations

As mentioned previously the project developed a series of project guidelines and regulations to ensure that the credit would be available to farmers and that they would repay that credit. It would be useful if we look briefly at some of the details of this.

It has always been project policy that close coordination be maintained with all government entities directly and indirectly associated. This has been a major reason for the success of the project to date. Policy has also dictated delegating authority and concurrent responsibility.

The subfinancing document provided for a number of processes among which were: the actual site selection in Transmigration areas was undertaken by a task force whose members consisted of the Projects Provincial Management Unit (PMU), the Provincial Livestock Inspector, the Provincial Governor's Office, the Regional Transmigration Office, Bank Rakyat Indonesia (BRI) and the Kabupaten Government (District). When the 'task force' had completed its selection of sites this was confirmed by a decree issued by the Provincial Livestock Inspector.

The task force operated under PMO guidelines, the principal ones being that: the site must be accessible; the site must have been settled at least one year; no similar scheme had been implemented in that location previously; the site should have soil type suitable for cattle (e.g. swamp areas were excluded); the location should have about 1500 families who have no cattle, with 500 of them being given animals and the next 1000 obtaining animals from the repayment cattle.

Information to Participants

This was provided by the task force in close cooperation with the next lower levels of government: the Kecamatan (District level) — the Kepala Desa (Village Head) — Kelompok Tani (Farmer Groups). Those farmers interested in obtaining credit were required to register with the projects and required to: complete the project application form assisted by the task force (in practice field level Satgas staff), and provide a letter from the Village Chief that the applicant was a permanent resident of the village.

Farmer Selection

This was undertaken by the task force with participation from the Subdistrict Government, Village Chief and Local BRI Office (if one was available).

Selection Criteria

The criteria were based on information supplied by the project and used as a guideline by the task force. The farmer, in order to qualify, was required to meet the following criteria: be a transmigrant or local farmer (project guidelines suggested 10% of recipients be local farmers); be a permanent resident of, and of good standing in, the community; not in possession of any draught animals; be in possession of about 2 ha of land (minimum allocation under transmigration guidelines); and be able to provide adequate fodder.

The farmer who met the above was then required to sign a formal agreement with the project which stipulated that the recipient: agrees to technical guidance (e.g. forage development schemes provided by the project); agrees to attend training sessions which cover the project concept, the credit system, recipient obligations, and technical aspects of animal management and utilisation for draught power; agrees to become a member of a farmers group; agrees to join an existing or planned village cooperative (KUD); agrees to sign a Credit Agreement with BRI.

The farmers who complied with the above and signed a formal agreement were then issued a certificate of participation.

The Credit Package

This consists of one female draught animal to every farmer and one female and one male to every tenth farmer who is normally the 'key farmer' or head of the farmer groups.

The repayment of the credit was based on the recipient of one animal repaying two animals within 5 years — one before the end of the third year and the last before the end of the fifth year. The bull recipients are required to pay back three animals, one at the end of the third year and the other two at the end of the fifth and sixth years, respectively. The age of all pay-back animals is about 18 months.

The Credit Risk

This is borne by either the farmer or the Government of Indonesia depending on cause and areas of responsibility.

The project (GOI) obligations under the credit agreement between the farmer and the BRI were: Sterile animals were to be replaced at no cost by the project. The criteria were if the cow showed no signs of pregnancy 6 months after distribution, and was mated on four subsequent occasions and did not become pregnant she was replaced. A bull was declared sterile after a semen test.

The credit was then cancelled by the BRI, a replacement animal provided and a new credit issued. The farmer could opt not to accept a new animal and drop out of the scheme.

The obligations of the farmer are clearly spelled out in the credit agreement, and the loan falls due and payable if the animal dies of neglect by the farmer or the animal is lost through negligence on the part of the farmer.

Impact of Animal Performance on Credit Collection

The project has concentrated almost exclusively on Bali cattle (97%). During implementation many valuable lessons have been learned affecting individual animal performance, beginning at the procurement farm, transporting, distribution and subsequent on-farm management by the transmigrant. These are too numerous and varied to discuss in detail, however a few major factors will be discussed.

The first is calving performance in the first year of distribution. At appraisal 60% calving rate was projected, but in practice the project achieved only 5% for a number of technical reasons that accumulate to stress the Bali cattle. This virtually added 1 year to the credit term. No Bali cattle movement of this size had ever been undertaken (92 500 head contracted to date, 82 831 distributed and 28 000 collected as credit repayment and subsequently redistributed or sold), so it was a learning process for all concerned. The performance of the Bali cattle during procurement and distribution is summarised in Table 1.

The animal performance on farm varies according to: (1) soil type low pH; (2) off-farm work; (3) draught animal importance/utilisation; (4) soil type, high soluble aluminium; (5) long dry season, (6) technical services; (7) site/location selection; (8) original standard of site preparation; (9) animal disease/internal parasites/external parasites; (10) mineral deficiency; (11) forage development/utilisation/low nutritional intake; and (12) field staff (Satgas) inputs/efficiency.

The above factors and their combinations affected animal performance between locations. An example is Riau Province where in the third year the highest calving was 92% and the lowest 12% (Table 2).

Forage Seed Production Credit Component

Potential growers were carefully screened for their expected capacity to generate forage seed of the quality required.

As part of this process their farms were inspected and the location and size of the areas of ground to be used for forage seed production determined.

Table 1. Bali cattle performance in procurement, shipping and distribution.*

Procurement				Shipping		Receiving Grounds					Farmers		
In	Reject	Accept	Load	Mort.	Unload	In	Reject	Mort.	Out	Arrive	Reject	Mort.	Replace
101439	19058	82381	82381	493	81888	81888	1037	871	79980	79880	528	932	3861
%	19.0	81.0	-	0.6	99.4		1.3	1.1	-	-	1.0	1.1	

* Fiscal year 1981-82 to 1988-89 (partial).

Table 2. Average calving (%) from project start-up (1982-83) over a 6-year period (to 1988-89).

	Year					
(1981-83)	1	2	3	4	5	6*
Calf % (avg)	5	46	52	45	31	48
High	20	80	92	75	62	63
Low	0.2	6.3	18	19	10	24

* Calf percent drops in latter years as project drops farmers after credit repayment, so remaining farmers/cows in latter year are poorest performers.

From this it was possible to make precise estimates of the amount of seed, transplant seedlings, fertiliser, herbicide and insecticide required to initiate production by each grower.

Credit to the value calculated was issued to each grower through the Bank Rakyat Indonesia (BRI).

The duration of this credit was 3 years with interest over that period being calculated at 6%/year, with 1 year grace period without interest payment. No collateral was required for the credit issued.

Repayment was in the form of forage seed at the preagreed price of seed.

At any time within the 3-year credit period the grower could repay all or a portion of his loan with the seed that he was selling through the project. This was coordinated through the Kelompok Tani (farmer groups) that were developed within the seed-growing areas.

In addition to coordinating the repayment of credit these farmer groups served as centres for the discussion of management problems. They facilitated general extension work by the Satgas and coordination between forage seed-growing activities and other farm works. A very significant role for these farm groups was in the utilisation of the income derived from the sale of forage seed. The seed that was purchased in the name of an individual would frequently, in fact, be the production of a number of small growers. This same group then had a genuine interest in these sales after they had been placed in the savings bank account (TABANAS) of the registered seller of the seed. The farm group then became the focus of discussion and decisions on how money in these bank accounts was to be spent.

On the basis of certified records of seed delivered to the PMU, the BRI would arrange for payments to be made to the growers who had supplied the seed.

This was achieved through arrangements with the Satgas and the Village Chief to visit the locations and make payments. It was part of the agreement entered into by growers coming into the project, that half of the payments for forage seed would be placed in savings accounts opened by the individual growers.

Withdrawals from these accounts were only permitted for purchases that could be justified as productive uses of the money set aside in these accounts. Much of this was utilised for the purchase of small livestock to be used as part of the overall Kelompok production system.

Credit Administration

It was realised early that the volume of credit especially for cattle could not be monitored manually, and therefore credit control was made an integral part of the Management Information System of the Project (MIS), controlled by a mainframe computer in Jakarta. The programs of the MIS were specially written for the various project requirements.

Credit Monitoring System

This system was based on individual Cow Numbers. At procurement each animal is branded and tagged with a number which indicates the Contract number and Individual Animal number. Around this is built the whole of the project Management Information System, Socioeconomic Impact Studies, and Special Studies.

Offspring automatically receive a number which relates to the Dam number. The field staff report monthly on a number of information requirements including Calvings Dam number, Calf Mortality and Adult Mortality. This information when entered into the central computer automatically allocates offspring the number the field staff will allocate.

Credit repayments are contractually due at 18 months, so in the quarter prior to the 18 months the program will indicate animals due for repayment by showing: - Province - District - Sub-district - Satgas Unit - Village - Name and address of farmer (Creditor) - Contract no. and individual dam no.

The program also indicates those whose credits have been paid and those past due on a separate printout.

Credit Recovery, Animals

Credit recovery overall has been satisfactory with areas of very high performance and some very low areas. Performance is directly related to transmigration site conditions (Table 3).

By mid 1989 (phase I and II) the project had contracted 92 500 head of Bali cattle from the Eastern Islands (the provinces NTT, NTB and South Sulawesi) and distributed 82 381 (the balance are in process), redistributed and sold (surplus) some 28 000 head.

Credit Recovery, Forage Seed

The number of credits issued and repayment rate are shown in Table 4. Credit recovery has been particularly satisfactory due mainly to a heavy input of technical services and good cooperation with the channelling bank.

Table 3. Status of cattle credit repayment.[a]

Province	No. farmers	No. credit repaid, Year 6	%
Lampung	2626	2150	82
South Sumatera	4047	3809	94
Riau	3213	2132	66
Bengkulu	2440	1863	76

[a] No farmers with final credit payment due end of 1988.

Table 4. Amounts of credit and rates of repayment.

(Province) District	No. farmers	Credit/ farmer (Rp)	Percentage who had repaid credit		
			Year 1	Year 2	Year3
(NTB)					
West Lombok	190	7 308	73	87	100
Central Lombok	173	4 147	89	100	100
East Lombok	106	4 179	33	100	100
Sumbawa	29	12 293	3	100	100
(NTT)					
Kupang	73	27 872	–	–	100
TTS	16	22 689	–	–	100
Belu	100	9 162	–	–	100
Sumlili	74	2 027	–	–	100
Total	761	18 369	43	62	100

Conclusions

The potential for draught animal credit in transmigration remains large. Only 25% of transmigrants have had the opportunity to obtain credit to date (including all projects).

The key factors in the credit program are to ensure the farmer is given an animal (e.g. Bali cattle) that is suitable for his requirements, that the credit package is one he can handle and understands, and that in the early years (at least during the life of the credit) a complete 'package' of technical services is provided. One of the most important components of the technical services package is to ensure that suitable forage varieties are provided to the farmer, that he understands their use and actually uses them. This project has expended much effort on seed production of suitable varieties adapted to local conditions. The project has produced some 150 000 kg of seed of various legumes suited to the soil types of the distribution areas.

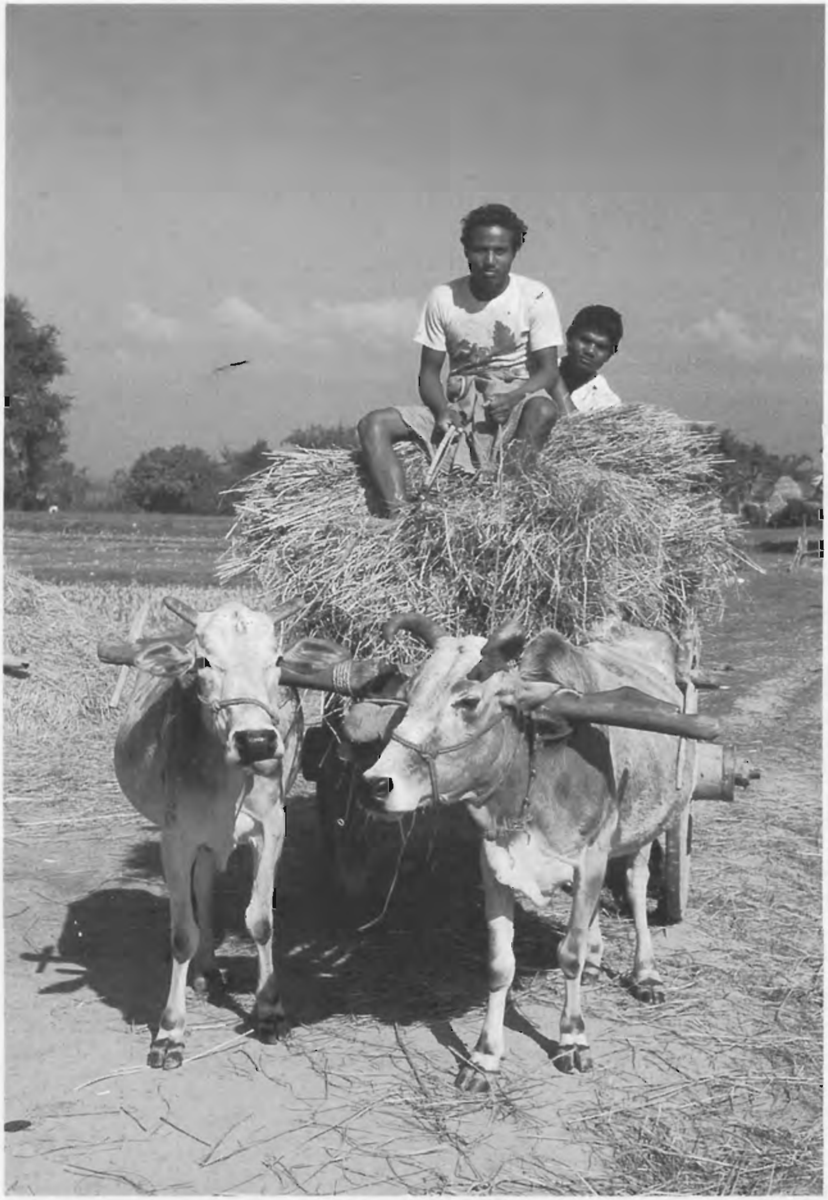
The major varieties are *Leucaena leucocephala, Desmanthus virgatus, Sesbania grandiflora,* Codariocalyx, Siratro, *Stylosanthes* spp. Forage grasses mainly Lampung setaria, *Andropogon gayanus,* Para, and King grass have been distributed as 'Pols' (cuttings). The objective is for each farmer to have the equivalent (along farm boundary roadways, etc.) of 2500 m^2 of forage.

The project at start-up concentrated on Bali cattle, which are very prolific (given average conditions), easy to train to work, works well and after an economic life has a good meat value. Most importantly they are readily accepted by the farmer.

The choice of this breed has been justified over the years and today Bali cattle make up nearly 80% of all draught animals provided to transmigrants.

There are, however, a number of matters that need to be investigated at field level to improve the on-farm performance of Bali cattle. A major one is the ploughing rates and most suitable plough types for various soil types on the outer islands. Presently this project has a cooperative program with the DAP at Ciawi, and we would like to see the program continued at least at its present level.

Field work needs to be intensified to further develop farming systems that fully integrate livestock and pay particular attention to the control of soil erosion by using a combination of forages on the contour.



Section 9
Abstracts

Abstracts

Village Visits as a Means of Motivating Farmers to Become Involved in Farm Trials

A. Thahar, Santoso, Ridwan and M. Winugroho*

Low educational levels of farmers and their consequent inability to assess the credibility of information on livestock improvement is a major constraint to the conduct of farm trials in farming systems research, and hence in the testing of technology. Marked improvement in acceptance of information amongst draught animal rearers was noted in three villages of Subang District, West Java, following a visit in July 1988 by some of the farmers to selected farmers in Central Java. It was concluded that farmers accepted ideas for trial on their farms much more readily after effective communication, i.e. in this case, of the practicality and benefits of growing improved forages and of preserving rice straw.

Such visits are seen as an essential part of the on-farm research procedure needed in village resource development. The general principles of teaching by showing and learning by doing may accelerate the process of farmer participation in farm trials, and hence success in FSR. Conversely, it can be argued that unless ideas for testing have been soundly communicated to farmers involved in a farm trial, the technology itself cannot be said to have failed.

* Sub Balai Penelitian Ternak, Grati, Pasuruan, East Java, Indonesia.

Period of Animal Work per Year and Liveweight Change During Working Season in Two East Java Villages

M.A. Yusran and P.A. Yudi*

A study was conducted from May to November 1988 in Sudimulyo village (0–100 m above sea level) and Martopuro village (300–500 m), to determine the variation in days of animal work per year and in liveweight of draught animals. The two groups of farmers studied at each village site were (A) those with <1 ha of land and (B) those with >1 ha of land.

The average period worked per year by farmers and their cattle was 43.0 and 11.8 days in Sudimulyo, and 65.8 and 38.4 days in Martopuro, for Groups A and B, respectively. Liveweight changes in draught animals during the work period (May–November) were 45.5 kg and 27.6 kg in Sudimulyo, and -24.0 kg and -11.1 kg in Martopuro for farmer groups A and B, respectively.

Statistical analysis showed that total days worked per year, and liveweight gain by draught animals, varied with agroecosystem (i.e. between villages) and was related to livestock density (>200 head/km^2 in Sudimulyo and 100–140 head/km^2 in Martopuro), and to the area of land operated by the rearer. Farmers with <1 ha of land (Group A) work their animals for longer periods (mainly on a hire basis) than those who operate >1 ha (Group B).

* Research Institute for Animal Production, PO Box 123, Bogor, Indonesia.

Comparison of the Use of Wooden Plough and Garu/Sisir in Land Preparation from Wet Rice Cultivation in Tarus Village, Kupang, West Timor

H. Marawali, C. Liem and U. Tonga*

A study was conducted in Tarus village, Kupang District, Nusa Tenggara Timur during the 1988–89 cropping season (January-June 1989). The aim was to introduce the use of animal-drawn wooden ploughs (West Java type), to compare this with the garu/sisir (leveller/harrower), in terms of the labour requirement and also the rice production.

Attempts to introduce animal-drawn metal ploughs in West Timor started over 20 years ago and in Tarus village some farmers use this method. However, the expense of metal ploughs (Rp 70 000) and other factors appear to have deterred most farmers from adopting ploughs. Some farmers have started preparing their land with animal-drawn wooden leveller/harrows, which appear to perform better on deep, wet soils than metal ploughs (which tend to sink).

Four farmers using wooden ploughs with their own cattle and four farmers using only the garu/sisir were monitored. The average time taken for land preparation with the wooden plough was 64.1 hours/ha and with the garu/sisir, 53.3 hours/ha. The time spent by the farmers other than while working the animals for land preparation (i.e. supplying water, planting, weeding, fertilising until harvesting) was 133.4 hours/ha for wooden ploughs and 126 hours/ha for garu/sisir.

The total amount of time spent throughout the period from land preparation to harvesting, was 197.5 hours/ha for wooden ploughs and 179.3 hours/ha using the garu/sisir. The rice yields measured were 4041.5 ± 837 kg/ha for wooden ploughs and 3680.5 ± 787.4 kg/ha using the garu/sisir.

The farmers who normally use the garu/sisir in the areas with deep soil were not interested in using the wooden plough. However, farmers who normally used the metal plough in this village were very interested in using wooden ploughs, as these are much lighter and more easily made and replaced than metal ploughs. Some farmers have sold their metal ploughs in favour of using wooden ploughs in the first season of this trial introduction. The wooden garu/sisir is easier for farmers to make than the wooden plough, but the garu/sisir can only be used in very wet soil conditions and does not invert the soil.

* Sub Balai Penelitian Ternak Lili, PO Box 23, Kupang, NTT, Indonesia.

Comparison of Trampling by Cattle and the Use of Wooden Ploughs for Preparation for Wetland Rice in Naibonat Village, West Timor

C. Liem, A. Saleh and H. Marawali*

A study was conducted in Naibonat Village, Kupang District, Nusa Tenggara Timur in the 1988–89 cropping season on the animal trampling (merancah) and ploughing (traction) methods for rice cultivation. The aim was to evaluate the labour efficiency of the trampling method, compared to animal-drawn wooden ploughs, as a means of land preparation. The trial involved training some farmers to make wooden ploughs and to break in their animals for work. A farmer from West Java was brought to West Timor as a trainer.

Ten farmers using trampling and 10 farmers using ploughs were monitored throughout the period from cultivating to harvesting (December to June). Only the labour in land preparation

* Sub Balai Penelitian Ternak Lili, PO Box 23, Kupang, NTT, Indonesia.

and the rice yields are reported. The average time taken to prepare 1 ha of land was as follows: Trampling: 16.3 hours/ha using 137 cattle, 3-4 operations and 5 people; Traction: 74.5 hours/ha using a pair of cattle for ploughing, harrowing and levelling.

The rice yields were 3.97 t/ha following trampling and 5.12 t/ha for ploughing. This suggests that there is a distinct advantage to farmers in using ploughs to prepare land for wet rice, compared to the use of trampling. Trampling is performed by large groups of animals (20–400 head) belonging to large cattle rearers, who charge a fee of one-third of the rice crop for land preparation. As most small-scale farmers have a few head of cattle they could train some animals for pulling ploughs. Some farmers involved in the trials are planning to fatten their trained animals for sale in 3 years.

One aim of introducing ploughs was to enable farmers to prepare land for rice planting earlier than can be achieved using trampling, which usually starts in January, some weeks after the first good rains (after cattle have gained condition). However, in 1988–89, the rains were early and no difference in planting date was observed.

Comparison of the Use of Plough, Tractor and Hand Labour in Upland Cultivation in Camplong II Village, Kupang, West Timor

A. Saleh, C. Liem and H. Marawali*

A study was conducted during the cropping season, from October 1988 to June 1989 in Camplong II Village, Kupang District, Nusa Tenggara Timur. The aim was to evaluate the labour efficiency and time consumed using three land preparation methods for upland cultivation, i.e. animal and tractor ploughing and hand labour. Two pairs of cattle for ploughing, eight farmers for hand labour and one four-wheel tractor were used. The area of 0.9 ha used consisted of 0.3 ha which had never been cultivated before and 0.6 ha which had been cultivated once. The average time taken for each method of land preparation was: Land never previously cultivated: 33 hours/ha for plough (DAP), 49 hours/ha for hand labour, 3 hours/ha for tractor; and Land previously cultivated once: 14 hours/ha for plough (DAP), 23 hours/ha for hand labour, 2.5 hours/ha for tractor.

It was concluded that there is potential for introducing animal-drawn ploughs in upland agriculture (maize, upland rice and legumes), which comprises about 90% of the total food crop area of Nusa Tenggara Timur. In this trial, some local farmers were trained to make ploughs and to work their Bali cattle. Other farmers in the area are keen to train their animals and to join in trials next year.

This abstract reports only the work on ploughing. Further studies are urgently needed on the use of DAP in cultivation (weeding) of dryland crops, which is considered to be the major constraint to improving upland productivity. Only trials on the deeper, raised coral soils are planned, and these should be in conjunction with a sound soil conservation plan.

* Sub Balitnak Lili, Kupang, Nusa Tenggara Timur, Indonesia.

Feeding Practices and Introduction of Forage Legumes to Draught Animal Rearers in East Java

P.A. Yudi and M.A. Yusran*

THIS study aimed to describe the main feeding practices in two village sites in East Java, and to assess the farmer acceptance of selected forage legumes. Previous studies had indicated that there is a shortage of high quality feed available, especially in the early wet and late dry seasons, for the existing high densities of draught cattle (Sudimulyo >200 head/ha and Martopuro >100 head/ha) in the villages.

All cattle are zero-grazed in both villages. In Sudimulyo (low altitude) stored rice straw forms the bulk of the diet (70%) in the dry season, and cut native grass (76%) the bulk in the wet season (December–April). Maize stover (mainly dry) was the main supplement to straw in the dry season, with some tree leaves, in Sudimulyo. Rearers of draught animals in this village obtained three cuts of grass per year off native grassland, which is often rented exclusively for forage production and fertilised with urea. The annual yield measured from December 1988 to May 1989 was 9450 kg DM/ha (*Polytrias amaura, Andropogon caricosum, Ischaemum* spp, and others). The species most highly valued by farmers was *A. caricosum*.

In Martopuro (medium altitude and longer wet season) green grass is available for cutting and feeding all year, from road and river sides, banks of fields and other areas regarded as communal forage. The grass (*Polytrias amaura, Axonopus compressus* and other species) supplied to draught cattle is supplemented with peanut and soya bean tops, maize stover, and fresh rice straw and sugarcane tops, especially in the dry season.

The three forage legumes introduced on trial were *Glyricidia maculata, Centrocema pubescens* and *Stylosanthes hamata* (Verano). Glyricidia is intended to improve productivity of hedgerows. Centro was planted mainly on banks between fields (mainly in Martopuro), while Verano was mixed with the native grassland in Sudimulyo. Initial results suggest that grass productivity was improved by the Verano. A cultivar of *Desmanthus virgatus* is found in both villages but is little used in Martopuro, where the existence of large thickets suggests that this may have high potential. Farmers have started to plant the three legumes voluntarily, after seeing them demonstrated in the first year. Cuttings of Glyricidia have been planted on communal land by village officials. When seed becomes available, it is hoped to plant Glyricidia seedlings to obtain better tap root development and hence longer retention of leaves in the dry season.

* Sub Balai Penelitian Ternak, Grati, Pasuruan, Indonesia.

Lactic Acid in Working Buffaloes

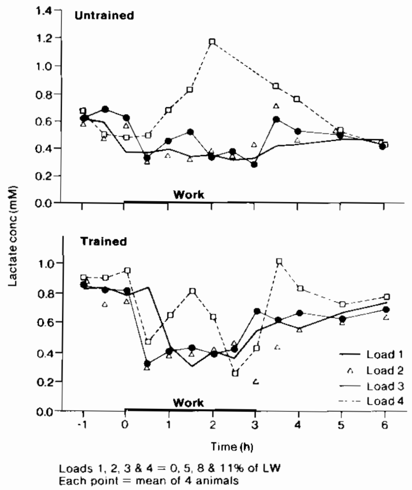
D. G. Martin and E. Teleni*

HEAT stress is considered a major factor which limits the work performance of buffaloes. Under certain workloads, the accumulation of lactic acid in muscle cells could also limit the capacity of the animal to work.

Changes in plasma lactic acid concentration were monitored in *trained* and *untrained* buffaloes subjected to different workloads. Other physiological responses were measured but are not presented here.

* Graduate School of Tropical Veterinary Science, James Cook University, Townsville Qld 4811, Australia.

Four female swamp buffaloes (mean liveweight 363 ± 16 kg), each prepared with chronic indwelling catheters in one external jugular vein, were fed 7 kg of rice straw plus 500 g cottonseed meal/head/day. Each animal walked on a treadmill at 2.5 km/hour for a maximum of 3 hours/day, pulling a draught load equivalent to 0, 5, 8 or 11% of its liveweight. The experiment was designed as a Latin square (4 workloads × 4 periods). Animals were trained on the treadmill by pulling a draught load of 20 kg for 3 hours/day over 3 weeks. During the measurement period blood samples were taken half-hourly, for 1 hour before work, 3 hours during work and 3 hours immediately after work. Environmental parameters were also monitored.



The mean air temperature and humidity were 26.1°C and 62% respectively. The maximum temperature recorded was 33.8°C.

Changes in plasma lactate concentrations in *trained* and *untrained* animals are shown in Fig. 1. The increasing mean plasma lactic acid concentration in the *untrained* buffaloes as work progressed suggests increased anaerobic metabolism in these animals.

The results suggest that *untrained* buffaloes subjected to a draught load equivalent to or greater than 11% of their liveweight might be limited in their work performance due to the accumulation of lactic acid in their muscle fibres.

Effect of Body Condition on Physiological Responses in Working Buffaloes

M. Winugroho*, S. Purba*, P. Situmorang*, E. Juarini* and E. Teleni**

In a study where the interactions between body condition, level of nutrition and ovarian activity were investigated in working buffaloes (Winugroho et al. These Proceedings), changes in respiration rates, pulse rates and rectal temperatures were also measured, and are reported in this communication.

The animals were fed and worked as previously described (Winugroho et al. These Proceedings). Measurements were carried out during the working period (80 days) on days 30, 34, 38, 41, 52 and 75. These were carried out on three groups of six buffaloes in body condition scores (on a scale of 1 to 5) of 4 (Group I), 3 (Group II) and 2 (Group III). The results are shown in Table 1.

There were no sigificant differences between the groups in their physiological responses to work, although it appeared that the animals in Group III had higher pulse rates and lower respiration rates than those in the other groups. The apparently higher mean respiration rate in fat buffaloes probably reflects the greater heat load generated by work in these animals.

It might be concluded that under the work regimes imposed on the animals, differences in body conditions do not appear to have a significant impact on the physiological responses measured.

* Balai Penelitian Ternak, Box 123, Bogor, Indonesia

** Graduate School of Tropical Veterinary Science, James Cook University, Townsville Qld 4811, Australia.

Table 1. Means ± SEM of rectal temperature, pulse rates and respiration rates in buffaloes of body condition scores of 4(I), 3(II) and 2(III) at rest, during work and after work.

Time measurement made		Rectal temperature (°C)	Pulse rate (no./min)	Respiration rate (no. of breaths/min)
Before start of work: 20 min	I	37.8 ± 0.4	40 ± 4	18 ± 3
	II	37.8 ± 0.3	39 ± 3	18 ± 3
	III	37.5 ± 0.2	39 ± 4	19 ± 2
After start of work: 120 min	I	39.0 ± 0.6	64 ± 9	53 ± 11
	II	39.1 ± 0.6	75 ± 15	58 ± 19
	III	39.0 ± 0.7	71 ± 9	51 ± 15
After start of work: 240 min	I	40.0 ± 0.6	73 ± 8	77 ± 19
	II	40.2 ± 0.6	82 ± 12	78 ± 22
	III	39.7 ± 0.7	81 ± 10	67 ± 18
After work stopped: 120 min	I	38.6 ± 0.4	44 ± 5	29 ± 4
	II	38.5 ± 0.4	44 ± 6	28 ± 5
	III	38.6 ± 0.5	46 ± 7	27 ± 5

Facilities for Measuring Gaseous Exchange of Large Ruminants When Working and Resting

P.R. Lawrence*

THE apparatus measures oxygen consumption, CO_2 production and methane production of animals weighing up to 1 t at oxygen consumption rates up to 20 l/min (equivalent to 6.6 kW of energy expenditure or a 1-t animal working at 7–8 times maintenance).

Gaseous exchange can be measured continuously using an open circuit system when the animal is at rest in a respiration chamber for 23.5 hours/day and when it is working indoors on a treadmill or out of doors in a circular race for periods of 3–8 hours.

Total air flow is measured by a mass flow meter for animals on the treadmill and in the respiration chamber and by a rotameter in the circular race. Gas samples from all three sections of the complex are analysed continuously for oxygen decrement (paramagnetic analyser), and for CO_2 and methane increment (infrared analyser). Signals from all analysers and the mass flow meter are sampled at 5 Hz and stored using a Metrabyte DAS 8 expansion board in an Amstrad 1512 personal computer. During an experiment, the computer program gives an 'on-line' chart recorder type graph of all inputs and afterwards allows the data to be inspected, divided into groups and filed in a form suitable for transfer to most types of commercial spreadsheet for further analysis.

* Centre for Tropical Veterinary Medicine, Easter Bush, Roslin, EH25 9RG, Scotland.

Cattle (*Bos indicus*) or Buffaloes (*Bubalus bubalis*) for Carting Loads?

R.A. Pearson and P.R. Lawrence*

BUFFALOES and cattle are the main sources of draught power in many countries in Asia. They are used for land cultivation, threshing and for transporting goods. In some areas cattle predominate, while in others buffaloes are the main draught animals. Although comparisons of their physiological responses to the environment (Mullick 1960); Prucsasri 1983 and Chikamune 1987) and to nutrition (Kennedy and Waterhouse 1987) have been reported, few impartial comparisons between the two species as draught animals have been made. Farmers in Nepal suggested that the buffaloes can pull heavier loads than the cattle but they walk at slower speeds. The differences in speed may be associated with differences in the ability of the two species to tolerate the additional heat stress associated with work, particularly when working in the sun. Cattle and buffaloes were compared when carting loads on the Terai, the flat plain in the south of Nepal, during the dry season.

Two pairs of cattle and two pairs of buffaloes carted loads, in wooden wheeled local carts, 16–17 km over the same flat route on village tracks. One team worked each day, usually in sunshine, in temperatures of 24–37°C for a total of 6 days/team. Body temperature, respiration rate and stepping rate in one animal from each pair and work done and distance travelled were measured using sensors and a data logging instrument designed to combine continuous measurements of work with measurements of physiological parameters in the field.

Buffaloes and cattle started work at speeds of 1 m/sec or more. Cattle kept this up for most of the day whereas the buffaloes showed a steady decrease in speed over the day to speeds of less than 0.9 m/sec in the last hour. Both cattle teams slowed down over the last half hour of work. Speed was significantly lower ($P < 0.05$) in the small team of oxen in this last hour than during the rest of the day. In all the teams stepping rate decreased gradually during the day with decrease in speed. Thus the pace length for any particular animal tended to remain constant. Average stepping rates in cattle were usually higher than in the buffaloes. This may account for the assumption that oxen pull loads at greater speeds than buffaloes.

The decrease in speed of buffaloes after the first hour of work in hot conditions seemed to be related to increasing body temperature, which began as soon as the buffaloes started working. Cattle in comparison did not decrease speed until later in the day, when fatigue, rather than heat stress, is likely to have been the main causative factor. Body temperature of the buffaloes increases during work. By 3.5 hours, increases of up to 3.5C° in starting values could be seen. It was necessary to stop and let the buffaloes wallow for at least 20 min to allow them to cool off before they would continue to work. During wallowing body temperature decreased to or below values seen at the start of the day's work. Unlike the buffaloes, the cattle showed changes of less than 1C° in body temperature during work. Respiration rates of buffaloes increased at least two-fold as they began panting usually after 1.5–2.5 hours. Respiration rates of the cattle could also increase up to three-fold during work. Estimated daily energy expenditures by the buffaloes and cattle on working days were similar, 1.75–1.79 and 1.74–1.78 × maintenance, respectively.

The results show that in well-fed animals of the same size there is little to choose between buffaloes and oxen in work output, provided buffaloes are allowed time to wallow on hot days. This is seen as the main disadvantage of using buffaloes for carting on longer routes. Results in this study suggested that cattle too need some rest if they have to work for long periods, otherwise work rate falls off rapidly as the animals become tired. If plenty of water is available, two factors in favour of using buffaloes for carting are their longevity and the fact that they can usually be sold for meat at the end of their working life, whereas oxen in many areas of Asia cannot easily be disposed of once they are no longer fit for work.

References

Chikamune, T. 1987. Energy-saving characteristics of buffaloes. Buffalo Bulletin, 6, 28–34.
Kennedy, P.M., and Waterhouse, D. 1987. Utilisation of a poor quality diet by swamp buffalo

* Centre for Tropical Veterinary Medicine, Easter Bush, Roslin EH25 9RG, Scotland.

and cattle. Paper presented at the 2nd International Symposium on the Nutrition of Herbivores. University of Queensland, Brisbane, Australia, 6–10 July, 1987.
Mullick, D.N. 1960. Effect of humidity and exposure to sun on the pulse rate, respiration rate, rectal temperature and haemoglobin level in different sexes of cattle and buffalo. Journal of Agricultural Science, Cambridge, 54, 391–394.
Prucsasri, P. 1983. Comparative studies on physiological responses between swamp buffalo and cattle. NBRDC, Annual Report, Bangkok, Thailand.

Reduced Work Output of Well-Fed Buffaloes Pulling Carts in East Nepal

R.A. Pearson*

ALTHOUGH disease is likely to affect the performance of draught animals, little information is available on the quantitative effects of any disease on work output. Using equipment designed at CTVM to measure work output and physiological responses to work, it is possible to obtain quantitative information on working animals to allow comparisons between animals to be made.

This study describes the reduction in work output that occurred in a pair of apparently healthy well-fed draught buffaloes (Team A: 233 and 264 kg). Their performance was compared with that of another pair of buffaloes of a similar size and weight (Team H: 310 and 237 kg). Both teams were given adequate feed daily (2 × maintenance) and environmental conditions experienced by both teams were similar (sunshine and temperatures of 24–37°C).

Work and distance were recorded continuously and body and ambient temperature every 54 sec when each team pulled a loaded cart (carrying 70% of the total liveweight of the team) over a flat route, which involved two river crossings, on three different nonconsecutive working days.

On day 1 team A slowed down during the day's work from about 1.1 m/sec to 0.7 m/sec and the right buffalo lay down particularly in the last 2 hours. At the second river crossing, the team wallowed just before the crossing point on the river as they were reluctant to go any further once the river was nearby. On day 2 (after 7 days of rest) the buffaloes set off at about 1.2 m/sec over the first hour, but became very tired in the last 2 hours. They stopped or lay down frequently and wallowed before the second crossing point. Both buffaloes refused food that evening, but had eaten the next morning. On day 3 (after 8 days of rest) the buffaloes walked slowly (about 0.8 m/sec) and were reluctant to pull the cart. In view of their apparent weakness the route was reduced to 14.7 km.

Team H worked steadily and consistently each day and rarely stopped. Over the 3 days the team showed a progressive increase in the speed at which they worked, from about 0.9 to 1.1 m/sec. In contrast to team A they had only 3 days and 4 days rest between each of the working days. Table 1 summarises the performance of each team on each day.

Body temperature was recorded from one buffalo from each team. Increases in body temperature during a day's work ranged from 1.5 to 5.5C°, and was higher in the buffalo from team A than from team H. Blood samples taken from each buffalo at the end of the study showed team A to have PCVs of 23 and 27% compared with PCVs of 33 and 37% in team H.

Although this study reports only a single instance of reduced work output it does illustrate that a rapid decline in work output can occur in apparently healthy buffaloes. That it was not resolved by adequate nutrition and rest periods between working days, and was associated with some degree of anaemia, suggests that ill health was the cause. Work clearly precipitated the situation as the buffaloes becam[illegible]gressively weaker over the 3 days work. It is suggested that the decline in wor[illegible] associated with a parasitic or disease infection.

* Centre for Tropical Veterinary Medicine, Easter Bush, Roslin, Midlothian EH25 9RG, Scotland.

Table 1. The performance of two teams of buffaloes (A and H) carting loads on three different nonconsecutive days over flat land.

	Distance travelled (km)	Work done (kJ)	Length of working day (hours)	Time spent wallowing (min)	Avg speed when working (m/sec)	Avg power output/ days work (W)
Team A						
Day 1	16.41	4529	5.8	19	0.83	217
Day 2	16.48	4548	5.8	48	0.91	216
Day 3	14.69	4054	6.1	36	0.74	185
Team H						
Day 1	16.42	4927	5.7	26	0.87	240
Day 2	17.05	5114	5.6	35	0.94	253
Day 3	17.08	5124	5.1	25	1.02	276

Effect of Exercise on Body Weight Change and Voluntary Intake of Barley Straw in Cows Fed One of Three Dietary Supplements

R. Matthewman*, A. Pearson* and J. Oldham**

TWELVE pregnant, lactating suckler beef cows (Hereford × Friesian) in three dietary treatment groups were walked for 3 hours/day for three periods of 5 days each divided by two nonwalking days. The cows walked approximately 10.6 km each day and climbed a height of 480 m each day. This expenditure was estimated to be equivalent to an energy expenditure of 12 MJ ME/ day. The three diet supplements were a high starch diet (HS2) based on 86% maize, a high protein diet (HP) based on 30% fishmeal/30% soya and a digestible fibre diet (DF) based on 87% molasses sugar beet pulp. Four kilograms of each supplement was fed to each cow each day and unchopped barley straw was fed ad libitum to all cows. The experimental design was 3 weeks nonwalking, 3 weeks walking and 3 weeks nonwalking (NW–W–NW).

The three treatment groups were balanced for body weight at the beginning of the experiment. Mean body weights (kg) at the beginning were 501 (HS2), 506 (DF) and 504 (HP). Mean weights at the end of the 9-week experiment were 510 (HS2), 510 (DF) and 555 (HP). Cows fed diet HP were significantly ($P<0.001$) heavier than cows fed diets HS2 or DF and HP cows gained weight faster than other groups ($P<0.05$). All diet groups lost weight when they walked. Mean losses (kg) were 10 (HS2), 5 (DF) and 4 (HP). These results were similar to those of Ffoulkes (1986) and Winugroho (1988) who measured weight losses in working female buffaloes.

Neither diet nor exercise had a significant effect on voluntary intake of barley straw. Cows fed diet HP ate an average of 8% more straw than cows fed other diets. A nonsignificant reduction in straw intake occurred when animals walked. The maximum response to exercise was seen in HS2 cows which had a reduced intake of 12.4% in the 3-week walking period. These results were similar to those of Barton (1987) who found no increased intake of rice straw in working cows in Bangladesh, but differ from those of Ffoulkes (1986) who found a positive effect of work in food intake.

* Centre for Tropical Veterinary Medicine, University of Edinburgh, Easter Bush, Roslin, Midlothian EH25 9RG, Scotland.
** East of Scotland College of Agriculture, Edinburgh, Scotland.

References

Barton, D. 1987. Draught animal power in Bangladesh. PhD thesis, University of East Anglia, England.

Ffoulkes, D. 1986. Studies on working buffalo — current research on nutritional aspects, Balai Penelitian Ternakliawi, Bogor. Draught Animal News 6, CTVM, University of Edinburgh.

Winugroho, M. 1988. Paper presented at the Congress of the Sixth Federation of Asian Veterinary Associations (FAVA), 16–19 October, 1988, Denpasar, Bali.

Effect of Dietary Heat Increment on Physiology of Working Animals

B. Bakrie*, R.M. Murray** and E. Teleni**

THE difference in ability to withstand the extra heat load during work between cattle and buffaloes causes a dissimilar physiological response to work by these animals. This to some extent may relate to the lower capacity of buffaloes compared to cattle to dissipate extra heat from the body, due to the former possessing fewer sweat glands and hair follicles (Hafez et al. 1955). Another source of internal heat load is dietary heat increment. A study has been conducted to investigate the effect of this heat load on working performance of cattle and buffaloes.

Four cattle and four buffaloes were fed either a roughage (high heat increment) diet (diet 1) or a concentrate (low heat increment) diet (diet 2), designed to provide the same metabolisable energy (ME) intake. Rations were formulated from hammer-milled sorghum hay plus urea and mineral supplement mixture and from finely ground maize. The animals were subjected to work by walking on a treadmill at a speed of 2.3 km/hour for 3 hours/day and pulling a load of 20 kg. Rectal temperature (RT) and respiration rate (RR) were measured immediately before work and at 60-min intervals during work until 3 hours after work.

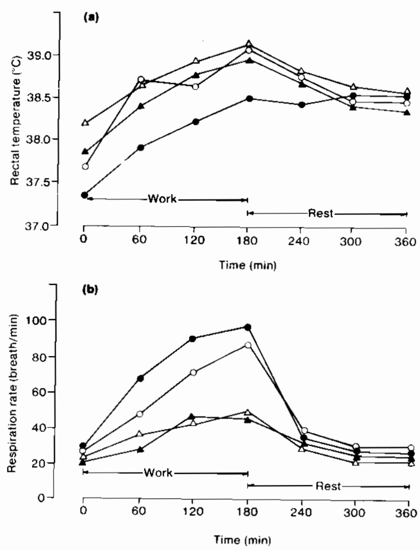


Fig. 1. Rectal temperatures (a) and respiration rates (b) of working cattle (◇, ◆) and buffaloes (○, ●) given either roughage (◇, ○) or concentrate (◆, ●) diets.

Diet had little effect on the physiological responses of cattle either at rest or during work (Fig. 1). Neither were there any differences between the roughage and concentrate diets in the physiological responses by buffaloes at rest. However, there was an initial effect of diet on the RR of buffaloes during work with rate increasing more rapidly when consuming the concentrate diet. These differences tended to disappear after 3 hours' work. Also during work there was a significant difference between the RT of buffaloes on different diets, those receiving the concentrate diet having lower temperature. While the higher RR of working buffaloes on the

* Balai Penelitian Ternak, PO Box 123, Bogor, Indonesia.

** James Cook University, Townsville Qld 4811, Australia.

concentrate diet may have contributed to the lower RT of the animals on this diet, the lower heat increment of the maize would indicate that working buffaloes may benefit from receiving diet of low heat increment.

It is suggested that although buffaloes are claimed to utilise high fibre diet better than cattle (NRC 1981), it seems beneficial to provide a less fibrous diet when these animals are required to work in relatively hot conditions.

References

Hafez, E.S.E., Badreldin, A.L., and Shafei, M.M. 1955. Journal of Animal Science, 46, 19-29.

National Research Council. 1981. The Water Buffalo: New Prospect for an Underutilised Animal. National Academic Press, Washington, D.C.

Resting Energy Consumption of Working Oxen

P.R. Lawrence*

THREE well trained Brahman × Friesian oxen (5 years old, liveweights 615–750 kg) were given a straw-based pelleted diet at levels calculated to provide either 1.4 × maintenance (high level) or 0.7 × maintenance (low level).

The metabolic rate (MR) of each ox as calculated from its gaseous exchange was measured continuously for 5 days. The ox was kept in a respiration chamber except during the period 0930–1600 hours on the third day when it worked at a rate sufficient to raise its MR to 3.5 × maintenance by pulling a load round a circular race. Each ox underwent this treatment twice at both levels of feeding.

The MR during the 17 hours following work on the third day was higher than the average rate during the same time of day on the other 4 days of the week by 8.2%, when the oxen were fed at the low level but only by 0.6% on the high level. This difference was significant at the $P < 0.01$ level.

The same three animals fed at maintenance were used to approach the problem of underlying rate of energy consumption whilst working in two ways:

The first was to give the animals a constant load to pull at various speeds, to extrapolate energy consumption back to zero speed and compare the extrapolated MR with the average daytime value on nonwork days (y). A regression equation of all values gave $y = 24.2x + 1.04$ ($n = 81, r = +0.90$) where x = speed in m/sec, which implies that the underlying average MR is 4% higher and not significantly different on working compared with nonworking days.

In the second approach, the MR was simply measured between bouts of work after the animal had been standing still for at least 10 min. The average value was $y = 1.26$ ($n = 18$, SD = 0.08).

Conclusions (a) On poor quality feed oxen use extra energy after work presumably to resynthesise food reserves.

(b) Methane production is increased when oxen on high levels of feed work. On lower levels the rate of production is the same whether the oxen work or not.

(c) The RQ of oxen falls steadily during work and often reaches values of 0.7 indicating that the animals are using their fat reserves for energy.

(d) At maintenance level of feeding work does not increase the maintenance component either during or after work.

(e) The MR whilst standing during the working day is about 26% higher than on nonwork days. This should be taken into account when applying data from 'laboratory' studies which often use MR when standing as a base line.

* Centre for Tropical Veterinary Medicine, Easter Bush, Roslin EH25 9RG, Scotland.

Regression of Body Weight on Body Measurements in Buffaloes

H. Prasetyo and R. Dharsana*

BUFFALOES as draught animals play an important role in rural areas. The minimum availability of scales for weighing animals in villages often presents problems in a transaction or in judging the potential of the animals. Methods of estimating live body weight (BW) from measurements of body surface would be useful, and the relationships have not been established in buffaloes.

Chest girth (CG) was measured using a measuring tape as the circumference of chest just behind elbows. Body length (BL) referred to the distance between point of shoulder and point of pin bones. The third measurement, height at withers (WH), was taken at the highest point above forelegs. Measurements were made only once, but twice or three times would be preferable to assure a higher precision.

Observations were obtained from 77 female and 12 male animals with BW ranging between 113.5 and 487 kg. Regression equations and correlation coefficients (r) were calculated between BW and CG, BL, and WH.

In females, BW had a higher correlation with CG (r = 0.90) than with BL (r = 0.77) or with WH (r = 0.74). The regression equation that fitted best was BW = -457.5 + 4.5 CG (P<0.001).

In males, the result was not very conclusive due to the small size of the sample. There was an indication that BW had a higher correlation with BL (r = 0.96) than with CG (r = 0.91) or with WH (r = 0.78). The fitted regression equation was BW = -501.3 + 6.6 BL (P<0.001).

The result on female animals is of importance due to the fact that the females represent a major portion of the population in the villages. The different results between males and females are not clear. More data on males are needed.

* Balai Penelitian Ternak, PO Box 123, Bogor, Indonesia.

Interaction Between Body Condition, Level of Nutrition and Ovarian Activity in Working Swamp Buffalo

M. Winugroho, P. Situmorang* and E. Teleni**

IN an experiment with *Bos indicus* cattle, Teleni et al. (1988) showed that animals in reasonably good body condition (mean liveweight of 338 kg) ceased cycling when they lost approximately 17% of liveweight. This loss was equivalent to a reduction in body fat: protein from approximately 0.96 to 0.24 (Teleni, unpublished data).

This communication reports on the effects of body condition, current nutrition and work on ovarian activity of swamp buffaloes. Twenty-four mature female buffaloes, exhibiting normal ovarian activity were divided into three groups of eight. All animals were offered chopped fresh rice straw ad libitum. Groups I and II were also given supplements of a commercial concentrate (Bk) at the rate of 4 and 2 kg/head/day respectively. At the end of 90 days (Period 1) the mean liveweights of animals in each group were 370, 344 and 288 kg for Groups I, II and III, respectively. Corresponding body condition scores (on a scale of 1 to 5) were 4, 3 and 2 and

* Research Institute for Animal Production, Bogor, Indonesia.
** Graduate School for Tropical Veterinary Science, James Cook University, Townsville, Qld 4811, Australia.

cyclic activity in animals in Group III, as determined through rectal palpation, had ceased. Means of peak progesterone concentrations over Period 1 were 3.3 ± 0.8, 3.3 ± 0.7 and 1.1 ± 0.6 ng/ml for Groups I, II and III, respectively.

In Period 2 (80 days), animals in Groups I, II and III were given Bk supplements at the rate of 2.5, 2.0 and 1.0 kg, respectively. In addition half the number of animals in each group were subjected to work by pulling sledges (approximate draught force of 72 kg) for 4 hours/day. Across groups, the means of peak progesterone concentrations in plasma were 3.1 ± 1.5 and 3.0 ± 1.1 ng/ml for the working and nonworking animals, respectively. Normal cycling patterns displayed by animals were 81% for the working animals and 88% for the nonworking animals. Mean liveweights at the end of Period 2 were 380, 341 and 290 kg for Groups I, II and III, respectively.

Results of this experiment suggest that depletion of body reserves is a major determinant of ovarian function and that work per se does not appear to have any significant effect. Animals with body condition score of 2, based on the scale used, would most likely have abnormal ovarian function. The difference in mean liveweight between animals with body condition score of 4 or 3 and 2 was 82 or 56 kg, suggesting that if animals in Groups I and II were to lose, respectively, 22% and 16% of liveweight, they would cease cycling. The data are consistent with that reported for cattle (Teleni et al. 1988).

References

Teleni, E., Boniface, A.N., Sutherland, S., and Entwistle, K.W. 1988. Effect of liveweight loss on ovarian activity in *Bos indicus* cattle. Proceedings of the Nutrition Society of Australia, 13, 126.

Body Weight Changes and Feed Supply Problems in Draught Animal Enterprises: An Example from Padamulya Village, Subang, West Java

Santoso, Ridwan and R. Nana*

A monitoring study (December 1986–June 1988) of cattle and buffalo body weight showed that, on average, animal body weight steadily increased throughout the year, and the young animals' body weight increased faster than that of adult animals. This was despite the fact that 95% of cattle rearers and 80% of buffalo rearers in Padamulya reported that they had serious problems in feed supply, due to limited grazing area. Most of the land is planted to crops in the wet season and no forages are traditionally planted.

Farmers were able to overcome the feed supply problems by seeking and cutting feed from areas outside the village, so that their animals gained some weight throughout the year. The labour involved in feeding was, however, very high at certain times of year, e.g. an average of 6–10 person-hours/day in herding plus 2–6 hours for handfeeding in the dry season. The high labour demand may be a serious deterrent to rearing draught animals for many of the farmers (73%) who do not rear at present. The labour involved in rearing animals could result in lost income from labour from off-farm sources. Improved forage supplies and preservation of straw are seen as important ways of attempting to reduce the labour costs in feeding draught animals in West Java.

* Research Institute for Animal Production, PO Box 123, Bogor, Indonesia.

Evaluation of Different Buffalo Genotypes for Meat, Milk and Draught Production

J.E. Vercoe and J.E. Frisch*

THERE is a paucity of information on the comparative performance of different breeds and strains of buffaloes throughout the world. Using existing genetic variation between breeds and strains of buffalo offers the most rapid means of genetic improvement through crossbreeding. The extent of the existing variation and the relative performance of crossbreds can only be assessed by comparative evaluation of different genotypes in a range of environments. In 1985, ACIAR developed a project to undertake such studies, based on proposals from an ACIAR workshop and ASEAN.

The aim of the project is to undertake a program that will encourage research institutes in Southeast Asia, under simulated management conditions of smallholders to (a) undertake comparative studies on feed utilisation between breeds and strains; (b) study differences in reproductive performances; and (c) study variations in draught power.

Further aims are to establish a mechanism for coordinating and transferring research findings between cooperating institutes, and to encourage their application in smallholder systems to improve productivity.

Comparative Studies in Reproduction In Sri Lanka research is under way to study the intercalving interval of Lanka and Murrah buffaloes under small farmer management in the dry zone with and without supplementary feeding. Although the feed supplement decreased the intercalving interval in both genotypes the Lanka buffalo had a shorter interval than the Murrah under both regimes.

In Malaysia investigators are studying the reproductive performance of F_1 Swamp × Murrah, Murrah and Swamp buffalo under two nutritional regimes, both of which were relatively 'high' (irrigated pasture with and without palm kernel cake). Supplements had no effect in this situation and the calving interval was over 300 days less in the F_1 than in either of the parental breeds.

Philippines researchers are collecting comparative information on Carabao, Nili-Ravi × Carabao and Murrah × Carabao. Whilst only relatively small numbers are available as yet trends are emerging. Crossbreds reach puberty 1 year earlier than Carabao and calve at 4 rather than 5 years of age. They also produce substantially more milk.

Thai and Indonesian scientists are generating F_1 Murrah × Swamp calves in Thai and Indonesian villages. Much is being learned about the technology by which crossbreeding can be made possible on a large scale using oestrous synchronisation and AI technologies. In Thailand large numbers of crossbred calves have been generated and growth rates are being compared (reproduction when the F_1 progeny are old enough) and in Indonesia the generation of F_1 calves is in its first year.

Comparative studies on growth and nutrition In Malaysia studies are being done on digestibility and rumen function in Swamp, ¼ Murrah and ¾ Murrah buffaloes on different diets. Although the Murrah-infused genotypes grew faster than the Swamp there were no significant differences between them in feed intake, or in rumen degradation and fermentation characteristics. Studies on the relative maintenance requirements of the three types will start in 1989.

The Thai researchers are collecting growth rate information on Swamp and ½, ¾ and pure Murrah genotypes as well as data to assess heat tolerance. At one location ½ and ¾ bred Murrahs grew faster than pure Murrahs and at another location Swamp grew as fast as the crossbreds. However these findings are being verified by comparing Swamp, ½ Murrah and ¾ Murrah in the second environment. Differences between the genotypes in physiological measurements related to heat tolerance were small.

In Thai villages F_1 crossbreds (Murrah and Swamp) apparently grow faster than the Swamp. A similar result has occurred in Philippine villages. The F_1 Murrah and Carabao Nili-Ravi × Carabao are growing faster than the Carabao and as more numbers come on stream this trend will become clearer. It is of interest that Carabaos at the same age appear to be heavier on the smallholder farms than at the UPLB farm.

Draught Power There is no work at present on draught power but comparisons of the crossbreed with Swamp types are planned in the Philippines and in Thailand. It is anticipated that crossbreds generated by the team in Indonesia will become available for DAP studies by 1992–93.

* CSIRO Tropical Cattle Research Laboratory, Rockhampton, Qld, Australia.

Acknowledgment

This work represents the combined efforts of researchers at eight institutions in Southeast Asia, and we thank them for allowing us access to their data as presented in this communication.

Draught Animal Power Implements of East Java

M. Komarudin, Gunawan and M.A. Yusran*

THE aim of this study was to describe the size, shape and weight of implements used in draught animal power of East Java. A survey was carried out at three village sites in Pasuruan, i.e. Sudimulyo, Dandang Gendis and Martopuro. At each site, six samples of each main type of implement were studied. Implements described were levellers and dry and wet land ploughs. Measurements of size, shape and weight of yoke and implement were recorded and the implements were further described with photographs. The dimensions of length, width of the yoke and length of beam, handle height, length of plough, width of plough wing and height of plough wing, were taken on the dry and wet land ploughs. For the levellers, length, width and handle height were recorded.

Later, a larger study was carried out in four districts: Malang, Probolinggo, Lunajang and Blitar, where the same range of implements was described. The size of levellers and yokes in villages in Pasuruan District were significantly different ($P<0.05$). Size of ploughs in three villages did not differ. The shape of ploughs in five districts in East Java differed widely, but the yoke and leveller were the same. Size, shape and weight of implements in Blitar District were different ($P<0.05$) to that in other districts. A similar study conducted in Madura, showed distinct differences between the type of ploughs used in different districts.

* Sub Balitnak, Grati, Indonesia.

Effect of Puddling on the Draught of Soil After Drying

R. Tranggono* and S.T. Willatt**

LOWLAND rice is a major crop in many Asian countries and rice-based cropping systems with other crops following the rice are becoming popular. Much emphasis for research into these systems has been on 'turn-around' period, that time between harvest and when the soil is ready to till, as well as what level of ploughing is necessary.

In an experiment in which rice was grown after puddling the soil different amounts, the turn-around was determined by measuring the time it took for the soil to dry to the lower plastic limit water content (Taylor 1972) after rice harvest. It was then ploughed to a depth of 10 cm and draught measured. Two soils were used in this experiment: a clay (75% clay sized particles)

* Program Studi Mekanisasi Pertanian, Fakultas Pertanian, Universitas Brawijaya, Malang, Indonesia.
** Physics Department, School of Pure and Applied Science, University of the South Pacific, Suva, Fiji.

and a loam (22% clay sized particles), and because these were at different locations in East Java ploughing at one site was done by oxen and the other by water buffalo.

The length of the turn-around period was determined by the degree of puddling and soil type. The degree of puddling was imposed by ploughing and harrowing the soil under water a number of times (P0, P1, P2, and P3). The values were: Loam P0, 12 days; P1, 17 days; P2, 22 days; P3, 27 days; and Clay P0, 14 days; P1, 20 days; P2, 26 days; P3, 36 days. The reason for the longer period for the puddled soil to dry relates to interparticle bonds being broken and water being held between clay plates (Tranggono 1988).

Draught was measured with a dynamometer (Eijkelkamp, the Netherlands) attached to the drawbar of the plough with the aid of a yoke. Ten runs per plot were done to determine the final draught. The results were: Loam P0, 0.30 kN; P1, 0.51 kN; P2, 0.64 kN; P3, 0.76 kN; and Clay P0, 2.94 kN; P1, 2.25 kN; P2, 1.52 kN; P3, 1.51 kN. The draught force was lower for the loam soil; it increased with puddling in the loam but decreased with puddling in the clay. Clay type (montmorillonite) (Raven et al. 1988) and orientation are implicated in this change in draught.

Other soil properties measured, i.e. penetration resistance of the soil and tensile strength of air dry aggregates sampled after this ploughing support these results. The values of these strength parameters were less in the loam than in the clay, and in the loam they increased with puddling while in the clay they decreased with puddling.

References

Raven, M.B., Tranggono, R., and Janik, L.J. 1988. Mineralogy of rice soils in relation to the long term effect of puddling on soil physical properties. Technical Memorandum No. 23, CSIRO Division of Soils.

Taylor, H.M. 1972. Effect of drying on water retention of a puddled soil. Soil Science Society of America Proceedings, 36, 972–973.

Tranggono, R. 1988. Puddling in a "sawah" and its effect on soil physical properties. PhD Thesis. La Trobe University, Melbourne, Australia (unpublished).

Bull Subsidy Scheme for West Java: A Demonstration/Trial in Tanjungwangi Village, Subang

T. Chaniago and Santoso*

A shortage of mature bulls is known to be a serious constraint to improving productivity of draught animal enterprises in many West Java villages. This is particularly critical in medium altitude villages (100–500 m) where the density of buffalo (or cattle) is low, cropping percentage is high and there is little communal grazing area (Santoso et al. 1987). Some villages have no mature bulls, and rearers must rely on animals mating with bulls from other villages. Estimates of calving rates in buffalo and cattle in West Java villages range from 10 to 70% (Petheram et al. 1982; Sumanto et al. 1987).

The reason for bull shortage is that farmers prefer to keep cows to bulls, because cows can produce calves as well as work. In addition, cows are considered easier to train and to handle while working. In the past farmers have been able to rely on their cows mating with other farmers' bulls. Today, however, fewer and fewer farmers feel that they can afford to keep mature male animals. Often the only male animal available for breeding in a village is a young or small bull which has not been sold because of its inferior condition and size.

Artificial insemination schemes have been set up in a few areas of West Java, but these have been notably unsuccessful, especially in swamp buffalo areas. In any case, AI can only reach

* Research Institute for Animal Production, PO Box 123, Bogor, Indonesia.

a small fraction of the farmers. The alternative of establishing 'subsidised sire' schemes would appear to be much less expensive and more practical than AI.

In an attempt to test the feasibility and farmer opinion of such a scheme, a farmer in Tanjungwangi village was subsidised (Rp100 000) for 1 year to keep a bull (which he would otherwise have sold at 18 months of age) for the use of all farmers in that village. The farmer could use the animal for work. No service fee was charged, as this is not traditional in the area.

In 1 year, seven farmers in the village were known to have used the bull, although the total number may have been much higher. These farmers and others in Tanjungwangi are very keen for the bull subsidy scheme to be continued in the second year. The fact that the calving rate in this village rose from 33% in 1987-88 to over 60% in 1988-89 is further evidence that such a bull scheme could result in valuable improvements in animal production in West Java. The urgency of this matter cannot be overstressed, especially when the potential ill-effects of negative selection through breeding with the poorest bulls are considered. Another matter requiring urgent intervention, revealed by this study, was that knowledge of principles of animal reproduction is poor; some farmers believe that bulls are not required for conception.

References

Petheram, R.J., Liem C., Priyatman Y., and Mathuridi. 1982. Village buffalo fertility study, Serang District of West Java. Report No. 1, Research Institute for Animal Production, Bogor, Indonesia.

Santoso, Sumanto, Perkins J., and Petheram, R.J. 1987. An agroeconomic profile of Tanjungwangi village, Subang — with emphasis on draught animal rearing. DAP Project Bulletin, 2, 4-28.

Sumanto, Santoso, Petheram, R.J., Perkins, J., Nana, and Rusastra, W. 1987. An agroeconomic profile of Padamulya village, Subang — with emphasis on draught animal rearing. DAP Project Bulletin, 4, 2-28.

Weights and Prices of Large Ruminants at Purwodadi Market, Subang, Indonesia

A. Semali* and J. Perkins**

MOST smallholder livestock are sold at some point in their life — and often traded more than once — to meet income needs of their owners. Relatively little information is published on the prices paid for cattle and buffalo and, in particular, the important price:weight:age relationships. Knowledge of such relationships is essential for realistic farm-level budgets.

The livestock market at Purwodadi, Subang, was observed from October 1988 to January 1989. Two enumerators attended each market day, equipped with a set of electronic cattle scales. They recorded the type, sex, age and weight of each large ruminant offered for sale. If an animal was sold, the price paid was asked of both buyer and seller.

A total of 701 cattle and 40 buffalo were offered for sale during the period, of which 94 cattle and one buffalo were sold. In total, twice as many females were offered as males with this ratio increasing for stock of 4 years or older. Some unsold cattle may be offered again for sale three or four times; many others are transferred to the larger market at Bandung. Most animals are traded by *blantiks*, or animal brokers, and it is possible that local merchants regard Purwodadi as a test-market for sales in Bandung.

Young animals of either sex, including calves and yearlings, find the readiest sale, usually for rearing on another farm. Relatively few animals are bought for slaughter although this is difficult to check.

* Agrostology Section, Balai Penelitian Ternak, PO Box 123, Bogor, Indonesia.

** Department of Agriculture and Forestry, University of Melbourne, Parkville Vic. 3095, Australia.

Price:weight relationships showed an expected trend of higher weights receiving higher prices. However, the variation in price at any particular weight was pronounced. Many factors may contribute, including the general condition and health of the animals. It may also be related to the relative bargaining strengths of the traders and their methods of appraisal: looking, pummelling and squeezing. A larger data set would be required to test these important variables.

There is a tendency for price/kilogram to drop with increasing age. The correlation is statistically weak and further confounded by problems of estimating age with accuracy, particularly for young, growing cattle.

Data obtained will provide an excellent resource for farm budget purposes. Realistic top and bottom prices can be inferred for cattle weights up to 350 kg, but not for buffalo. The most important lesson is the riskiness of rearing large ruminants: the price obtained depends upon both the merits of the animal and the skills of the participating traders. Any farm budget incorporating cattle or buffalo should be subjected to a sensitivity analysis of ±25% of the sale price when predicting the income, and profit, that derives from animal management.

No scales are provided in Purwodadi market, as is the case in many parts of Indonesia. The installation of cattle scales would probably narrow the price variation and reduce uncertainty for both buyers and sellers.

Section 10
Participants

Participants

ABDELSAMIE, Dr Richard E., IPB Australia Project, PO Box 28, Bogor, Indonesia.

ANDERSON, Professor Frank, Department of Agricultural/Horticultural Systems Management, Massey University, Palmerston North, New Zealand.

ATMADILAGA, Professor Didi, Universitas Padjadjaran, Bandung, Indonesia.

AYRE-SMITH, Dr Robert, Consultant, ACIL Australia Pty Ltd, 5th Floor, Norplaza, 169 Miller St, North Sydney NSW 2060, Australia.

BAKRIE, Dr Bachtar, Ruminant Program, Balitnak, Box 123, Bogor, Indonesia.

BAMUALIM, Dr Abdullah, Head, Sub Balitnak Lili, Box 23, Kupang NTT, Indonesia.

BAMUALIM, Ir Wirdahayati, Sub Balitnak Lili, Kupang, Indonesia.

BARKER, Dr J. Stuart, Department of Animal Science, University of New England, Armidale NSW 2351, Australia.

BASUKI, Ir Purwanto, Animal Husbandry Faculty, Universitas Gajah Mada, Jogjakarta, Indonesia.

BASUNO, Drs Edi, Farming Systems Program, Balitnak, Box 123, Bogor, Indonesia.

BETKER, Mr Joachim, Universitat Hohenheim, Institut für Agrartechnik 440, Postfach 70 05 62, 7000 Stuttgart 70, Federal Republic of Germany.

BIRD, Dr Simon, Department of Biochemistry, Microbiology & Nutrition, University of New England, Armidale NSW 2351, Australia.

BUNYAVETCHEWIN, Mrs Pakapun, Buffalo and Beef Production Research and Development Centre, Department of Animal Science, Kasetsart University, Bangkhen, Bangkok 10900, Thailand.

CAMPBELL, Professor Rod S.F., Graduate School of Tropical Veterinary Science, James Cook University, Townsville Qld 4811, Australia.

CARMICHAEL, Dr Ian, C/- Balitvet Project, PO Box 52, Bogor, Indonesia.

CASOLANI, Ms Catherine, ODA/DGLS Project, Sumedang, West Java, Indonesia.

CHANIAGO, Dr Thamrin D., Ruminant Program, Balitnak, Box 123, Bogor, Indonesia.

CHAPMAN, Mrs Pam, Research Services Officer, Economics Program, ACIAR, GPO Box 1571, Canberra ACT 2601, Australia.

CHIKWANDA, Mr Basiolio B., AETC (Farm Mechanisation Centre), PO Box 330, Borrowdale, Harare, Zimbabwe.

COCKREM, Dr Manika, IPB Australia Project, PO Box 28, Bogor, Indonesia.

CONROY, Dr John D., Team Leader, IPB Australia Project, PO Box 28, Bogor, Indonesia.

DAMAYANTI, Drh Rini, Balitvet, PO Box 52, Bogor, Indonesia.

DANIELS, Dr Peter, Balitvet, PO Box 52, Bogor, Indonesia.

DEN HERTOG, Dr Geiss, Larenstein International Agricultural College, Brinkgreverweg 69, PO Box 7, 7400AA Deventer, The Netherlands.

DESMAYATI, Ir Z., Balitnak, Box 123, Bogor, Indonesia.

DEVENDRA, Dr C., IDRC, Tanglin, PO Box 101, Singapore 9124.

DHARSANA, Dr Rini S., Balitnak, Box 123, Bogor, Indonesia.

EGAN, Professor Adrian, School of Agriculture and Forestry, University of Melbourne, Parkville Vic 3052, Australia.

ELMS, Mr Andrew, ACIAR Liaison Officer, Australian Embassy, 6th Floor Citibank Building, Jl Thamrin 55, Jakarta, Indonesia.

ESPARON, Ms Nanette, School of Agriculture and Forestry, University of Melbourne, Parkville Vic 3052, Australia.

FALVEY, Dr J. Lindsay, Managing Director, MPW Australia, 302 Little Lonsdale St, Melbourne Vic 3000, Australia.

FATHUROCHMAT, Ir Ade, Dinas Peternakan Dt I, Bandung, Jawa Barat, Indonesia.

FFOULKES, Dr David, Department of Primary Industry and Fisheries, Berrimah Agricultural Research Centre, PO Box 79, Berrimah NT 0828, Australia.

FORMAN, Dr Tony, CSIRO Australian Animal Health Laboratory, Box 24, Geelong Vic 3220, Australia.

GINTING, Dr Ngepkep, Pathology Program, Balitvet, PO Box 52, Bogor, Indonesia.

GOE, Dr Michael R., Animal Scientist, ILCA, Box 5689, Addis Ababa, Ethiopia.

GUNAWAN, Dr Benny, Director, Balitnak, Box 123, Bogor, Indonesia.

GUNAWAN, Ir, Sub Balitnak, PO Grati, Pasuruan, Java Timor, Indonesia.

HADIWIGENO, Dr Sutatwo, Badan Litbang Pertanian, Bogor, Indonesia.

HARJOUTOMO, Drh Soeprojo, Bacteriology Program I, Balitvet, PO Box 52, Bogor, Indonesia.

HASTIONO, Drh Soekardi, Bacteriology Program II, Balitvet, PO Box 52, Bogor, Indonesia.

HENDRATNO, Ir Nelly, AARD/Badan Cirtbangtan, Bogor, Indonesia.

HERAWATI, Ir Tati, Forage Program, Balitnak, Box 123, Bogor, Indonesia.

HOFFMANN, Dr Denis, Research Program Coordinator (Animal Sciences), ACIAR, GPO Box 1571, Canberra ACT 2601, Australia.

HOGAN, Dr Jim P., Division of Tropical Animal Production, CSIRO Davies Laboratory, PMB Aitkenvale Qld 4814, Australia.

IRVINE, Mr David, Deputy Ambassador, Australian Embassy, Jl Thamrin 55, Jakarta, Indonesia.

ISKANDAR, Dr Sofyan, Research Coordinator, Balitnak, Box 123, Bogor, Indonesia.

JUARINI, Ir Elizabeth, Balitnak, Box 123, Bogor, Indonesia.

KARTO, Ir Abdullrais A., Balitnak, Box 123, Bogor, Indonesia.

KOMARUDIN, Ir Maksum, Head, Sub Balitnak, PO Grati, Pasuruan, Jawa Timur, Indonesia.

KOSASIH, Mr D., Administration Section, Balitnak, Box 123, Bogor, Indonesia.

KUSWARDONO, Dr, Agricultural University (IPB), Bogor, Indonesia.

LAMID, Dr Azinal, Balittan Sukarami (Food Crops), PO Box 34, Padang, Indonesia.

LAWRENCE, Dr Peter R., Centre for Tropical Veterinary Medicine, University of Edinburgh, Roslin EH25, 9RG, Midlothian, Scotland.

LENGEFELD, Mr Klaus, Project Officer for Animal Traction, GATE in GTZ GmbH, Postbox 5180, D-6236 Eschborn 1, Federal Republic of Germany.

LIANG, Mr Juan Boo, Research Officer, Livestock Research Division, MARDI, PO Box 12301 GPO, 50774 Kuala Lumpur, Malaysia.

LIEM, Cornelius, Sub Balitnak Lili, Box 23, Kupang NTT, Indonesia.

LOC, Dr Chau ba, University of Cantho, Haugiang, Vietnam.

LUBIS, Ms Adriana, Ruminant Program, Balitnak, Box 123, Bogor, Indonesia.

LUDGATE, Dr Patrick, SR-CRSP Project, Balitnak, Jln Padjajaran, Bogor, Indonesia.

MacINTYRE, Mr Reginald, Communications Consultant, ACIAR, GPO Box 1571, Canberra ACT 2601, Australia.

MACKERETH, Ms Viv, PO Box 120, Whitianga, New Zealand.

MAGUMISE, Mr Jairos, AETC, PO Box 330, Borrowdale, Harare, Zimbabwe.

MANGUNWIRYO, Dr Hariadi, Virology Program, Balitvet, PO Box 52, Bogor, Indonesia.

MANURUNG, Ir Tambak, Pimpro Balitnak, Bogor, Indonesia.
MARAWALI, Ir Hendrik, Sub Balitnak Lili, Box 23, Kupang NTT, Indonesia.
MARPAUNG, Ir M., Bina Program, Ditjen Peternakan, Jakarta, Indonesia.
MARTIN, Ms Donna G., Research Assistant, Graduate School of Tropical Veterinary Science, James Cook University, Townsville Qld 4811, Australia.
MATONDANG, Ir Rasali H., Kepala Seksi Sarana Penelitian Balitnak, Bogor, Indonesia.
MBAKE, Dr Momodou, International Trypanotolerant Centre, PMB 14, Banjul, The Gambia.
McEVOY, Mr Michael, ANZDEC/IFAD Adviser to DGLS/IFAD, Smallholder Cattle Development Project, Jln Salemba Raya No. 16, Jakarta, Indonesia.
MOHAMAD, Saud, USAID, C/- U.S.A. Embassy, Jakarta, Indonesia.
MOMONGAN, Professor Vince G., University of the Philippines, Los Baños College, Laguna 3720, Philippines.
NARI, Drh Jan, Director of Puslitbang Peternakan (CRIAS), Jln Padjajaran, Bogor, Indonesia.
NEUGEBAUER, Mr Joachim, GTZ-AETC, PO Box 2406, Harare, Zimbabwe.
NOLAN, Dr John, University of New England, Armidale NSW 2351, Australia.
PARAKASIH, Professor Arminudin, Agricultural Engineering IPB, Bogor, Indonesia.
PARTOUTOMO, Drh Sutyono, Balitvet, PO Box 52, Bogor, Indonesia.
PATTEN, Dr Barry, ACIAR ELISA Project, C/- Balitvet, PO Box 52, Bogor, Indonesia.
PEARSON, Dr R. Anne, Centre for Tropical Veterinary Medicine, University of Edinburgh, Roslin EH25 9RG, Midlothian, Scotland.
PERKINS, Mr John M., School of Agriculture and Forestry, University of Melbourne, Parkville Vic 3052, Australia.
PETHERAM, Dr R. John, ACIAR DAP Project Coordinator, Graduate School of Tropical Veterinary Science, James Cook University, Townsville Qld 4811, Australia.
PRASETYO, Dr Hardi L., Sub Pelayanan Biometrik dan Genetik, Balitnak, Box 123, Bogor, Indonesia.
PRYOR, Dr Bill J., Consultant to ACIAR, "Galwiji", RMB No. 141, Pryors Rd, Scotsburn, Ballarat Vic 3352, Australia.
PUDJIONO, Ir Ekoyanto, Universitas Brawijaya, Malang, Java Timor, Indonesia.
PURCELL, Dr Dennis, World Bank, Jakarta, Indonesia.
PUTU, Dr I. Gede, Ruminant Program, Balitnak, Box 123, Bogor, Indonesia.
RANGKUTI, Drh M., Puslitbang Peternakan, Bogor, Indonesia.
RIDWAN, Mr, Balitnak, Box 123, Bogor, Indonesia.
RISNAWATI, Dr Hetti, Balitnak, Box 123, Bogor, Indonesia.
ROBERTS, Dr John, ACIAR Toxocara Program, Sri Lanka/James Cook University, Sandakulum, 29 Pak Avenue, Dangolia, Kandy, Sri Lanka.
RONOHARJO, Dr Purnomo, Balitvet, PO Box 52, Bogor, Indonesia.
RUSASTRA, Ir Wayan, Pusat Penelitian Agronomi, Bogor, Indonesia.
SANTOSO, Drh, Farming Systems Program, Balitnak, Bogor, Indonesia.
SCARBOROUGH, Mr William E., USAID, Jakarta, Indonesia.
SEMALI, Ir Armiadi, Forage Program, Balitnak, Box 123, Bogor, Indonesia.
SETIOKO, Dr Argono, Poultry Program, Balitnak, Box 123, Bogor, Indonesia.
SIMS, Mr Brian, Overseas Division, AFRC-Engineering, Silsoe, Bedford MK45 4HS, United Kingdom.
SIRAIT, Ir Celly H., Balitnak, Box 123, Bogor, Indonesia.
SIRIWEERA, Professor W.I., Department of History, University of Peradeniya, Sri Lanka.

SITORUS, Dr P., Puslitbang Peternakan, Jln Pajajaran, Bogor, Indonesia.

SITUMORANG, Dr Polmer, Balitnak, Box 123, Bogor, Indonesia.

SLINGERLAND, Ir Maja A., Department of Tropical Animal Production, Wageningen Agricultural University, POB 338/6700AH, Wageningen, The Netherlands.

SOEDIMAN, Ir S., Pig and Small Animal Program, Balitnak, Box 123, Bogor, Indonesia.

SOEDJANA, Dr Tjeppy, Small Ruminant Program, Balitnak, Box 123, Bogor, Indonesia.

SOEJOTO, Ir Bambang, Director, Smallholder Cattle Development Project, Ditjen Peternakan/IFAD, Jln Salemba Raya No. 16, Jakarta, Indonesia.

SOEKRESNO, Drs Djarot, Puslitbang Peternakan (CRIAS), Jln Pajajaran, Bogor, Indonesia.

SRIVASTAVA, Dr N.S.L., Coordinator of All India Research Project on Utilization of Animal Energy, and Director, Central Institute of Agricultural Engineering, Bhopal 462003, India.

STARKEY, Mr Paul H., Animal Traction Consultant, Oxgate, 64 Northcourt Avenue, Reading RG2, 7HQ, United Kingdom.

SUMANTO, Ir, Farming Systems Program, Balitnak, Box 123, Bogor, Indonesia.

SUMMERS, Professor Phillip M., Head, Graduate School of Tropical Veterinary Science, James Cook University, Townsville Qld 4811, Australia.

SUTIKNO, Irawan, Forage Program, Balitnak, Box 123, Bogor, Indonesia.

TELENI, Dr Esala, Senior Lecturer in Nutrition, Graduate School of Tropical Veterinary Science, James Cook University, Townsville Qld 4811, Australia.

TEMBO, Mr Solomon, Faculty of Agriculture, University of Zimbabwe, PO Box MP167, Mt Pleasant, Zimbabwe.

THAHAR, Drs Ashari, Farming Systems Program, Balitnak, Box 123, Bogor, Indonesia.

TONGA, Ir Umbu, Sub Balitnak Lili, Box 23, Kupang NTT, Indonesia.

TRANGGONO, Dr R., Universitas Brawijaya, Malang, Java Timor, Indonesia.

TURNIAMAN, Mr Aang, Reprographics Section, Balitnak, Bogor, Indonesia.

UPADHYAY, Dr Ramesh C., National Dairy Research Institute, Karnal 132001, Haryana, India.

VERCOE, Dr John, Division of Tropical Animal Production, CSIRO Tropical Cattle Research Centre, Box 5545, Rockhampton Mail Centre Qld 4702, Australia.

WANAPAT, Dr Metha, Faculty of Agriculture, Khon Kaen University, Bangkok 40002, Thailand.

WILLATT, Professor Steve, Physics Department, The University of the South Pacific, PO Box 1168, Suva, Fiji.

WILSON, Dr Alan, Project Leader, Balitvet Project, PO Box 52, Bogor, Indonesia.

WINUGROHO, Dr M., Ruminant (DAP) Program, Balitnak, Box 123, Bogor, Indonesia.

YURI, Ir P.A., Sub Balitnak, PO Grati, Pasuruan, Jawa Timur, Indonesia.

YUSRAN, Ir Moh Ali, Sub Balitnak, PO Grati, Pasuruan, Jawa Timur, Indonesia.

ZULBARDI, Ir, Balitnak, Box 123, Bogor, Indonesia.