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Farm income analyses of milk production operation in simulated smallholder systems

(Analisis pendapatan di ladang bagi pengendalian pengeluaran susu dalam sistem pekebun kecil yang diramalkan)

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Key words: smallholder dairy, production system, farm income

Abstrak

Tiga ujikaji telah dijalankan berturutan dalam tempoh 4 tahun untuk meneliti kesan jenis pastura *(Setaria sphacelata* dan campuran *Brachiaria decumbens-Leucaena leucocephala),* sistem pengurusan (meragut secara pusingan dan potong angkut), dan kadar pemberian konsentrat (0, 4 dan 6 kg berat basah/lembu sehari) terhadap pendapatan ladang daripada pengeluaran susu bagi setiap unit percubaan penternak kecil tenusu. Setiap unit tersebut mempunyai keluasan 1 ha dan 5 ekor lembu tenusu jenis Sahiwal-Friesian telah digunakan. Makanan tambahan tidak diberikan di dalam Ujikaji 1. Pengeluaran laktasi sebanyak 4 392.4, 6 903.7, 7 114.7 dan 9 104.1 L/ha masing-masing untuk sistem potong angkut Setaria (CC/S) dan Brachiaria-Leucaena (CC/BL) dan sistem ragutan berpusingan bagi sistem Setaria (G/S) dan Brachiaria-Leucaena (G/BL) telah dicatatkan. Ujikaji kedua dan ketiga berikutnya ditumpukan terhadap kesan pemberian konsentrat pada lembu-lembu yang meragut Brachiaria-Leucaena sahaja. Penambahan konsentrat daripada 0 kg (G2/BL0) kepada 4 kg (G2/BL4) berat basah (11 MJ/kg BK dan 150 g CP/kg BK) di dalam Ujikaji 2 meningkatkan pengeluaran susu daripada 7 831 kepada 13 165 L dan apabila pemberian konsentrat ditingkatkan daripada 4 kg (G3/BL4) kepada 6 kg (G3/BL6) berat basah seekor/hari di dalam Ujikaji 3, pengeluaran susu/ha meningkat daripada 14 365 liter kepada 16 941 liter. Pendapatan bersih ladang sehektar daripada jualan susu dalam Ujikaji 1 ialah $5 117, $2 938, $1 499 dan ($33) masing-masingnya bagi G/BL, G/S, CC/BL dan CC/S.

Dalam Ujikaji 2, dengan penambahan 4 kg konsentrat/lembu sehari pendapatan tersebut meningkat sebanyak $885/ha setiap laktasi daripada $4 029 dan bertambah lagi sebanyak $442 apabila kadar konsentrat ditingkatkan kepada 6 kg/lembu sehari dalam Ujikaji 3. Keputusan percubaan ini menunjukkan bahawa penternakan tenusu pada peringkat penternak kecil berasaskan sistem meragut secara pusingan terhadap rumput Brachiaria-Leucaena dan ditambah konsentrat mempunyai potensi ekonomi untuk diusahakan dan mampu bersaing dengan perusahaan pertanian yang lain seperti getah dan kelapa sawit.

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Abstract

Three experiments were conducted consecutively for a duration of 4 years to examine the effect of pasture types *(Setaria sphacelata* and a mixture of *Brachiaria decumbens-Leucaena leucocephala),* management systems (rotational grazing versus cut and carry) and levels of concentrate supplement (0, 4 and 6 kg fresh weight/cow per day) on the farm income from milk production in simulated smallholder dairy units. Each unit was one hectare in size and stocked with 5 Sahiwal-Friesian cows. Experiment 1 was without concentrate supplement. Lactation yields of 4 392.4, 6 903.7, 7 114.7 and 9 104.1 L/ha were recorded for Setaria and Brachiaria-Leucaena cut and carry, Setaria and Brachiaria-Leucaena rotational grazing system, respectively. The second and third experiments were based on Brachiaria-Leucaena rotational grazing. A concentrate supplement from 0 kg (G2/BL0) to 4 kg (G2/BL4) fresh weight/cow per day (11MJ/kg DM and 150 g/kg DM CP) in Experiment 2 increased milk yield from 7 831 L to 13 165 L and when the concentrate was raised from 4 kg (G3/BL4) to 6 kg (G3/BL6) per day in the third experiment, milk yield was further increased from 14 365 to 16 941 L/ha. The net farm income per hectare from milk in Experiment 1 was $5 117, $2 938, $1 499 and ($33) for G/BL, G/S, CC/BL and CC/S respectively.

In Experiment 2, the income increased by $885/ha per lactation from $4 029 when the animals were supplemented with 4 kg concentrate/cow per day and a further increase of $442 with 6 kg concentrate/cow per day. These results indicated that smallholder dairy units based on Brachiaria-Leucaena rotational grazing system and supplemented with concentrate are economically viable and are competitive with other agricultural enterprises such as those of rubber and oil palm.

Introduction

While it has been recognised that dairy operation in the tropics lacks the comparative advantages relative to operations in European and other temperate regions (Wan Hassan 1986), concerted efforts are still being made in the tropical and sub-tropical countries to develop the dairy industry. The main aims of such efforts are to reduce dependence on imported milk and milk products, to save foreign exchange and to provide additional employment and income to the local people.

The technical feasibility of setting up smallholder dairy units in Malaysia based on improved pastures has been shown by Wan Hassan et al. (1989). This paper examines the effect of pasture type, management system and level of concentrate supplements on farm income on simulated smallholder dairy units. All costs (fixed and variable) and farm income are calculated based on current prices.

Materials and methods

Four 1-ha smallholder dairy units were established at the Malaysian Agricultural Research and Development Institute (MARDI) at Serdang in Selangor Darul Ehsan. A completely randomized design was used where two units were established with *Setaria sphacelata* var Splendida and the other two with *Brachiaria decumbens-Leucaena leucocephala* (Peruvian). In the establishment of these pastures, 60 kg N, 40 kg P and 50 kg K/ha were applied to the units based on Setaria while 40 kg P, 50 kg K and 2 000 kg lime per hectare were used for the Brachiaria-Leucaena pastures.

Three experiments were consecutively carried out involving three complete lactations of Sahiwal-Friesian crossbred cows which were uniform in age, weight and stage of lactation as described by Wan Hassan et al. (1989) and summarised in *Table 1.*

The net farm income was determined

Table 1. Structure and management for each smallholder dairy unit

Unit	Lact. no.	Pasture	Management	Conc. (kg/cow/day)	Fertilizer(kg/ha/year)		
					N	P	K
Experiment 1							
A	1	Setaria	Cut & carry	0	300	40	100
B	1	Setaria	Rot. grazing	0	300	40	50
C	1	Bra-Leu	Cut & carry	0	0	40	100
D	1	Bra-Leu	Rot. grazing	0	0	40	50
Experiment 2							
D1	2	Bra-Leu	Rot. grazing	0	0	40	50
D2	2	Bra-Leu	Rot. grazing	4	0	40	50
Experiment 3							
D1	3	Bra-Leu	Rot. grazing	4	0	40	50
D2	3	Bra-Leu	Rot. grazing	6	0	40	50

Bra-Leu = Brachiaria-Leucaena; Lact. no. = lactation number; conc. = concentrate level; rot. = rotational
N = nitrogen; P = phosphorus; K = potassium

Table 2. Comparison of production performance of Sahiwal-Friesian crossbred cows under different management systems

Item	Experiment 1				Experiment 2		Experiment 3	
	CC/S	G/S	CC/BL	G/BL	G/BL0	G/BL4	G/BL4	G/BL6
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lactation number	1	1	1	1	2	2	3	3
Conc.level (kg/cow/day)	0	0	0	0	0	4	4	6
Av. milk/cow/day (L)	4.4	4.8	4.9	6.1	5.2	8.6	9.4	11.5
Total milk/lact (L)	878.5	1380.7	1422.9	1820.8	1566.2	2632.9	2873.0	3388.2
Total milk/ha (L)	4392.4	6903.7	7114.7	9104.1	7831.1	13164.6	14364.8	16941.0
Lact. length (days)	199.0	285.0	292.0	296.0	300.0	304.0	305.0	295.0
Forage (t/ha/year)	9.1	15.0	11.9	17.0	15.4	13.5	13.4	15.0
CP: Forage(g/kg DM)	87.0	92.0	112.0	139.0	139.0	134.0	135.0	139.0
ME: Forage(MJ/kg DM)	7.6	8.1	8.4	8.7	8.2	8.1	8.2	8.4

CC/S, CC/BL = Setaria, Brachiaria-Leucaena cut & carry; G/S, G/BL = Setaria, Brachiaria-Leucaena grazing; G/BL0, G/BL4, G/BL6 = Brachiaria-Leucaena grazing + 0 kg, 4kg and 6 kg concentrate respectively.

from the gross farm income from milk and calves minus the fixed, variable and operating expenses. All cows were producing milk and alive calves. The forage offered to the cows met the animals' requirement for growth, maintenance and milk production throughout the experiments. Current prices (1990) were used for estimating the value of milk. The expenses involved for fixed and working assets were estimated at cost on annual depreciating value with its respective year of live span. No salvage values were given except for the cows which were sold at $3/kg live weight. Productive man-hours work on the farm for milking; cleaning the shed and equipment; cutting and carrying the grass; tick spraying and fertilizing the pastures were recorded and valued at $2.50/man-hour. An analysis of variance was carried out on the observed data in which comparisons were made on the various treatment combinations.

Results

Table 2 summarises the effects of pasture type, management system and level of concentrate on milk production of Sahiwal-Friesian cattle. Milk yields were affected by both management system and pasture type with significantly (p <0.01) higher yields

Table 3. Average milk production, cost and farm income from Sahiwal crossbred cows, grazing or cut and carry on either Setaria or Brachiaria-Leucaena pastures without concentrate supplementation

Experiment	Treatment		Milk prod.	Av. per day	Labour per cow	Gross farm income from		Cost of milk production										Net farm income from	
						Milk	Calves	Mineral licks	Labour	Fertilizer	Vet. and chem.	Land taxes	Cows*	Equip.*	Pasture* fences, & bldg.	Total cost	Cost/L	Milk	Dairy
			(L)	(L)	(h)	($)	($)	($)	($)	($)	($)	($)	($)	($)	($)	($)	($)	($)	($)
1	CC/S	Total	5 506.3		1 260.6	4 625.3	710.0	120.0	3 151.4	525.3	202.3	25.0	228.2	182.0	224.2	4 658.4		-33.1	676.9
		Av./cow	1 101.3	4.7	252.1	925.1	142.0	24.0	630.3	105.1	40.5	5.0	45.6	36.4	44.8	931.7	0.85	- 6.6	135.4
	G/S	Total	6 903.7		512.5	5 799.1	710.0	120.0	1 281.2	489.7	280.2	25.0	228.2	125.0	312.2	2 861.4		2 937.7	3 647.7
		Av./cow	1 380.7	4.8	102.5	1 159.8	142.0	24.0	256.2	97.9	56.0	5.0	45.6	25.0	62.4	572.3	0.41	587.5	729.5
	CC/BL	Total	7 114.7		1 317.0	5 976.3	710.0	120.0	3 292.4	160.0	241.6	25.0	228.2	186.4	224.2	4 477.9		1 498.5	2 208.5
		Av./cow	1 422.9	4.9	263.4	1 195.3	142.0	24.0	658.5	32.0	48.3	5.0	45.6	37.3	44.8	895.6	0.63	299.7	441.7
	G/BL	Total	9 104.1		523.5	7 647.4	730.0	120.0	1 308.7	124.5	287.8	25.0	228.2	124.4	312.2	2 530.8		5 116.7	5 846.7
		Av./cow	1 820.8	6.1	104.7	1 529.5	146.0	24.0	261.7	24.9	57.6	5.0	45.6	24.9	62.4	506.2	0.28	1 023.3	1 169.3
	CC	Total	12 621.0		2 577.5	10 601.6	1 420.0	240.0	6 443.8	685.3	444.0	50.0	456.4	368.4	448.4	9 136.3		1 465.4	2 885.4
		Av./cow	1 262.1	4.8	257.8	1 060.2	142.0	24.0	644.4	68.5	44.4	5.0	45.6	36.8	44.8	913.6	0.77	146.5	288.5
		S.D.	307.2		8.4											26.8			
	G	Total	16 007.8		1 035.9	13 446.6	1 440.0	240.0	2 589.9	614.1	568.0	50.0	456.4	249.4	624.4	5 392.2		8 054.4	9 494.4
		Av./cow	1 600.8	5.5	103.6	1 344.7	144.0	24.0	259.0	61.4	56.8	5.0	45.6	24.9	62.4	539.2	0.36	805.4	949.4
		S.D.	344.0		5.0											36.6			
	S	Total	12 410.0		1 773.0	10 424.4	1 420.0	240.0	4 432.6	1 014.9	482.5	50.0	456.4	307.0	536.4	7 519.8		2 904.6	4 324.6
		Av./cow	1 241.0	4.7	177.3	1 042.4	142.0	24.0	443.3	101.5	48.2	5.0	45.6	30.7	53.6	752.0	0.65	290.5	432.5
		S.D.	287.3		75.1														
	BL	Total	16 218.8		1 840.4	13 623.8	1 440.0	240.0	4 601.1	284.5	529.5	50.0	456.4	310.8	536.4	7 008.7		6 615.1	8 055.1
		Av./cow	1 621.9	5.5	184.0	1 362.4	144.0	24.0	460.1	28.5	52.9	5.0	45.6	31.1	53.6	700.9	0.47	661.5	805.5
		S.D.	339.0		79.4														

Note: S, BL, CC, G = Setaria, Brachiaria-Leucaena, cut and carry, grazing
CC/S, CC/BL = cut and carry on Setaria and Brachiaria-Leucaena
G/S, G/BL = grazing on Setaria and Brachiaria-Leucaena
*Depreciation expenses

Table 4. Average milk production, cost and farm income from Sahiwal crossbred cows, grazing or cut and carry on either Setaria or Brachiaria-Leucaena pastures supplemented with different levels of concentrate

Experi-ment	Treat-ment		Milk prod.	Av. per day	Labour per cow	Gross farm income from		Cost of milk production										Net farm income from	
						Milk	Calves	Mineral licks	Labour	Ferti-lizer	Vet. and chem.	Land taxes	Cows*	Equip.*	Pasture* fences, & bldg.	Total cost	Cost/L	Milk	Dairy
			(L)	(L)	(h)	($)	($)	($)	($)	($)	($)	($)	($)	($)	($)	($)	($)	($)	($)
2	G2/BL0	Total	7 831.1		527.7	6 578.1	730.0	120.0	1 319.2	124.5	290.7	25.0	228.2	129.4	312.2	2 549.2		4 028.9	4 758.9
		Av./cow	1 566.2	5.2	105.5	1 315.6	146.0	24.0	263.8	24.9	58.1	5.0	45.6	25.9	62.4	509.8	0.33	805.8	951.8
	G2/BL4	Total	13 364.8		562.1	11 058.3	710.0	3 626.4	1 405.2	124.5	293.5	25.0	228.2	129.4	312.2	6 144.5		4 913.8	5 623.8
		Av./cow	2 632.9	8.6	112.4	2 211.7	142.0	725.3	281.0	24.9	58.7	5.0	45.6	25.9	62.4	1 228.9	0.47	982.8	1 124.8
3	G3/BL4	Total	14 364.8		562.7	12 066.4	690.0	3 626.4	1 406.7	124.5	294.0	25.0	228.2	129.4	312.2	6 146.4		5 920.0	6 610.0
		Av./cow	2 873.0	9.4	112.5	2 413.3	138.0	725.3	281.3	24.9	58.8	5.0	45.6	25.9	62.4	1 229.3	0.43	1 184.0	1 322.0
	G3/BL6	Total	16 941.1		553.1	14 230.5	670.0	5 379.7	1 382.7	124.5	287.3	25.0	228.2	129.4	312.2	7 868.9		6 361.6	7 031.6
		Av./cow	3 388.2	11.5	110.6	2 846.1	134.0	1 075.9	276.5	24.9	57.5	5.0	45.6	25.9	62.4	1 573.8	0.46	1 272.3	1 406.3

Note: G2/BL0, G2/BL4 = Brachiaria-Leucaena grazing + 0 and 4 kg concentrates in the second lactation respectively
G3/BL4, G3/BL6 = Brachiaria-Leucaena grazing + 4 ang 6 kg concentrates in the third lactation respectively
*Depreciation expenses

being recorded from rotationally grazed animals when compared with stallfeeding and from Brachiaria-Leucaena mixture when compared with Setaria pasture. A concentrate supplement of 4 kg fresh weight/cow per day in the second experiment increased milk yield by 62.5% when compared with no supplementation. A further increase of 23% was recorded when the concentrate level was increased from 4 to 6 kg fresh weight/cow per day in the third experiment. These differences were significant (p <0.01).

Table 3 and *Table 4* present the detail of farm income analysis of milk production from each unit under its respective management system. The values for net farm income from dairy in these tables include the values for the calves born.

In Experiment 1, it was noted that labour constituted the major cost of production. The values for labour/total cost for Setaria cut and carry (CC/S) and Brachiaria-Leucaena cut and carry (CC/BL) were $3 151/$4 658 and $3 292/$4 478, respectively. The corresponding values for Setaria rotational grazing (G/S) and Brachiaria-Leucaena rotational grazing (G/BL) were in the order of $1 281/$2 861 and $1 309/$2 531. The average costs of milk production per litre were in the order of $0.85, $0.63, $0.41 and $0.28 for CC/S, CC/BL, G/S and G/BL, respectively. At a selling price of $0.84/L (current/1989 ex-farm price paid to the smallhoders), the net farm incomes from milk/cow for CC/S, CC/ BL, G/S and G/BL were in the order of –$7, $300, $588 and $1 023, respectively.

In the second and third experiments, concentrate was the major production cost item followed by labour. The average costs of milk production for G2/BL0, G2/BL4, G3/BL4 and G3/BL6 (Brachiaria-Leucaena rotational grazing supplemented with 0, 4 and 6 kg/cow/day fresh concentrate) were $0.33, $0.47, $0.43 and $0.46/L, respectively and the respective average net farm income from milk/cow was $806, $983, $1 184 and $1 272.

Table 5. Break even point in milk yield/cow per ha per year lactation under different smallholder production systems (based on 5 milking cows/ha)

Production system	CC/S	CC/BL	G/S	G/BL	G2/BL0	G2/BL4	G3/BL4	G3BL6
Milk yield(L)/cow/ ha/year lactation	1 109	1 066	681	602	607	1 463	1 463	1 874

CC/S, CC/BL = Setaria, Brachiaria-Leucaena cut & carry; G/S, G/BL = Setaria, Brachiaria-Leucaena grazing; G/BL4, G/BL6 = Brachiaria- Leucaena grazing + 4 kg and 6 kg concentrate respectively

Table 6. Estimation of farm income of smallholders dairy operation based on Brachiaria-Leuceana rotational grazing system at various levels of production and farm size (under 4 kg fresh concentrate supplement)

Farm size (ha)	1	2	3	4	5
No. of cows	5	10	15	20	25
Milk production @70% milking (L)	10 055.4	20 110.7	30 166.1	40 221.4	50 276.8
Net farm income ($)					
From milk	3 257.3	6 514.6	9 771.9	13 029.2	16 286.5
From dairy	3 740.3	7 480.6	11 220.9	14 961.2	18 701.5

Discussion

Although this experiment lacked replication of the units in the design, the results consistently showed that nutrition and management were the major factors affecting the viability of smallholder dairying. As discussed in previous papers (Wan Hassan 1986; Wan Hassan, Phipps and Owen 1989) Brachiaria-Leucaena mixture produced significantly (p <0.01) higher dry matter (DM) and nutritional quality than the Setaria under both management systems. A significantly (p <0.01) higher DM yield and forage quality, intake and milk yield were also recorded for the grazing animals when compared with those under the cut and carry system.

In the analyses of farm income of milk production under the systems considered in this study, in Experiment 1 it was found that labour cost constituted about 70% of the total cost in both systems. Changing the system from cut and carry to rotational grazing, resulted in an increase in milk yield and about 60% of labour cost was saved. Thus, under the conditions of this study (at a stocking rate of 5 Sahiwal-Friesian cows/ha, with and without concentrate supplementation), the break even point in milk yield/cow per ha per year-lactation is as shown in *Table 5* under the respective management systems.

However, when the best system of Experiment 1, that is G/BL was picked to test the response to concentrate supplementation in Experiment 2 and Experiment 3, concentrate became the major cost of production and labour cost came second. Nevertheless the large increase in the cost of production, (mainly due to concentrate) was compensated by the increase in milk yield, and hence the farm income.

The response of milk yield to concentrate supplementation was 1.9 and 1.5 kg milk/kg fresh concentrate respectively for 4 and 6 kg levels of supplementation. Converting these figures to dollars and cents, it means that for every $1.00 spent on concentrate at 4 kg/cow per day fresh concentrate, a farmer gets a return of $3.33 and at 6 kg/cow per day fresh concentrate supplementation the return is $2.63. The net farm income from dairy achieved in this experiment at 4 and 6 kg/cow per day concentrate supplement was $6 610 and $7 031/ha per lactation, respectively. At this level of income from 1 ha of land, milk production in this country would be

Table 7. Estimation of farm income of smallholders dairy operation based on Brachiaria-Leuceana rotational grazing system at various levels of production and farm size (under 6 kg fresh concentrate supplement)

Farm size (ha)	1	2	3	4	5
No. of cows	5	10	15	20	25
Milk Production @ 70% milking (L)	11 858.8	23 717.5	35 576.3	47 435.1	59 293.9
Net farm income ($)					
From milk	3 877.3	7 754.7	11 632.0	15 509.4	19 386.7
From dairy	4 346.3	8 692.7	13 039.0	17 385.4	21 731.7

Assumption: *Table 6* and *Table 7* assume that only 70% of the cows are in milk at all times and dry animals are supplemented with 2 kg concentrate/cow/day

Estimation of cost	@4 kg/day	@6 kg/day
Feed concentrate and mineral	2 898.7	3 859.7
Labour for milking, cleaning and others	1 177.4	1 161.2
Fertilizers	124.5	124.5
Chemicals & vet. drugs	293.7	243.9
Depreciation of cows, equipment, pasture, building, fences and taxes	694.8	694.8
Total cost	5 189.2	6 084.0

competitive with other agricultural enterprises. Ariffin et al. (1979) estimated that the gross income from rubber, oil palm, coconut and cocoa ranged from $1 550–$5 150, $730–$2 780, $900–$2 045 and $670–$3 080/ha per year, respectively. While the World Bank (1984) reported that the average gross income from rubber, oil palm and coconut was in the order of $5 258, $2 905 and $1 089/ha year, respectively. The rubber smallholder could only gross $1 150–$1 300/ha per year. On the other hand, Mohd. Sharif et al. (1983) estimated that the gross income from oil palm and coco-monoculture was in the order of $3 150–$4 980/ha per year.

One might argue that the results obtained were in ideal experimental conditions where all the five animals lactated at the same time. A counter argument to that would be to simulate the normal average smallholder farm condition where about 70% of the cows are in milk at all times. The net farm income would be reduced to 70%, or at $3 110–$3 139/ha per year, and it would still be competitive to other agricultural enterprises (World Bank 1984).

Based on these results, the production economics for 2, 3, 4 and 5 ha units are projected and are shown in *Table 6* and *Table 7*. It could be seen that the operation is within the capability of the family labour. The operation can be made more efficient and more milk can be produced in the country if this system is adopted by the government along the lines of FELDA-type land development scheme where each participant has between 4 to 5 ha of land to farm.

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References

Ariffin, M. N., Chan, H. Y., Chuah, A. S. and Chan, E. (1979). A comparative study of investments in four major perennial crops. *Proc. RRIM Plant. Conf.*, p. 1–19

Hopkins, J. A. and Heady, E. O. (1974). *Farm records and accounting* Ames: The Iowa State University Press

Mohd. Sharif, A., Wan Hassan, W. E., Mohd. Khusahry, M. Y. and Osman, Y. (1983). Potensi perladangan bersepadu dalam kelapa sawit (the potential of intercropping in oil palm plantation). Bengkel Pemindahan Teknologi Perusahaan Kelapa Sawit, Universiti Pertanian Malaysia, 7–8 Nov., 1983 (mimeo.)

Thacker, R. J (1979). *Accounting principles* New Jersey: Prentice-Hall, Inc.

Wan Hassan, W. E.(1986). Factors affecting dairy production in Malaysia. Ph.D thesis, University of Reading, 245 p.

Wan Hassan, W. E., Phipps, R. H. and Owen, E. (1989). The development of smallholder dairy units in Malaysia. *Trop. Anim. Health Prod. 21:* 175–82

World Bank (1984). Sector Report: Malaysia Incentive Policies in Agriculture. Report No. 4792 – MA Vol. III, p 39, 45 & 50

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