Labour use in Swedish production of red veal

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ABSTRACT

Swedish production of red veal is based on rearing dairy-breed calves to the age of 8 months and carcass weight ~160 kg. The short rearing period, young age of the animals and mixing of calves from many different herds place high demands on work organisation and working routines for cost-efficient production. This study investigated labour use and working routines on 31 farms, 61% of all Swedish red veal farms rearing 100-1500 calves annually, and identified factors with a high influence on labour input. The median labour input per week for small (SF) (100-399 calves/year), medium (MF) (400-699 calves/year) and large (LF) (700-1150 calves/year) farms was 22, 24.5 and 31 h/week, respectively. The median labour input per calf for pre-defined work tasks was 5.7, 2.3 and 1.8 hours for SF, MF and LF, respectively. A non-linear relationship was found between labour efficiency and veal unit size, and no effect on labour efficiency was found when unit size increased from 550 to 1150 calves/year. Some suggested strategies for increased labour efficiency are to lower the level of farm fragmentation, reduce the frequency of work tasks and plan for strategic handling of animals.

Key words: calf, beef cattle, work load, work efficiency, questionnaire

INTRODUCTION

During the past two decades, consumption of beef in Sweden has increased from 18 kg per capita in 1990 to 26 kg per capita in 2008. At the same time, competitive imports and low produce prices have led to a continuous decrease in the number of production units and animals produced, so that in 2008 only 48% of beef consumption was of domestic origin. (SJV, 2009). Input costs are increasing in agriculture and labour costs are no exception. In Swedish veal production at present, about 25% of the total cost is associated with labour (Agriwise, 2009). Furthermore, shortage of labour from outside the family is a growing concern. The time left after all routine work associated with red veal production could be used for other work on farm or increased time with the family. The issue of labour use is attracting increasing attention in different sectors of livestock farming (O'Shea et al. 1988; Kung et al. 1997; Leahy et al. 2004; Schick, 2005; Schrade et al. 2005; Fallon et al. 2006; Gillespie et al. 2008; O'Brien et al. 2006a; O'Brien et al. 2006b; Gleeson et al. 2008; Madelrieux and Dedieu, 2008; Martel et al. 2008; Madelrieux et al. 2009; Olsson et al. 2009; Quendler et al. 2009) but very few studies on labour input have been found as regards finishing calves or young cattle for beef. This livestock sector plays a large role in utilising practically all male calves, pre-weaned (2-8 weeks) or weaned (≥8 weeks), from the dairy industry. The short rearing period, young age of the animals and mixing of calves from many different herds place high demands on work organisation and working routines for cost-efficient production. Swedish veal production concentrates entirely on red veal and represents slightly less than 10% of total beef cattle production in Sweden. In addition to the EU Council directives on rearing and finishing of calves (91/629/EEC; 97/2/EC; 97/182/EC), Swedish red veal production is regulated by some national standards, (SJV, 2007) e.g. group housing after 8 weeks of age, no tethering of calves under 6 months, free access to roughage from week two and no restrictions on the iron content in feed or water. To prevent cross-infection and spread

of diseases, the newly arrived calves must be kept separate from older calves for a minimum five-week quarantine period before being moved for the last months of fattening (SJV, 2007). Calves are weaned from 8 weeks. The calves are primarily of dairy breed (Swedish Holstein and Swedish Red) and are bought through meat marketing agencies or bilateral contracts between dairy farmers and red veal producers. Male (bull) calves are mainly used but also some female (heifer) calves not required for replacement in the dairy herd. The calves are purchased either as pre-weaned or weaned and reared according to abattoir preferences regarding carcass weight and body conformation. The desired slaughter age is 8 months with carcass weight ~160 kg, but some different standards can apply at regional abattoirs and certain meat retailers.

When estimating the labour cost for Swedish young cattle producers a labour input of 1 min/calf/day is typically used as a rule of thumb (Taurus, 2009). The estimation is based on small studies but no extended work time analysis from the Swedish intensive calf finishing producers has been published. Internationally, labour input in calf rearing during the milk feeding period in dairy production has predominantly been investigated. An American study on labour input and calf performance using different milk feeding and management methods in a dairy herd found an average daily time requirement for group-housed calves of slightly less than 1 min/calf (Kung et al., 1997). A recent Irish study (Gleeson et al., 2008) found an average daily labour input of 2.1, 1.7 and 1.8 min/calf within small, medium and large size dairy herds with different calf rearing methods. A Danish study of labour use in quarantine areas for newly introduced calves on 12 farms averaged between 30-60 minutes per day for daily tasks including milk feeding (Dalgaard *et al*., 2007). Danish finishing house equivalents from a similar study of 13 farms (Dalgaard, 2009) spent an average of 16 sec/calf/day, ranging from 5 to 37 seconds of daily work per calf.

Red veal production typically comprises several systematic work tasks performed daily, weekly or monthly, with no particular seasonal changes in labour input typically found on suckler beef or dairy farms (Fallon et al. 2006; O'Brien et al., 2006a; Madelrieux et al. 2009). The objectives of the present study were to investigate the current use of labour during common pre-defined work tasks in red veal production units of different size categories and to identify factors that affect labour efficiency.

MATERIALS AND METHODS

Records of all Swedish farms producing red veal during 2007 were obtained from the Swedish Board of Agriculture in April 2008, under rules of confidentiality. The distribution of veal unit size was highly positively skewed, with 155 farms with a median production of 53 finished calves per year, ranging from 21 to 1500 calves/year. The overall response rate to the questionnaire was 45%, with a low representation of farms with less than 100 calves (25 responses out of 80 farms). Therefore this paper focuses on the farms with annual production of 100-1500 calves in 2007 (response rate 67%). The responding farms were categorised into small-scale farms (SF) = 100-399 calves/year (n=14); medium-scale farms (MF) = 400-699 calves/year (n=11) and large-scale farms (LF) = 700-1150 calves/year (n=9), representing 50 %, 85 % and 82 % of farms within the three size categories, respectively.

Questionnaire

A semi-structured questionnaire was designed and tested on experts within different areas of red veal production (farmer, advisor and researcher) and refined before being posted together with a covering letter at the end of April 2008 to the 155 farms with annual production of 21-1500 calves. Twenty-one questions divided into three sections addressed the following topics

1) farm structure and facilities (i.e. age of farmer, number of employees, type of buildings/housing, age of calves at purchase, length of rearing period and number of calves produced); 2) labour input (work time and frequency of work tasks) and 3) perceived work strain related to the work tasks (not presented in this paper). Open questions addressed the farmers' own opinions and attitudes about work efficiency and the working situation, as well as possible future plans for investment in labour saving implements.

Field study

For a close-up study of labour patterns, 10 of the 21 largest red veal farms (producing ≥500 calves/year) from the 2007 records were contacted for field studies with interviews supplementing the questionnaire. The farms were contacted according to calf production numbers, beginning with the largest farm, until 10 farms had consented to participate in the study. The farm manager or main worker involved in the pre-defined work tasks was interviewed about labour use and working routines. Farm layout and facilities, such as buildings, housing system, machines and equipment, were recorded, as well as strategies and techniques related to the different work tasks. Main characteristics of the field study farms are shown in Table 1.

Table 1: Descriptive data on 10 farms involved in the field study; number of calves/year, group sizes in QH (calves/pen), housing system and number of buildings for quarantine house (QH) and fattening house (FH), respectively.

Farm no.	No of calves	Housing system QH	No. of QH	Housing system FH	No. of FH
1	500 (w^1/not w^2)	*Group. Straw litter ^{cl} (20-50/pen)*	2	*Straw litter & cubicles with paved alleys^{op} + slatted floors^{cl}*	2
2	520 (w^1/not w^2)	*Group. Straw litter^{cl} (20-50/pen)*	2	*Straw litter^{op}*	1
3	550 (w^1)	*Group. Straw litter^{cl} (20/pen)*	2	*Straw litter with paved alleys^{cl} + straw litter^{cl}*	2
4	700 (w^1/not w^2)	*Group. Straw litter^{cl} (15-20/pen)*	2	*Straw litter with paved alleys^{op} + slatted floors^{cl}*	2
5	700 (not w^2)	*Group. Straw litter^{cl} (4/pen*24)*	1	*Straw litter with paved alleys^{op} + slatted floors^{cl}*	2
6	720 (w^1)	*Group. Straw litter^{cl} (100/pen)*	1	*Straw litter with paved alleys^{op}*	1
7	800 (w^1)	*Group. Straw litter^{cl} (70/pen)*	1	*Straw litter with paved alleys^{cl}*	1
8	1000 (w^1)	*Group. Straw litter^{cl} (40/pen)*	1	*Straw litter with paved alleys^{op}*	1
9	1000 (w^1)	*Group. Straw litter^{cl} (40/pen)*	3	*Slatted floor^{cl} + straw litter^{cl}*	3
10	1150 (w^1)	*Group. Hutches+ straw litter^{cl}(12-50/pen)*	3	*Straw litter with paved alleys^{op} + slatted floors^{cl}*	2

[1]w=weaned calves; [2]= not weaned calves
[op]permanently open building, at end or long sides; [cl]closed building

Definition of terms

Eleven common work tasks were investigated, 9 of which concerned the frequent handling of feed, bedding, animals and manure and two tasks involving administrative work and labour management. Labour input for unpredicted tasks, maintenance and repair of farm equipment and outdoor seasonal work were not included. 'Feeding' was defined as the time taken for the worker to load and supply the animals with feed, including milk. The feeding techniques were defined as 'tractor', 'automatic' and 'manual', referring to the degree of mechanisation of the work task. 'Bedding' referred to transporting and spreading of fresh straw in the pens. The techniques for straw litter work were defined as 'tractor' (with or without blower), 'semi-mechanical' (strewing machines) and 'manual'. 'Manure removal' referred to removal of the deep litter after the animals had been shifted from a pen, scraping of yards and cubicles. Manure removal techniques were defined as 'tractor', 'mechanical' or 'manual'. 'Cleaning' referred to high pressure cleaning of group pens between batches. Animal handling tasks were divided into five sub-categories; 'unload calves', 'shifting', 'weighing', 'medical treatment' and 'load calves' referring to the unloading of new calves off vehicles and into pens, relocating or regrouping calves, moving destined calves up through the weighbridge and back, medical treatment of calves and loading finished calves onto vehicles, respectively. 'Administrative work' and 'labour management' referred to paper-/computer work and management of employees, respectively.

Labour efficiency

Labour efficiency was calculated as min/calf/day and min/calf per batch in quarantine houses (QH), fattening houses (FH) and over the entire rearing period, based on the average number of calves and days in the quarantine and finishing houses. Labour inputs related to 'feeding', 'bedding', 'manure removal' and 'cleaning' were analysed separately for the period in the

quarantine houses and the finishing houses (FH). Labour inputs for animal handling and administrative tasks were analysed on the basis of the entire rearing period (QH + FH).

Statistical analysis

Labour use in min/calf/day or min/calf/batch was analysed by the Kruskal-Wallis test (non-parametric analysis of variance) in Minitab 15.1. The effect of farm size was tested using Mann-Whitney test (non-parametric t-test).

Labour inputs were analysed for 31 farms (91%), due to incomplete details regarding work time for each work task in three questionnaires. Labour input data for two of the pre-defined work tasks were not further analysed in the study; the labour input during 'medical treatment of calves', which in many cases was not a routine task and therefore difficult to assess for the farmer, and the work time related to 'labour management', as few farmers had employees specifically involved in veal calf production.

RESULTS

Characteristics of respondents and farms

The average age of farmers was 47.2 years (range 31-68 years) and the median area of arable land per farm was 103 hectares (range 25-500 ha). Nineteen farms combined red veal calf production with other animal enterprises. Additional common farm enterprises were machinery contracting, forestry and tourist accommodation. Eight farmers (28%, 5 replies missing) considered the correlation between work efficiency and productivity on their farm to be very high. A 'quite high' relationship was reported by 55% of the farmers, while 14% and 3% considered it to be quite low and very low, respectively.

Overall, 32% of the farms bought pre-weaned calves. Forty-four percent of the farms bought calves only from the meat marketing agency (always weaned), 22% bought calves only from neighbouring farms and 6% kept calves from their own herds. The remaining farms (28%) obtained calves from two or all three sources. Age of calves at purchase and length of the rearing period (no. of days in QH + FH) are presented in Table 2, along with the number of calves continually managed in QH and FH. Small farms bought calves with more variable ages and also had higher variability in length of rearing period compared to the medium and large farms (Table 2).

Farm layout and housing

The median year for the most recent investment in a new building or rebuilding for red veal production was 2003 (range 1991-2008). Ninety percent of the farms used only one housing system in the quarantine houses, mainly full litter group pens (85% of farms). For finishing houses 35% of farms utilised buildings with up to three different housing systems. These were full straw litter pens (38%), combined straw litter pens with an alley (tractor- or mechanically scraped) along the feed table (29%) or slatted floor pens (23%).

Table 2. Number of calves managed daily (median and inter quartile range, IQR) in the quarantine (QH) and finishing houses (FH), age of calves at inset and slaughter, and length of rearing periods in QH, FH at small (SF), medium (MF) and large (LF) size veal units.

		No. of calves				Age at start (days)		Age at end (days)		Rearing period (days)					
Veal unit size* range (mean)		QH		FH						QH		FH		QH+FH$_{tot}$	
	n	median	*IQR*	median	*IQR*	median	*IQR*	median	*IQR*	median	*IQR*	median	*IQR*	median	*IQR*
SF 100-399 (204)	12	40[i]	*20*	107	*50*	54	*34*	267	*65*	42	*28*	189	*70*	219	*79*
MF 400-699 (528)	11	95[ii]	*83*	220	*110*	56	*9*	244	*23*	56	*30*	132	*68*	193	*49*
LF 700-1150 (853)	8	100	*120*	300	*52*	61	*7*	244	*38*	42	*14*	150	*42*	192	*48*

*= number of finished calves per year
[i]= Quarantine houses were not used on three farms of the SF-category
[ii]= Quarantine houses were not used on one farm of the MF-category

Labour input

The farmers estimated their weekly median labour input in red veal production to be 20, 22.5 and 40 h/week for small (SF), medium (MF) and large (LF) farms. Corresponding median values from the work time analysis for the pre-defined work tasks were 25, 24.5 and 31 h/week for the three farm size categories (Table 3), indicating a tendency to underestimate among the small and medium sized farms. For large farms the additional work load of about one hour per day might be expected for additional tasks not included in the study, presumably the result of a higher awareness of the labour input on the most specialized farms. Median labour input per calf for the whole rearing period was 5.5, 1.9 and 2.0 h, resulting in an index of 1.5, 0.6 and 0.6 min/calf/day based on both quarantine and fattening houses. Daily labour input was generally higher in FH than in QH, however with fewer calves in QH, labour efficiency was generally twofold in FH, and in MF even 60 % higher (Table 3). A positive correlation was found between work time on the individual farm for daily routines (feeding and strewing) in QH and FH (r=0.4) indicating that a labour efficient farm tends to operate with well designed systems in both housing sections.

Effect of farm size

Labour input per calf was positively correlated with veal unit size up to 300 calves/year, from where the relationship turned negative with veal unit size to a break point of 550 calves/year (r = -0.663). A further increase in farm size up to 1150 calves/year had no effect on labour input per calf (r = -0.045). As a result labour efficiency was no different between MF and LF except for the individual work task of manure handling (Table 3). The non-linear relationship between labour efficiency and veal unit size is illustrated in Figure 1. ‘Loading on truck’ and ‘weighing’ were the only animal handling task where veal unit size had an effect on labour efficiency (Table 3).

Table 3: Labour input for pre-defined work tasks in red veal production for small (SF), medium (MF) and large farms (LF) prod. 100-399, 400-699 and 700-1150 calves/year.

	Labour input																	
	SF (100-399)						**MF (400-699)**						**LF (700-1150)**					
	n	Q_1	Median	Q_3	mean	%*	n	Q_1	Median	Q_3	mean	%*	n	Q_1	Median	Q_3	mean	%*
Daily labour input[i]																		
Labour input QH *(min/calf/day)*	9	1.4	*2.4*[b]	3.5	2.5	-	10	0.6	*1.1*[a]	1.3	1.2	-	8	0.5	*0.6*[a]	1.0	0.8	-
Labour input FH *(min/calf/day)*	12	0.8	*1.2*[b]	1.5	1.3	-	11	0.2	*0.4*[a]	0.5	0.4	-	8	0.2	*0.3*[a]	0.4	0.3	-
Labour input 'other' *(min/calf/day)*	12	0.09	*0.15*	0.40	0.24	-	11	0.07	*0.10*	0.12	0.10	-	8	0.08	*0.10*	0.16	0.11	-
Labour input QH *(h/day)*	9	0.9	*1.5*	2.5	1.8	*0.41*[†]	10	1.3	*1.4*	2.3	1.7	*0.40*[†]	8	1.0	*1.2*	2.4	1.6	*0.35*[†]
Labour input FH *(h/day)*	12	1.2	*1.8*	2.9	2.3	*0.49*[†]	11	0.7	*1.6*	2.4	1.6	*0.46*[†]	8	1.1	*1.5*	2.5	1.7	*0.44*[†]
Labour input 'other' *(h/day)*	12	0.2	*0.4*	1.8	0.5	*0.10*[†]	11	0.4	*0.5*	0.6	0.5	*0.14*[†]	8	0.6	*0.7*	1.1	0.8	*0.21*[†]
Total labour input (h/day)	12	2.4	**3.6**	5.8	4.1	-	11	2.6	**3.5**	4.5	3.7	-	8	2.6	**4.4**	5.2	4.2	-
Labour input per batch																		
Total QH *(min/calf/batch)*	9	80.0	*118.9*[b]	226.2	150.7	*0.35*	10	31.2	*64.8*[a]	76.8	62.0	*0.48*	8	22.7	*33.3*[a]	43.7	34.2	*0.31*
Total 'FH' *(min/calf/batch)*	12	133.9	*185.3*[b]	298.1	225.6	*0.55*	11	25.3	*48.7*[a]	92.8	58.8	*0.36*	8	36.6	*53.6*[a]	62.7	56.4	*0.49*
Total 'other' *(min/calf/batch)*	12	22.5	*33.6*[b]	71.3	49.3	*0.10*	11	14.8	*20. 3*[a]	22.3	21.2	*0.15*	8	15.4	*21.4*[b]	30.0	23.0	*0.20*
Total (h/calf/batch)	12	*3.6*	**5.5**[b]	*9.6*	*6.2*	-	*11*	*1.7*	**1.9**[a]	*2.9*	*2.3*	-	*8*	*1.2*	**2.0**[a]	*2.1*	*1.9*	-
Labour input per work task																		
Quarantine house (QH)																		
Feeding (*min/calf/batch)*	9	56.0	*71.4*[b]	143.7	108.3	*0.22*	10	12.0	*43.1*[a]	57.0	37.1	*0.32*	8	7.6	*24.3*[a]	33.5	23.7	*0.22*
Bedding *(min/calf/batch)*	8	8.5	*20.7*[b]	93.3	31.0	*0.06*	10	5.1	*8.6*[a]	46.7	12.6	*0.06*	8	2.7	*5.3*[a]	9.0	6.5	*0.05*
Manure removal *(min/calf/batch)*	9	2.2	*4.7*[b]	21.0	11.1	*0.01*	10	1.9	*4.5*[b]	8.1	7.9	*0.03*	8	0.6	*0.8*[a]	3.8	2.1	*0.01*
Cleaning *(min/calf/batch)*	9	0.9	*3.1*[b]	5.6	3.6	*0.01*	9	1.2	*2.9*[a]	6.7	4.9	*0.02*	8	0.8	*1.3*[a]	1.7	1.9	*0.01*
Finishing house (FH)																		
Feeding *(min/calf/batch)*	12	69.9	*122*[b]	229.4	170.1	*0.37*	11	11.2	*38.1*[a]	63.7	39.6	*0.28*	8	8.6	*37.6*[a]	51.2	37.6	*0.34*
Bedding *(min/calf/batch)*	10	29.5	*54.5*[b]	72.1	64.6	*0.17*	10	7.0	*12.8*[a]	17.8	14.1	*0.09*	8	6.8	*13.6*[a]	19.9	15.0	*0.12*
Manure removal *(min/calf/batch)*	11	5.4	*16.2*[c]	26.5	26.3	*0.05*	11	2.6	*4.0*[b]	5.1	4.1	*0.03*	8	1.7	*2.1*[a]	2.9	2.2	*0.02*
Cleaning *(min/calf/batch)*	10	2.5	*6.9*[b]	9.1	7.9	*0.02*	9	0.8	*2.3*[a]	4.3	3.0	*0.02*	6	0.8	*1.1*[a]	3.7	2.0	*0.01*
Other common tasks																		
Unload calves *(min/calf/batch)*	12	1.6	*4.0*	26.7	11.2	*0.01*	11	0.7	*2.8*	7.3	3.8	*0.02*	8	1.3	*2.8*	7.8	4.0	*0.03*
Shifting *(min/calf/batch)*	10	2.2	*3.3*	18.1	8.4	*0.01*	6	1.6	*2.9*	5.8	3.6	*0.02*	8	0.8	*3.5*	6.8	3.9	*0.03*
Weighing *(min/calf/batch)*	8	5.6	*13.0*	19.0	18.8	*0.04*	6	3.6	*5.7*	8.1	5.8	*0.04*	5	3.8	*6.2*	7.9	5.9	*0.06*
Load on truck *(min/calf/batch)*	12	2.5	*6.2*[b]	10.9	9.1	*0.02*	10	2.0	*3.2*[a]	6.7	4.3	*0.02*	8	1.6	*2.8*[a]	3.4	2.5	*0.03*
Administration *(min/calf/batch)*	9	4.9	*7.8*	19.0	12.6	*0.02*	10	4.8	*6.1*	9.7	8.7	*0.05*	6	5.1	*7.5*	20.9	12.0	*0.07*

[n] number of farms

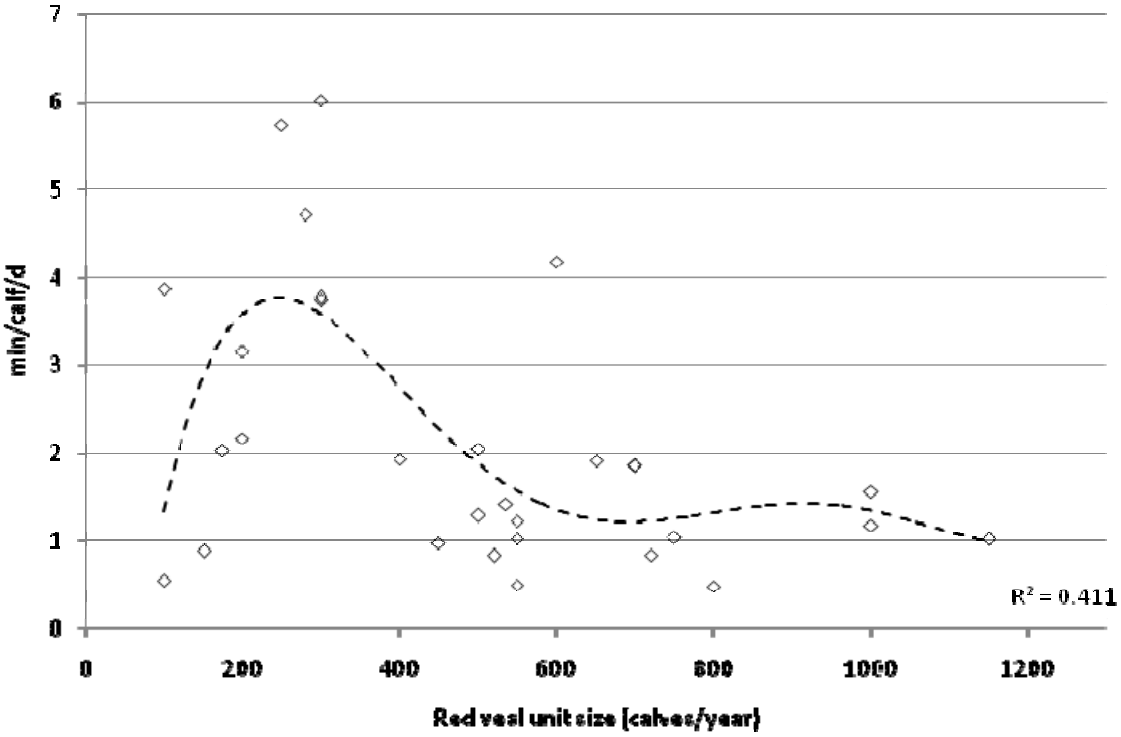
[i] All labour data refers to work time for 9 pre-defined work tasks (see table), and does not include work time e.g. for supervision, medical treatment of calves and infrequent unforeseen tasks.

*relative amount of total labour input per calf specific to work task

[†] relative amount of labour input on daily basis specific to combined work tasks ('QH',' FH' and 'other').

[ab] Values (within rows) with different superscripts are significantly different (P<0.05)

Figure 1. Labour input (min/calf/day) on Swedish red veal farms producing 100-1150 calves/year.



Factors influencing labour efficiency

Feeding tasks required the greatest proportion of labour input per calf, with 59%, 60% and 56% of total labour input on SF, MF and LF, respectively (Table 3). This was also the most frequent task, with a majority (50-80%) of the farmers having once or twice daily feeding routines. Daily labour input for feeding in QH was correspondingly 120, 47 and 31 sec/calf/day. The most common feeding strategy was to feed roughage and concentrate separately, both in QH and FH, with only 6% of the farms using a total mixed ration (TMR). Different techniques were used for feeding, even within the one farm, and partly or completely manual work was not uncommon.

The variation within farm categories decreased with a higher number of calves (Table 3), indicating that the largest farms were applying similar strategies. However, the inter quartile range (IQR) of 0.9 h/calf/batch on LF reveals that a labour input of up to ~750 working hours

per year could be saved by the average farm in this size category, a considerable increase in the allocative efficiency of the farm. On the whole, the large IQRs in Table 3 indicate possibilities for improved labour efficiency within every farm size category and for every work task. As regards the largest farms (LF), IQR for 'feeding' was more than one hour per calf/batch in QH+FH (Table 3).

The field study confirmed the variation in work patterns and facilities between farms, and with seven of eight farms in the LF category being studied in detail, differences in labour efficiency could be examined in depth. Field study farms no. 6 and 7 (Table 1) were examples of farms within Q1 for feeding tasks in both QH and FH. These farms had several common factors for the efficient use of labour during feeding such as a) relatively large groups of weaned calves in QH; b) one single farm building centrally located for QH and FH, respectively; c) automated concentrate feeders; d) roughage feeding at low frequency (2-3 times/week). The field study farms no. 8-10 placed around the median value for feeding in QH. Farms with labour input above Q3 were the two LF field study farms, characterized by purchasing pre-weaned calves reared in small groups of 4-10 calves (farm no. 4 and 5, Table 1).

In FH, the feeding tasks consumed 46, 17 and 16 sec/calf/day on the three farm size categories, respectively. The 50% most efficient farms included field study farms no. 6 and 7 (described above) followed by farms no. 5 and 10 (Table 1). The two latter farms both had a supplementary old slatted floor building, affecting the overall labour efficiency negatively with the need for manual feeding techniques. Farm no. 8 feeding twice daily using TMR was in the third quartile together with a non field study farm producing 750 calves/year performing once daily feeding of 60 minutes in FH. Common for farms with the highest

labour input was twice daily feedings in two or three different buildings for each calf age category (i.e. farms no. 4 and 9).

Labour input for bedding in QH was 3.7, 1.7 and 1.0 min/calf/week for SF, MF and LF, respectively. Bedding tasks consumed correspondingly 23%, 15% and 17% of the total labour input per calf. In FH, bedding tasks consumed 1.8, 0.7 and 0.7 min/calf/week. Overall, 51% of the farms handled the bedding material daily or every second day, in general more frequently in FH (daily basis) than in QH (weekly basis). Manual bedding was most common on SF, with 67% and 81% of QH and FH, respectively. A general increase in mechanization was found with increased farm size, but as a result of large variations in techniques within farms, bedding tasks on LF were still manually performed on 38% and 25% of QH and FH.

Quarantine houses were typically cleared for manure, high pressure cleaned and dried before putting new calves in, but also the majority of farms cleared and cleaned the pens in finishing houses between batches (Table 3). Overall, manure removal was in 52% of cases performed monthly. At 61 % of the farms, starter stables were washed once a month or every fifth week, followed by 13 % washing every second month. The remaining 26% washed 1-4 times a year. As seen in Table 3, the median time for manure removal was significantly shorter on LF compared to MF and SF, whereas work time for cleaning was affected by farm size already from the medium farm size category.

Animal handling tasks consumed proportionally higher labour input per calf as farm size increased, with 10%, 15% and 20% of total labour input on SF, MF and LF. Within the LF-category the 25% farms with highest total work efficiency were categorized by operating few buildings, centrally located on the main farm facilitating efficient loading, unloading and

shifting of calves, concentrated weighing and limited transportation between houses. Buying pre-weaned calves and collecting the calves with their own vehicles characterized some of the farms with the work time above the median value for animal handling tasks. Work efficiency for administration was not increased by a larger veal unit size but a high proportion of work time was spent recording individuals entering and leaving the enterprise (7% of total labour input per calf on LF). Shifting, unloading and loading of calves consumed ~10 min/calf/batch on MF and LF and ~15 min/calf/ batch on SF and might, like the administration tasks, represent tasks that can hardly be expected to have a clear linear relationship between labour efficiency and unit size. Weighing of calves was done weekly or every second week and performed on 45-50% of SF, MF and LF, respectively, and was relatively labour intensive comprising 4%, 4% and 6% of the total labour input, respectively.

DISCUSSION

Different techniques have been used in previous studies of work time, such as observing the worker by use of a handheld computer, (Schrade et al. 2005) using digital stopwatches (Gleeson et al. 2007; Ferris et al. 2008) or keeping a work journal (Leahy et al. 2004; Schrade et al. 2005; O'Brien et al. 2006a; Gillespie et al. 2008; Gleeson et al. 2008). All these techniques have advantages and disadvantages for the accuracy of labour studies. In the present study, labour input data were based on the farmer's assessment of the labour input during common pre-defined work tasks on a normal working day. On-farm measurements would have required a large number of farm visits, as the time interval between many of the work tasks on red veal farms could be weeks, compared to pig or dairy farming where more work tasks are performed on a daily basis. With the questionnaire, the farmers had a 3-4 week deadline and thus the possibility to consider the labour input during several work tasks before the questionnaire was returned. Data from every farm were carefully evaluated after retrieval

and checked for ambiguities or possible errors before analysis, and the good agreement between reported labour inputs from the questionnaire and data obtained on farm visits validated the choice of methodology.

The index for labour input of 1 min/calf/day currently used by farm advisors (Taurus, 2009) calculates costs for Swedish beef cattle producers on a total work time of 3 hours per calf for a 6 months rearing period. From our results in Tables 2 and 3 we found that the median rearing period is 7.2 months for SF and 6.2 months for MF and LF, and a labour use of 1.5, 0.6 and 0.6 min/calf/day, respectively, for the predefined work tasks only. Considering factors such as the additional work hour of about one hour per day for tasks not included in the study on large farms, a more than halved herd size for the average Swedish red veal producer and the difference in labour input per calf and day in QH and FH it appears that labor assessment in commonly used cost estimation guides for Swedish beef cattle producers might underestimate the true labor demand for red veal production.

Although the end-product was the same, the Swedish red veal production units studied were diverse. Housing systems, level of mechanisation, age and group size of calves during the production period differed not only between farms, but even within farms. All work tasks were not performed on every farm, which influenced the total labour input, and thus the variation between farms. Further, not all farms had a QH. This large variation in facilities and time management among farms is not exclusive to Swedish beef cattle producers, but has been reported for other types of farm (Leahy et al. 2004; Schrade et al. 2005; Fallon et al. 2006; Gleeson et al. 2008). Labour efficiency was not significantly different between medium and large farms, which may indicate that the trend towards high mechanisation and effectiveness has not been as noticeable in veal calf production as in the dairy, pig and poultry

industries. This might illustrate the limitations of many farming facilities used at present, with a minimum amount of time per calf that can be put into production.

With the present economic situation in the Swedish veal calf industry, it is common to use old buildings or buildings originally designed for other livestock production, even when calf herd size increases, alone or as a complement to new buildings. However, this reduces the possibilities for the farmer to run his enterprise without employees, as the labour demand is too large and inadequate animal handling systems require at least two people to perform some tasks. In this study, using older buildings typically involved several houses and the number of quarantine and finishing houses could range from one to four or five, diversifying the strategies and techniques on the individual farm and sometimes involving considerable distances between the farm centre and certain calf houses. However, with this trend being common, it seems very relevant not only to discuss how expensive investments can reduce labour costs, but also to highlight how labour costs can be reduced in low-cost buildings. Feeding frequency as a labour saving method in beef cattle production has been discussed in some other studies (Schrade et al. 2005; Fallon et al. 2006) but little information is available on the effect of roughage feeding frequency on finishing cattle. Estimating the cost of labour using the value obtained in this study of a 42.6 min/calf difference between the large farms with the 25% lowest and 25% highest labour input during feeding in finishing houses gives a difference of 9741 EURO (700 calves*42.6 min/calf*current wage of 19.6 EUR/h; January 2010) (Agriwise, 2009) on a farm producing 700 calves annually.

Relative to the number of days that calves stay in the QH, the daily labour input per calf here had a large effect on the total labour input. The medium size farms had particularly low labour efficiency (48% of total time), which might be explained by the longer rearing period

for calves in QH. Efficient use of QH is thus crucial. Using neighbouring buildings for the same age category of animals would concentrate the work tasks and make it possible to focus on the needs of the different groups of calves. Keeping quarantine houses close to the farm centre and using farm buildings further away as finishing houses could be one strategy for improving the supervision of younger calves.

Over the entire rearing period, feeding and bedding tasks accounted for 73% (LF) to 81% (MF) of the pre-defined tasks. The frequent and repetitive physical work with feed and bedding material involves not only a high work load in time, but also a risk of developing work-related musculoskeletal disorders (Hagberg et al. 1997; Kolstrup et al. 2006) as well as involving a risk of impacts from animals, particularly in the finishing houses. Large groups are admittedly efficient from a workload point of view (Neindre, 1993; Hanekamp et al. 1994; Gleeson et al., 2007; Pedersen et al. 2009), but are nevertheless agreed to be a challenge from several other aspects such as transmission of illnesses, conflict situations as to social ranking of calves, work safety and lower individual control and supervision by the farmer (Kung et al. 1997; Andrighetto et al. 1999; Lensink et al. 2001; Xiccato et al. 2002; Svensson and Liberg, 2006). Taking calves that are not weaned requires extra time and effort, as calves at this age are at a very sensitive period. A drawback taking weaned calves is that the farmer cannot control quality at this stage or be sure that the calf has been weaned in a way that ensures a proper uptake of roughage and concentrate after weaning. Being weaned on the truck can leave a calf with many stress factors at the same time.

The relationship between a reduction in labour input per animal with increased size of the enterprise is well established (Langvatn, 1960). Nevertheless, labour input per calf for handling animals was similar for all three farm size categories. The present result is

apparently another effect of the use of older buildings or buildings not originally constructed for red veal production. The great variation between farms in work time for animal handling indicates an urgent need for proper animal handling facilities. In general, beef cattle advisors recommend weighing as an important tool for planning slaughter maturity and for optimal utilisation of buildings and input resources (Taurus, 2009), but 53% of the respondents in the present study never weighed the calves. The farmers who weighed calves regularly were convinced about the value of this, however those who did not weigh their calves argued that the scales could not tell more about carcass measurements than a skilled eye. From a work efficiency point of view, where the facilities are inappropriate, the ability to judge a mature animal would save valuable work hours and even avoid stressful situations with risk for injuries to both animals and humans.

Adequate systems for efficient handling of animals, shifting them between pens and loading and unloading the transport vehicle are not only labour saving but also crucial for a safe working environment, above all as the farm expands and the size of the veal production unit increases. The proportion of work time needed for administration work (Table 3) confirmed the issue commonly stressed by farmers, that paperwork is taking more and more time. The increased availability of electronic identification of animals will probably reduce this burden and also facilitate safe and efficient animal handling in the future.

CONCLUSIONS

This study of labour use on Swedish red veal farms revealed that the median labour input per calf for pre-defined work tasks was 5.5, 1.9 and 2.0 hours on small, medium and large farms, respectively. Labour efficiency was not significantly increased by herd size once the unit size exceeded 550 calves per year. Some strategies to reduce labour requirements are to lower the

level of farm fragmentation, reduce the frequency of work tasks and plan for strategic handling of animals. Improvements are particularly crucial in quarantine houses, where the number of animals is low and the batch period short.

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