Key Performance Indicators to Diagnose Poor Farm Performance and Profitability of Smallholder Dairy Farmers in Asia

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ABSTRACT : This review presents a series of Key Performance Indicators (KPI) to assist Asian smallholder dairy farmers in identifying the possible causes for their poor farm performance and profitability. When assessing farm profitability, these indicators can be split into two types, those diagnosing problems with feeding management and those indicating poor herd management. As home grown forage is generally cheaper to source than purchased forage, the more produced on farm, the better. Too many stock on limited land is a common feature on Asian dairy small holdings. Unlike other classes of livestock, milking cows have very high nutrient requirements, therefore high quality forages and concentrates are essential for profitable dairying. Milk income less feed cost is one of the simplest and easy to measure indicators of farm profitability and is also quick to respond to small changes in farm practices. Problems with herd management can be diagnosed using measures such as the proportion of cows actually milking in the herd or their peak yield and persistency of production. There are also simple indicators of herd reproductive performance and of health and growth of young stock that assist in searching for the underlying causes of poor farm profitability. (**Key Words** : Dairy, Asia, Smallholder, Key Performance Indicators)

INTRODUCTION

Throughout the tropics, smallholder dairy farming was established as part of social welfare and rural development schemes, to provide a regular cash flow for poorly resourced and often landless farmers. Now it is an established industry in most countries thus requiring a more business-minded approach to farm management. Not only does locally produced raw milk replace imported dairy products, it provides some degree of national food security to counteract the vagrancies of the current global financial and politically unstable world in which we live (APHCA, 2007). Dairy consumption in Asia has more than doubled over the last 25 years, and this has led to more than 50% of the world's total dairy imports now entering Asian markets (FAOSTAT, 2008). Consequently, dairy development programs attain high priority in most Asian countries (Dudgill and Morgan, 2008).

In South East Asia, smallholder dairying has become a good income earning occupation for crop/livestock farmers in mixed farming systems. This is evident in Thailand, Malaysia and Indonesia where such farmers turned to small scale dairying and were able to make enough income and savings to support their children to receive college education. With further improvement in productivity and reduction in production costs, Chantalakhana and Skunmun (2002) concluded that small holder dairying in these countries can become very sound and sustainable enterprises.

Although many Asian dairy farmers intuitively think about farm costs and returns, greater use could be made of formats allowing them to be more aware of the relative importance of all their financial inputs in terms of cost of production (COP) per kg of milk produced on the farm (Moran, 2009). At a recent training program on farm business management in Vietnam, a spreadsheet was developed by a team of dairy advisers to summarise cash flows and other financial transactions on small holder dairy farms in terms of COP, return on assets and other measures of farm profit (Moran, 2008); this spreadsheet, FARMPROFIT, is freely available from the author of this review.

Knowing their cost of production allows small holder farmers to determine their profit margins and this is critical to operating a sustainable dairy enterprise. Farmers must do

more and better planning if they are to achieve greater profits. Profits are not something they end up with at the end of the year. Rather, they are something for which farmers must plan (Makeham and Malcolm, 1986).

This review presents a range of Key Performance Indicators (KPI) to help farmers diagnose the strengths and weaknesses in their dairy enterprise. Farmers should use these indicators to identify these weaknesses in, rather than set targets for, their farm (McConnell and Dillon, 1997). Farmers are more likely to try to improve their systems if they know they are less productive compared to others. Such an approach may simply encourage farmers to look more critically at their cost structures. Expressed simply, this is a diagnostic tool to help identify production weaknesses adversely affecting financial performance.

The following ten series of questions should be asked on any farm, big or small. Because more than half of farm costs are feed related (Moran et al., 2000), the first six questions are directly related to feeding management. Even though the remaining four are more related to overall herd management, they are still very much feed-dependent. For some of the questions, specific indicators relevant to particular farming systems can be developed. However, for others, there is no single indicator that farmers can work towards because the most correct answer is the higher the better for some (such as on farm forage production or forage quality) or the lower the better for others (such as total feed costs or calf mortality and heifer wastage rates). These indicators are presented as ranges rather than a single value emphasising the fact that they are only guidelines. These ten key measures or symptoms of poor farm performance for which diagnoses should be considered are presented in Table 1.

FEED RELATED KEY FACTORS INFLUENCING FARM PROFITABILITY

Stocking capacity

Forages almost always provide a cheaper source of the key feed nutrients (energy and protein) than do concentrates (Moran, 2005). It is usually cheaper to grow these forages on the farm rather than purchase them. It is easier to control forage quality on farm, through fertiliser and harvest interval, than with purchased forages. When relying on off-farm forage supplies, farmers depend on what is available, either from traders who harvest the roadsides, paddy fields, tree plantations or forests or from other farmers who sell their excess supplies, either as crop byproducts (such as rice straw or corn stover) or forage crops specifically grown for sale.

In my book (Moran, 2005), I have listed a series of assumptions and calculations of optimum stocking capacities for small holder dairy farmers with different level of forage management. Calculations were made for farmers who run replacement heifers on the same farm as their milking herd and for farmers that have them reared off farm. The calculations also included three levels of forage management, namely poor, average and good, to produce 10, 20 and 30 ha forage DM/ha/yr respectively. Table 2 presents the range of optimum stocking capacities.

For a farmer growing the maximum quantities of quality forages, to feed his milking cows well, he should have no more than 8 to 10 milking cows per hectare of forage grown on his farm. However most dairy small holders do not manage their forages well enough to produce the highest yields of forage. Therefore a more realistic recommendation would be 6 to 8 milking cows (plus the replacement heifers) per hectare of forage grown on farm.

Table 1. Ten key measures of small holder dairy farm performance (Moran, 2009)

Measure	Questions to ask
Feeding management	
1. Stocking capacity	Is the farm carrying too many stock for the available forage supplies?
2. On-farm forage production	How much of the farm's annual forage requirements must be purchased?
3. Forage quality	Is the forage being harvested or purchased at its optimal quality for milking cows?
4. Concentrate feeding program	What is the quality of the concentrates being fed and how much is allocated per milking cow?
5. Total feed costs	Are the forages and concentrates costing too much per unit of feed energy or protein?
6. Milk income less feed costs	How does this compare with those of other farmers with good feeding management?
Herd management	
7. Percent productive cows	What is the percent of adult cows actually milking? What is the proportion of milking cows in the entire dairy herd, expressed as a percentage?
8. Pattern of milk production	What is the peak milk yield of the herd and what is its lactation persistency (rate of decline from peak milk yield)?
9. Reproductive performance	How many days after calving do cows cycle? What is the submission rate and the conception rate to first insemination?
10. Heifer management	What is the pre weaning calf mortality and the wastage rate of heifers from birth to second lactation? What is their age and live weight at first calving?

Table 2. Optimum stocking capacities for small holder dairy farms with different levels of forage management (Moran, 2005)

Quality of forage management*	Poor	Average	Good
Forage yield			
t DM/ha/yr	10	20	30
t fresh/ha/yr	67	130	200
Milking units/ha forage	3.4	6.9	10.3
Adult cows/ha forage	4.0	8.1	12.1

* Quality of forage management: Poor, fertilising grass only with cow manure; Average, fertilising grass with cow manure and limited inorganic fertiliser; Good, fertilising grass with sufficient inorganic nitrogen and phosphorus fertilisers to match optimum requirements.
One milking unit is one adult cow plus 20% of a replacement heifer.
Assumed forage intakes: 7.5 kg DM/d for 275 d/yr for milking cows. 4.5 kg DM/d for 90 d/yr for dry cows. 3.0 kg DM/d for 365 d/yr for 20% of a replacement heifer.

Table 3. Required intakes of concentrates (kg DM/d) to achieve target milk yields in cows fed forages of varying quality (Devendra, 1975)

Target milk yield (L/d)	Forage quality (MJ/kg DM of metabolisable energy)			
	7.3	8.2	9.0	9.9
6	3.2	0.7	-	-
10	4.9	2.5	0.8	-
14	6.6	4.8	1.1	0.3
18	8.2	6.0	3.0	0.7
22	9.8	7.7	5.4	1.7

Unfortunately most small holder dairy farmers like to keep more cows than this recommendation, meaning they must either have to purchase forages off farm, underfed their milking cows (and heifers) with less forage, or if they aim to produce high yields of milk (say more than 12 to 14 kg/d), feed excessive levels of concentrates to each milking cow. This is a more expensive way to produce milk, and frequently leads to digestive problems, such as sub clinical acidosis. Not only will this reduce feed efficiency, it will increase the cost of production and reduce farm profits. Therefore as all good businessmen aim to, smallholder farmers should produce at the optimum level to maximise efficiencies and profits. In other words, they should not put too many cows onto their farm if they cannot feed and manage them properly.

On farm forage production

As it is cheaper to grow quality forages on farm, the less purchased, the lower the feed costs. With well planned dairy production systems, it should be possible to supply 95 to 100% of the forages from on farm supplies, through strategies such as fodder conservation. Strategic purchases of small quantities of very cheap, lower quality forages (such as rice straw) for stock with lower daily nutrient requirements, such as dry cows, may still be a good management decision.

The biggest problem with on farm forage supplies is to produce them twelve months of the year. As forage growth rates are markedly reduced during periods of low rainfall or low temperatures, the challenge for a good feed manager is to match stock requirements with forage supplies. In seasonal calving areas of southern Australia, farmers manipulate calving patterns to ensure most cows calve during the spring flush of pasture growth and dry off during winter. Their low cost production systems allowed this to be economic. This is not the case in Asia where farmers need to calve their cows year round to provide a regular cash

flow. Conserving forages through silages and hays during periods of peak forage growth is the best way to overcome seasonal forage supplies. Hay making requires many more days of dry weather than silage making and this is rare during wet seasons when excess forage supplies are more likely. Making silage from forage crops or quality crop byproducts (such as legume tree leaves, corn stover or other cash crop residues) can augment supplies of other conserved wet season forages (Mickan, 2003).

Forage quality

To produce milk and calves, dairy cows require feed nutrients which are supplied through forages and concentrates. To produce acceptable milk yields, say 15 L/d, cows require a ration containing at least 10 MJ/kg DM of metabolisable energy (ME). The more of this supplied by forages, the less required by concentrates. For milking cows, the recommended forage quality would be 9.5 to 10.0 MJ/kg DM of ME and 12 to 14% crude protein (Target 10 2005).

The higher the quality of the forage, the less concentrates necessary to achieve the desired milk yield. Devendra (1975) estimated the amount of concentrates required for target milk yields in 400 kg milking cows (non-pregnant with zero weight change) when fed *ad libitum* forage of varying qualities (Table 3). He assumed the concentrate to be home mixed containing 12.2 MJ/kg DM of ME and 24% protein.

Concentrate feeding program

Concentrates should be formulated to provide adequate dietary nutrients to supplement available forages. The recommended concentrate quality would be 11 to 12 MJ/kg DM of ME and 16 to 18% crude protein (Target 10 2005).

Many Asian dairy advisers use a general "rule of thumb" that farmers should feed 1 kg concentrate for every 2 L of milk produced. This is a safety measure because of the lack of knowledge on the nutritive value of the feeds, particularly the forages. It also provides supplemental energy to cows when fed only limited amounts of forage.

With knowledge of the feeding value of the forages and

concentrates, and their costs, more objective hence better decisions, can be made on how much concentrates should be fed to achieve target milk yields. This requires more knowledge and greater effort than following the "feed 1 kg concentrate per 2 L milk" rule, but such decisions can greatly reduce feed costs hence improve profitability, when expressed as milk income less feed costs.

Table 3 listed the level of concentrates required to achieve target milk yields with varying forage qualities. These feeding decisions have been converted into milk: concentrate ratios in Table 4. When cows are fed better quality forages, more milk is produced per kg concentrate fed. The 1:2 (1 kg concentrate/2 L milk) rule is only applicable with very low quality forages, namely those with ME contents of 7 to 8 MJ/kg DM.

Total feed costs

The choice of available feeds for milk production will differ from country to country as do their relative costs. The principle of formulating profitable rations is to compare different feeds firstly on the basis of their cost per unit energy because energy is nearly always the first limiting nutrient. When protein deficiencies limit cow performance, the unit cost of protein becomes important. The fibre content of each potential feed ingredient is considered just to make sure the voluntary intake of the cow is not too restricted and she will not eat all that is offered.

When formulating rations, either by computer or by calculator, so long as farmers are confident that the raw data (feed costs and nutritive values) are representative of that feed being fed to those cows, then traditional ration formulation calculations, such as those presented by Moran (2005), will provide a meaningful answer to any least cost ration. With experience, the process is less time consuming because "best bet" rations can be easily checked for their nutrient content and likely milk yield response.

Milk income less feed costs

Milk income less feed costs (MIFC) is one of the simplest indicators of farm profitability. In addition, changes in MIFC are quick to monitor because of the

rapidity with which milking cows respond even to small variations in their feeding management (Target 10 2005). When introducing new feeds into the diet or varying their amount, the cows' milk responses will reflect these changes within a few days as will their MIFC within a week or two. The development of generic indicators for total feed costs and MIFC depend greatly on the base costs of feeds in different dairy regions.

At a recent training program on dairy farm management in Indonesia, Moran and Nugraha (unpublished data) developed a spreadsheet (FEEDPROFIT) to calculate the nutrient requirements to achieve target milk yields then, from a local feed database, the cost of a selected ration and the MIFC achieved. FEEDPROFIT can easily be modified for use in other countries and is freely available from the author of this review.

HERD RELATED KEY FACTORS INFLUENCING FARM PROFITABILITY

Proportion of cows milking of those that have calved

One good measure of the performance of the milking herd is the proportion of cows actually producing milk. For herds with a 12 month calving interval, lactation length should be 300 d (for a 65 d dry period), so lactation length would be the calving interval less 65 d, meaning that 82% of the cows are milking at any one time with 100% calving rate. However in most year-round calving systems, less than 75% of the adult cows are milking. The longer the dry period, the less the number of cows milking at any one time. The number of cows milking as a percent of the total cow herd is influenced by several factors, the most important being lactation length, inter-calving interval and calving rate (Holmes et al., 2002). The effects of these factors on % cows and first calf heifers milking in the adult herd have been quantified in Table 5. It is assumed that cows with a 12

Table 4. Milk: concentrate ratios (L milk produced/kg concentrate fed) for cows to achieve target milk yields when fed forages of varying quality (Devendra, 1975)

Target milk yield (L/d)	Forage quality (MJ/kg DM of metabolisable energy)			
	7.3	8.2	9.0	9.9
6	1.8	8.6	-	-
10	2.0	4.0	12.5	-
14	2.1	2.9	12.7	46.7
18	2.2	3.0	6.0	25.7
22	2.2	2.9	4.1	12.9

Table 5. Proportion (%) of cows and first calf heifers milking in the adult dairy herd as influenced by lactation length, inter calving interval and calving rate (Moran, 2009)

Lactation length (d)	Calving rate (%)	Inter calving interval (m)		
		12	15	18
330	90	-	65	54
300		74	59	49
270		67	53	44
240		59	47	39
330	80	-	58	48
300		66	53	39
270		59	47	35
240		53	42	32
330	70	-	51	42
300		58	46	38
270		52	41	35
240		46	37	31

Table 6. Proportion (%) of days milking as influenced by calving interval and lactation length (Moran, 2009)

Calving interval (d)	Dry period (d)	Lactation length (d)	% days milking
365	65	300	82
	90	275	75
	115	250	68
400	65	335	84
	100	300	75
	125	275	69
	150	250	62
450	65	385	86
	115	35	74
	150	300	67
	175	275	61
	200	250	55

Table 7. Proportion (%) of cows and first calf heifers milking in the entire dairy herd as influenced by lactation length, inter calving interval and calving rate (Moran, 2009)

Age at first calving (m)	Calf and heifer mortality (%)	Inter calving interval (m)		
		12	15	18
25	10	44	40	35
30		40	36	33
35		37	34	31
25	15	47	41	37
30		42	37	33
35		39	35	31
25	20	48	42	37
30		43	40	35
35		40	36	32

month inter calving interval were dried off 65 d prior to calving. It also assumes no cows were culled for poor fertility or production and there were no mortalities among the milking herd. This table highlights the adverse effects of inter-calving interval on the proportion of productive cows in the herd and this can easily fall below half the adult cows in the milking herd.

One way to demonstrate the importance of having as many of the adult cows milking as possible is develop a table, as in Table 6, in which the % days any one cow is milking is related to the herd's inter-calving interval, the length of the dry period hence the average lactation length. This is essentially the same as calculating the % adult cows milking for 100% calving rate.

Suggested KPI's for tropical small holder dairy farmers (Moran, 2009) are:

74%; excellent
60-73%; acceptable
50-59%; below average
40-49%; not good

Cows milking as a proportion of the total dairy herd

Another useful measure of the proportion of productive cows is the size of the milking herd as a percent of the total dairy herd, which includes the milk-fed and weaned replacement dairy heifers, breeding bulls (if any), dry cows and milking cows. As well as lactation length, inter-calving interval and calving rate, other important factors are heifer wastage (a combination of pre-weaning calf mortality and losses between weaning and second calving), age at first calving, culling of cows for poor performance and mortalities among the milking herd.

Based on a model developed by Waittiax (1999), Table 7 presents the effects of some of the key factors, namely lactation length, calf and heifer mortality (up to 24 months

of age) and age at first calving, on the % milking cows (and first calf heifers) in the total dairy herd. A series of assumptions had to be made on other key variables in this model, namely a lactation length of 300 d, calving rate of 90%, half of the calves born were heifers, 10% of these heifers were sold before calving and the annual culling rate for the milking herd was 35%.

From Table 7, the proportion of milking cows decrease with age of first calving because heifers spend a longer time as young stock prior to joining the milking herd. The proportion of milking cows increased with higher calf and heifer mortalities because there were fewer heifers. Longer inter-calving intervals have the most dramatic effect on milking cow numbers. Table 7 highlights the fact that at any one time, less than half the dairy herd (ranging from 31 to 48%) are generating income.

Suggested KPI's for tropical small holder dairy farmers (Moran, 2009) are:

48%; excellent
40-47%; acceptable
35-39%; below average
30-34%; not good

Pattern of milk production

The two major factors determining total lactation milk production are the peak lactation yield (within six to eight weeks post calving) and its rate of decline from this peak (or lactation persistency) (Chamberlain and Wilkinson 1996). The persistency quantifies the average rate of decrease in yield (in % per month from peak yield) for each month after the peak. The higher this number, the faster the rate of decline hence the less milk produced. In Asia, lactation persistencies of less than 8% per month may be achievable on very well managed farms, but more realistic levels are 8 to 12% per month (Moran personal observations).

Using a computer simulation model, Moran (2005)

calculated that over a 300 d lactation, a cow with a peak milk yield of 15 L/d and an 8% persistency would produce 9.9 L/d average and a total of 2,980 L, while a 12% persistency would equate to 7.8 L/d average and 2330 L total. A cow peaking at 20 L/d with an 8% persistency would then produce 13.2 L/d and 3,970 L total, or with a 12% persistency, she would produce 10.4 L/d and 3,110 L in total. A more productive cow, say with a 25 L/d peak and 8% persistency, would produce 16.6 L/d average and 4,960 L in total, while a 12% persistency would result in 13.0 L/d average and 3,885 L total. Such average and full lactation milk yields for the same peak and persistency will vary with lactation lengths. In summary, milk yields at any one time are the result of peak milk yield and persistency. If they are below expectations, it is important to diagnose the cause.

A very high rate of decline, indicating a rapid drop off in milk yield post peak, can be indicative of poor feeding management during mid lactation which often, particularly in high quality dairy cows, leads to a rapid weight loss and a delay in the first post-calving oestrus hence reduced fertility (Target 10 2005). Therefore, feeding management must be directed towards supplying adequate nutrients, particular energy, in early lactation to achieve high peak yields, and in mid lactation to maintain milk yields hence reduce persistency values.

Reproductive performance

For year-round calving herds, there are four useful measures of reproductive performance (Morton et al., 2003). These are:

100 day-in-calf rate : This calculates the percentage of the cows in the herd that become pregnant by 100 d after calving. It also describes how many cows will calve within about 13 months of their previous calving. High 100 day-in-calf rates leads to fewer cows with long intervals between calving and fewer cows culled as non-pregnant. Cows that conceive within 100 d of calving will calve again within 12.5 months and generate higher profits than cows that take a longer time to conceive or fail to get pregnant (Morton et al., 2003). This measure usually allows for the voluntary waiting period (the days between calving and the first mating) of say 55 d plus two oestrus cycles of AI (say 42 d) before the cow is put out for natural mating.

200 day-not-in-calf rate : This calculates the percentage of cows not pregnant by 200 d after calving. Farmers want as many cows as possible to calve no more than 15 to 16 months after their previous calving. This coincides with six months after which non-pregnant cows are often culled. It cannot be calculated until many months after cows have calved, but because it is closely related to 100 day-in-calf rate, it can be estimated from that measure. It cannot be calculated unless the whole herd is pregnancy tested.

Submission rate : Submission rate is the percentage of

the herd which received at least one insemination within a specified number of days after calving. To achieve a high 100 d in calf rate, a high percentage of cows in the herd must be submitted to insemination with minimum delay after calving. An 80 d submission rate is the percentage of cows that receive at least one insemination by 80 d after calving.

Conception rates : Conception rates are the number of services resulting in pregnancy divided by the total number of services. This describes the percentage of inseminations that are successful and result in pregnancy. This has always been considered an important measure of reproduction but it does not fully describe overall herd performance. Herds can have high conception rates but poor 100 day-in-calf and high 200 day-not-in-calf rates. Sometimes the first insemination conception rate is calculated by including only the first services after calving in the analyses.

For a smallholder milking herd in Asia, target KPI's (Moran and Tranter, 2004) are:

100 day-in-calf rate; 55 to 60%
200 day-not-in-calf rate; 13 to 15%
submission rate; 65 to 70%
voluntary waiting period; 50 to 60 d
conception rate to first insemination; 45 to 50%
inseminations per conception in an AI program; 1.8 to 2.0

Better fed cows have higher fertility which can improve 100 day-in-calf rate from 41 to 57% and reduce 200 day-not-in-calf rate from 15% to 9% (Morton et al., 2003).

These measures of reproductive performance are rarely used in Asia, because they require routine pregnancy testing of the entire herd. More typical ones are days from calving to first service and inter calving interval. Targets for these are for cows to be first mated 60 to 80 d post calving which should lead to 12 to 13 month inter-calving intervals.

STOAS (1999) compared reproduction and calf survival in two rearing systems to calculate their relative replacement rates for a dairy herd with stable stock numbers (in Table 8). System A measures could be considered as a set of key indicators.

Assuming cows remain in the milking herd for four to five lactations, 20 to 25% should be replaced each year.

Table 8. Measures of reproduction and calf rearing to produce replacements for a stable dairy herd (STOAS, 1999)

Rearing system	A	B
Calving interval (m)	12	18
Calving rate (%)	85	65
Still born calves (%)	2	5
Calf mortality from 0-24 m (%)	8	20
Non pregnant heifers (%)	5	10
Heifer calves born (%)	36	15

From Table 8, the supply of 36% heifers from System A allows for the sale of young breeding stock or a higher culling rate to better address genetic improvements in the herd. Only one in every six or seven cows could be replaced annually in System B (Table 8), which would hardly be enough to maintain herd numbers, let alone allow for much genetic selection.

With high ages at first calving (>30 months) and long inter-calving intervals (>15 months), it is very difficult to increase herd size through natural increases. That is why it is so important to seek the underlying causes of herds with high percentages of dry cows or a high proportion of heifers to cows. The most likely cause is poor feeding management but there could be others, such as disease, heat stress or simply poor reproductive practices.

Heifer management

Poor heifer management is a major problem in many (if not most) Asian small holder dairy farms (Moran 2005). Young stock receive insufficient attention because they do not generate income for many months. In addition, the first three months are the most expensive period in the life of any dairy cow and many farmers are just not prepared to invest in the calves' future. A low calf mortality rate indicates that early milk rearing practices are adequate and allow for greater opportunity for economic and genetic improvement in the herd. When a heifer dies, there are fewer opportunities for culling unprofitable cows.

There are many hidden costs arising from poor management of the replacement dairy herd. The milking potential of small stunted animals that do not calve until three years of age has been markedly reduced (Moran and McLean, 2001), while very high mortality and morbidity rates in calves during their milk feeding period represent an enormous waste of genetic potential in the dairy herd as well as cash outlay (Moran, 2002).

There are easily quantifiable benefits in having more newly calved heifers available to replace older unprofitable cows, as heifer and reproductive managements improve (Morton et al., 2003). These benefits are:

1 to 2% more first calf heifers for every month reduction in age at first calving

3 to 5% more first calf heifers for every 10% reduction in calf mortality

2 to 3% more first calf heifers for every month reduction in inter-calving interval

Farmers should aim to rear 20 to 25% of their milking herd each year as replacements, to calve down for the first time by about two years of age and produce at least five calves during their productive life. Realistic target for tropical dairy systems (Moran and Tranter, 2004) are:

Calf mortality to weaning, 4 to 6%

Heifer wastage rate from birth to second calving, 20 to 25%

Live weight at mating, 250 to 300 kg

Live weight at first calving, 400 to 500 kg (depending on breed type)

Age at first calving, 28 to 30 months.

Another good indication of heifer management is first lactation milk yield, expressed as % of mature cow production, with a target of 80 to 85%. If this is less than 75% of the mature equivalent, then the heifer rearing program should be reviewed (Moran and McLean, 2001).

Wither height (or height at the shoulder) is a good measure of bone growth and potential body frame size in heifers. Frame size can influence ease of calving and appetite of milking cows. Farmers should aim for wither heights of 115 to 120 cm by 15 mo and 125 to 130 cm by 24 mo of age (Moran and McLean, 2001).

EASE OF COLLECTING RAW DATA

Each and every one of the above KPI's can provide a valuable insight into the farm resources and management skills of individual smallholders. However it is important to prioritise them based on;

Their relevance to the farmer's current stage of farm development

The farmer's ability to interpret the data and use it in future decision making

The ease and accuracy of collecting the necessary raw data.

The ability of smallholder dairy farmers to collect the raw data would vary greatly with their management skills, level of education, support from service providers and of most importance, their motivation to want to use the particular KPI in their farm decision making.

Some of the easiest to collect are the raw data to calculate the proportion of productive cows (KPI 7) as most smallholder farmers know the number of milking cows, dry cows, heifers and calves in their herd. In a matter of minutes, the author collected such data from a dozen smallholders at a dairy farmer conference in Vietnam, which indicated that most of these particular farmers had acceptable values for % milking cows in the milking herd (KPI 7a) and % milking cows in the entire herd (KPI 7b). Another "easy to collect" data set is the stocking capacity (KPI 1), as most farmers know their forage production area. These same farmers had 8 to 9 total stock/ha and 5 to 6 adult cows/ha, indicating that they did not overstock their farms. As they were selected to attend the conference, one could assume that they were considered to be "good" farmers.

It is not difficult to collect raw data on pattern on milk

production (KPI 8) as many farmers record daily milk yields from individual cows. The level of concentrate feeding (KPI 4) is another data set readily available while many farmers could estimate their daily forage feeding program (as a guide to KPI 2). Likewise, some of the reproductive (KPI 9) and heifer data (KPI 10) can be easily calculated from raw data on dates of inseminations, calvings and ages at first calving, while a chest girth tape can easily provide estimates of live weights of different classes of stock.

With limited experience, the raw data for the two spreadsheets (FARMPROFIT and FEEDPROFIT) can be quite easily collected, thus providing valuable measures of farm profits, such as KPI's 5 and 6.

CONCLUSIONS

The above diagnoses require the calculation of many KPI to allow a value judgement to be made on business performance. Many of these indicators are simply common ratios or proportions, assessing some level of output in relation to some level of input. Others measure success simply with numbers or amounts, such as target forage quality or heifer live weight. Although they are valuable guides, there is no all encompassing or perfect indicator of business success. All indicators must be viewed within the whole business, with each one contributing only a part.

It is possible to achieve high performance in a KPI which does not translate into business financial success. If a farmer whose farm has very poor quality soils and may not be able to grow as good a quality forage as he can purchase, at a good price, close by, it would be more profitable to let someone else grow the bulk of his forages.

Low performance measures in some key factors, well below these KPI, often lead to high performance measures in other key factors which can produce a false sense of security about the ability to achieve some of the production targets. One example is low peak milk yield and short inter-calving intervals in cows of low genetic merit. Because such cows are not 'genetically programmed' to use their body reserves to supplement the limited intakes of feed nutrients during early lactation, their live weight will hardly change and they may cycle soon after calving. If the farmer plans to improve the genetic merit of the cows by using imported cows or high grade semen without improving the feeding management during early lactation, peak milk yields may not greatly improve while herd fertility is likely to drastically fall.

The above list is an initial attempt to prioritise these indicators to develop a structured approach to addressing poor farm profitability. It must be stressed that no single KPI should be used in isolation to assess farm performance and hence profitability, as each one is the end result of

interactions between many farm inputs. It is important to ensure there is a balance between their utilisation so that one production target is not achieved at the expense of others within the farming system.

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