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RECENT ADVANCES IN THE PATHOGENESIS OF SHIPPING FEVER PNEUMONIA

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SUMMARY: Shipping fever pneumonia causes severe economic burden to the beef and dairy cattle industry worldwide. The bacterium Mannheimia haemolytica has been identified as the primary aetiological agent contributing to the clinical presentation and acute fibrinonecrotizing pneumonia associated with this disease. Although M. haemolytica possesses several virulence factors including capsule, outer membrane proteins, neuraminidase, flimbriae, lipopolysaccharide, and leukotoxin, several lines of evidence indicate leukotoxin as the primary virulence factor. This review article focuses on recent advances in the knowledge of the molecular characteristics and mechanisms of action of M. haemolytica leukotoxin as well as its role in the pathogenesis of lung injury in shipping fever pneumonia. Understanding the role of leukotoxin in the pathogenesis of shipping fever pneumonia is crucial for the development of better treatment and prevention strategies to control this devastating disease.

SHIPPING FEVER PNEUMONIA

Shipping fever pneumonia (SFP), also called bovine pneumonic pasteurellosis, is an important respiratory disease of beef and dairy cattle worldwide particularly in North America and Western Europe (Dyer, 1982; Wohlgemuth and Herrick, 1987; Griffin, 1997; Ames, 1997). SFP continues to cause more than 1 billion dollar annual economic loss through treatment costs, prevention measures, and mortality (Lillie, 1974; Wikse, 1985; Ames, 1997). Although this disease is caused by a complex set of circumstances including stressful management practices in conjunction with previous viral and bacterial infections, Mannheimia haemolytica (previously known as Pasteurella haemolytica) biotype A, serotype 1 (ST1) has been identified as the primary microbial agent responsible for the clinical presentation, and subsequent peracute fibrinonecrotizing pneumonia of affected cattle (Whiteley et al., 1992). This conclusion is based on the observations that the Gram-negative M. haemolytica can be isolated in pure cultures from pneumonic lesions in natural cases of shipping fever pneumonia, and the symptoms and lung pathology can be experimentally reproduced in cattle by endobronchial, intratracheal, or intrapulmonic inoculation of pure cultures of M. haemolytica ST1.

In healthy cattle, M. haemolytica serotypes ST2, ST4 and others (not the ST1) are predominantly colonized in the upper respiratory tract (URT) of cattle as commensals. Stress of cattle caused by shipping, transporting, abrupt weather changes, and viral and other bacterial infections lead to selective proliferation of ST1 in the URT that finally replaces all other serotypes (Gonzalez and Maheswaran, 1993). It has been shown the cell surface expressed ST1-specific factor of M. haemolytica may induce this shift (Gonzalez et al., 1995). Once extensive colonization of the URT is achieved, M. haemolytica ST1 enters the lung through repeated aspiration of infected particles and triggering an inflammatory cascade leading to fibrinonecrotizing pneumonia with an anteroventral lobar distribution of the lung. The pathological hallmarks in shipping fever pneumonia are massive neutrophil influx into alveolar spaces with extensive accumulation of fibrin, and subsequent cytolysis of emigrated neutrophils and resident alveolar macrophages.

VIRULENCE FACTORS OF M. HAEMOLYTICA A1

At least six virulence factors in M. haemolytica have been identified including, capsule, outer membrane proteins, neuraminidase, flimbriae, endotoxin (Lipopolysaccharide; LPS) and exotoxic leukotoxin. These factors enable

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the bacterium to gain access to the host, multiply in the host, and facilitate spread of the bacteria to healthy animals in the herd (Clinkenbeard et al., 1992; Confer et al., 1990; Whiteley et al., 1992). These factors enhance the virulence properties of the bacterium by specific mechanisms, including inhibition of phagocytic and bactericidal property of phagocytes (capsule); favoring bacterial adherence to the host (fimbriae); disruption of host tissue structure and function (neuraminidase); and damage or killing of host cells (endotoxin and exotoxic leukotoxin).

*M. haemolytica* capsular polysaccharide (CP) is not believed to be responsible for the pulmonary lesions typical of shipping fever pneumonia, but a number of studies suggest that CP is involved in pathogenesis (Morck et al., 1988). The CP may be involved in the adherence of bacteria to the mucosa of the lower lung, attraction of neutrophils to sites of infection, inhibition of phagocytosis by neutrophils, and resistance to complement-mediated lysis (Confer et al., 1990).

For *in vivo* growth in an iron-restricted environment such as lung tissue, *M. haemolytica* produces iron-regulated outer membrane proteins (IROMPs) that function to sequester and transport iron into the bacterial cell (Mosier et al., 1989). Three IROMPs have been found in *M. haemolytica* grown under iron-limiting conditions (Deneer and Potter, 1989; Morck et al., 1991). Antibodies to these IROMPs occur in convalescent serum from calves recovering from natural *M. haemolytica* infections (Morton et al., 1995). Therefore, these studies suggest a role for IROMPs for *in vivo* growth of *M. haemolytica*, and may be important in protective immunity against shipping fever pneumonia.

Neuraminidase contributes to mucosal adhesion and colonization of *M. haemolytica* through two different mechanisms. First, it lowers the viscosity of mucus in the respiratory tract and thereby impairs the bacterial clearance of the mucociliary blanket (Milligan et al., 1978). Second, it decreases the net negative charge by cleaving sialic acid residues on the epithelial surface resulting in closer bacterial approximation to the host cell surface (Abdullah et al., 1992).

Fimbriae have high affinity for mucosal glycolipids and glycoproteins present on the surface of epithelial cells, allowing the bacterium to colonize in the URT. *M. haemolytica* possesses two types of fimbriae: a tall 12-nm rigid structure and a short 5-nm flexible structure (Morck et al., 1987). These studies suggest that *M. haemolytica* ST1 may possess these adhesion factors that facilitate the bacterium to colonize in the URT.

Endotoxin or lipopolysaccharide (LPS) appears to be an important factor involved in pathogenesis via several complex mechanisms. The interaction of LPS with macrophages results in a plethora of pathological effects associated with LPS. Macrophages interact with *M. haemolytica* LPS and become activated to produce proinflammatory cytokines (Stevens and Czuprynski, 1995; Yoo et al., 1995a; Lafleur et al., 1998), lipid mediators (Saban et al., 1997) and nitric oxide (Yoo et al., 1996). More interestingly, purified LPS administered intrabronchially caused neutrophil and fibrin exudation, pulmonary edema, and platelet aggregation in capillaries of calves (Whiteley et al., 1990). Although purified LPS caused this pathology, the lesions were small and restricted, indicating that other virulence factors are involved in shipping fever pneumonia. In addition, recent *in vivo* studies demonstrated that LPS stabilizes leukotoxin against proteolytic degradation (Li and Clinkenbeard, 1999) and enhances leukotoxin-induced cytolysis and proinflammatory cytokine gene (TNF-α and IL-8) expression in bovine macrophages (Lafleur et al., 2001).

Leukotoxin (LktA) is an exotoxin produced by all serotypes of rapidly growing (logarithmic phase) *M. haemolytica* (Baluyut et al., 1981; Berggren et al., 1981; Saddati et al., 1997). Leukotoxin is specifically lethal to the leukocytes and platelets of ruminants (cell-type and species specificity), by the formation of cell membrane pores, which cause the uncontrolled influx of calcium and fluid, thus rupturing the cell (Clinkenbeard et al., 1989; Clinkenbeard and Upton, 1991). Leukotoxin is therefore believed to interfere with host defense mechanisms by inhibiting phagocytosis and destroying white blood cells, and as a result of extensive cytolysis, increasing the proinflammatory response in the lung.

**UNIQUE ROLE OF LKT A IN SHIPPING FEVER PNEUMONIA**

Although *M. haemolytica* possesses several virulence factors, studies have unequivocally shown that LktA of *M. haemolytica* is the primary factor responsible for the clinical presentation and peracute lung damage in shipping fever pneumonia (Reviewed in Jeyaseelan et al., 2002). First, in experimentally induced shipping fever pneumonia in calves, the severity of clinical signs and lung pathology positively correlate with the amount of LktA secreted by the challenge strain of *M. haemolytica* (Ames et al., 1985). Second, intrapulmonary administration of an isogenic LktA negative mutant of *M. haemolytica* that was produced by site directed mutagenesis induced milder clinical signs and restricted lung pathology (Tatum et al., 1998). Third, intratracheal inoculation of an isogenic *M. haemolytica* mutant producing an inactive LktA caused milder clinical signs and less lung pathology compared to the parental strain (Highlander et al., 2000). Fourth, cattle with high anti-LktA neutralizing antibody titres have higher resistance to the natural and experimental shipping fever pneumonia than cattle with low antibody titres (Confer et al., 1988). Fifth, vaccines enriched with recombinant LktA causes enhanced protection to *M. haemolytica* challenge in calves (Sreevatsan et al., 1996; Srinand et al., 1996a and b). In addition to these *in vivo* findings, numerous *in vitro* ob-
servations have implicated a pivotal role for LktA in the pathogenesis of shipping fever pneumonia. At cytoidal concentrations, LktA can impair the phagocytic and antimicrobial properties of alveolar leukocytes (neutrophils and alveolar macrophages) in the lung and therefore, enhance survival and proliferation of *M. haemolytica* in the alveolar spaces (Maheswaran et al., 1980; Baluyut et al., 1981; Berggren et al., 1981). Cytolysis of neutrophils and alveolar macrophages by LktA also results in release of their proteolytic enzymes and proinflammatory substances, which can mediate structural damage of the lung. In this context, recent studies have shown that LktA-induced cytosis requires a signaling cascade involving the generation of arachidonic acid metabolites in bovine leukocytes (Jeyaseelan et al., 2001). At sub-cytoidal concentrations, LktA can activate neutrophils and alveolar macrophages, resulting in translocation of the nuclear transcription factor κB (NF-κB) into the nucleus (Hsu et al., 1999), the release of toxic oxygen radicals and proteases (Maheswaran et al., 1992 and 1993), mediators of arachidonic acid metabolism (Henriks et al., 1992; Clinkenbeard et al., 1994), nitric oxide (Yoo et al., 1996), proinflammatory cytokines (Yoo et al., 1995a,b; Hsu et al., 1999), and the causation of apoptotic cell death (Stevens and Czuprynski, 1996; Wang et al., 1998). At both cytolytic and sub-cytolytic concentrations, LktA causes dose-dependent calcium influx in neutrophils (Cudd et al., 1999) and alveolar macrophages (Hsu et al., 1998) from the extracellular medium. Collectively, all of these evidence supports that the interaction of *M. haemolytica* with neutrophils and alveolar macrophages is necessary and sufficient to induce lung inflammation and peracute lung injury in shipping fever pneumonia (Figure 1).

**GENETIC AND MOLECULAR CHARACTERISTICS OF LKT A**

*M. haemolytica* LktA is a pore-forming cytolysin and a member of the Gram-negative bacterial exotoxins termed repeats in toxins (RTX) family (Coote, 1992)(Table 1). These toxins termed RTX because of their varying number of highly conserved glycine-rich nonapeptide (L/I/F-X-G-G-G-G-N-D-D-X, where X is any amino acid) tandem repeats in their C-terminus. The number of tandem repeat regions for RTX toxins varies from 6-41. The tandem repeat regions are believed to be involved in calcium binding of the toxin that is crucial for toxin activity on the host cells (Cruz et al., 1990; Coote, 1992). The RTX family of toxins is related by DNA sequence homology, mechanisms of activation inside bacterial cells and secretion to extracellular medium. The *Escherichia coli* haemolysin (HlyA) is well studied in the RTX toxin family and thereby serves as a prototype for other RTX exotoxins.

Four chromosomal genes *lktC, lktA, lktB, lktD*, responsible for synthesis, activation and secretion of *M. haemolytica* LktA, are arranged contiguously in a 7745 base pairs polycistronic gene cluster termed *lktCABD* (Lo et al., 1987; Highlander et al., 1989). The predicted proteins encoded by *lktC, lktA, lktB*, and *lktD* are 166, 953, 708, and 478 amino acids in length, with corresponding molecular masses of 19.9, 102, 79.7, and 54.7 kilo Daltons (Figure 2). Comparison of deduced amino acid sequences

**Figure 1:** Interaction of *M. haemolytica* LktA with ruminant (bovine) leukocytes leads to lung injury
Table 1: RTX family of exotoxins

<table>
<thead>
<tr>
<th>Bacterium</th>
<th>Toxin</th>
<th>Repeats</th>
<th>Target cells</th>
<th>HlyA identity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Escherichia coli</em></td>
<td>Hemolysin (HlyA)</td>
<td>13</td>
<td>Broad range</td>
<td>50</td>
</tr>
<tr>
<td><em>Mannheimia haemolytica</em></td>
<td>Leukotoxin (LktA)</td>
<td>6</td>
<td>Ruminant leukocytes and platelets</td>
<td>59</td>
</tr>
<tr>
<td><em>Actinobacillus pleuro- pneumoniae</em></td>
<td>Hemolysin - ApxIA</td>
<td>13</td>
<td>Broad range</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Hemolysin - ApxIIA</td>
<td>8</td>
<td>Porcine leukocytes</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>ApxIII A</td>
<td>13</td>
<td>Human neutrophils and monocytes</td>
<td>54</td>
</tr>
<tr>
<td><em>Actinobacillus actinomycetemcomitans</em></td>
<td>Leukotoxin (LtxA)</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Bordetella pertussis</em></td>
<td>Adenyl cyclase</td>
<td>41</td>
<td>Broad range</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>hemolysin (CyaA)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

reveals that *M. haemolytica* LktC, LktA, LktB and LktD proteins share 50.3, 36.5, 90.5 and 75.6% identity with corresponding determinants of *E. coli* (Lo et al., 1987; Highlander et al., 1989). LktA encodes the structural protein LktA, which is biologically inactive. The ltkC gene product is responsible for fatty acid acylation of the biologically inactive LktA protein, resulting in the bioactive form of LktA (Fedorova and Highlander, 1997). The proteins encoded by *ltkB* and *ltkD* are responsible for the secretion of LktA into extracellular environment through type I secretion/translocation system (Highlander et al., 1989). The outer membrane protein TolC forms a periplasmic bridge to the inner membrane components of the type I transport apparatus (Figure 2).

**TARGET CELL SPECIFICITY OF LKT A**

Although the members of the RTX family are genetically related, there are distinct differences in their target cell specific biological effects (Table 1). Most members of the RTX toxin family cause intoxication to a broad range of cell types from several animal species (Welch, 1991; Coote, 1992; Welch et al., 1995). On the contrary, RTX toxins produced by *Actinobacillus actinomycetemcomitans* and *M. haemolytica* induce their biological effects primarily on leukocytes, and are therefore termed 'leukotoxins'. Furthermore, these leukotoxins also display species-specificity. The leukotoxin (LtxA) of *A. actinomycetemcomitans*, a human periodontal pathogen, is cytotoxic only to cells of the lymphocytic and monomyelocytic lineage of humans and some higher non-human primates (Taichman et al., 1987; Shenker et al., 1994), and the LktA of *M. haemolytica*, a ruminant pathogen, is cytotoxic only to leukocytes and platelets of ruminants (Sutherland, 1985; Clinkenbeard and Upton, 1991). This narrow target cell specific biological effects of these toxins strongly suggest that these toxins interact with specific receptors on respective target cells.

A large body of evidence indicates that *M. haemolytica* LktA interacts with specific receptors on target cells (bovine leukocytes). First, immunohistochemical studies on lung sections obtained from *M. haemolytica* indicated that LktA binds only to alveolar leukocytes showing degenerative changes, but not to other cell types in the alveolar lining (Whiteley et al., 1990). Second, flow cytometry studies have demonstrated that LktA specifically binds to bovine leukocytes and that this binding moiety is a cell surface protein (Brown et al., 1997). Third, using ELISA based dot blot assay, it has been demonstrated that LktA binds not only to bovine leukocytes, but also to porcine, equine and canine leukocytes (Sun et al., 1999). However, LktA-induced biological effect as measured by elevation of intracellular calcium elevation was observed only in bovine leukocytes.

Recent studies have identified cellular and species-specific receptors for narrow target cell specific RTX toxins. A study by Lally and coworkers has shown that LtxA of *A. actinomycetemcomitans* binds to a cell surface β2 integrin, human lymphocyte function-associated antigen 1 (LFA-1; CD11a/CD18 heterodimer) (Lally et al., 1997). They showed that antibodies against CD11a and CD18, the subunits of the LFA-1 heterodimer, neutralize LtxA of *A. actinomycetemcomitans* mediated killing of a human cell line, HL-60. The role of LFA-1 in LtxA toxin was further supported by the observation that transfection of a non-LFA-1 expressing and LtxA-resistant human erythroleukemia cell line (K562) with a recombinant plasmid encoding the CD11a and CD18 subunits of LFA-1 leads to LtxA sensitivity. Moreover, polystyrene beads coated with LtxA binds to LFA-1 of lysates obtained from the HL-60 cell line. A direct inference of Lally's receptor work is that a similar mechanism may exist in *M. haemolytica* LktA, a ruminant leukocyte-specific toxin. In this context, a study by Wang et al. (1998) has shown that LktA physically associates with one of the LFA-1 subunit, CD18. They also demon-
Pathogenesis of shipping fever pneumonia

Stratified that monoclonal antibodies (MAbs) against CD18 or CD11a/CD18 significantly inhibited LktA-induced apoptosis in a bovine lymphoma cell line, BL-3. In a subsequent study, Ambagala et al. (1999) observed that the MAb specific for CD18 attenuated LktA-induced cytotoxicity in bovine neutrophils. This study further demonstrated that LktA binds to β2 integrins through the CD18 subunit. In a study by Li et al. (1999) have shown that LktA interacts with bovine CD18 and antibodies against CD18 or CD11a/CD18 caused partial attenuation of LktA-induced cytotoxicity in BL-3 cells. Since CD18 subunit is common to all three bovine β2 integrins (CD11a/CD18; LFA-1, CD11b/CD18; Mac-1, CD11c/CD18; p150/95), it was not clear which of the member of the β2 integrin family acts as a receptor for LktA. Jeyaseelan et al. (2000) extended these observations and demonstrated that bovine LFA-1, but not other members of the β2 integrin family as a receptor for LktA of *M. haemolytica*. Furthermore, MAbs against CD11a and CD18 inhibited LktA-induced biological effects as measured by calcium elevation and cytologysis. Moreover, LktA interacts only to CD11a and CD18, but not to CD11b or CD11c. Finally, neutrophils with reduced surface expression of LFA-1 isolated from calves with leukocyte adhesion deficiency are less sensitive to LktA-induced cytoly-

sis as compared to healthy calves. More intriguingly, this study has shown that LktA also interacts with porcine LFA-1 without inducing any biological effects. These findings led to formulate the hypothesis that LktA-mediated biological effects entail both binding of LktA to LFA-1 and LFA-1-induced signaling cascades that eventually results in cellular and species-specific biological effects. A follow up study by Jeyaseelan et al. (2001a) demonstrated that LktA binding to LFA-1 results in the activation of a non-receptor tyrosine kinase-signaling cascade (NRTK), which is required for biological effects mediated by LktA. The findings of this study further demonstrated that the NRTK signaling cascade is absent in porcine leukocytes *albeit* LktA binding to porcine LFA-1. These observations imply that the cellular and species-specific effects of *M. haemolytica* LktA lie at the level of toxin-induced host signaling, and not at the level of toxin binding to LFA-1.

CONCLUDING REMARKS

Our knowledge on *M. haemolytica* leukotoxin has progressed significantly over the past decade about its interactions with ruminant leukocytes through receptors, and the downstream signaling mechanisms by which it con-
tributes to peracute lung damage. LktA is a sophisticated effector molecule secreted by *Pasteurella haemolytica* through the type I secretion machinery, which helps to overcome the host defense mechanisms of the lung, and thereby contributes to the success of *M. haemolytica* as a well-adapted respiratory pathogen in ruminants. However, the role of other LktA receptors and other signaling cascades underlying LktA interaction with bovine leukocytes remain to be elucidated. Understanding the role of leukotoxin in the pathogenesis of shipping fever pneumonia is critical for the development of more effective therapeutic and prophylactic strategies to control this deadly disease.

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MILK PROCUREMENT, MARKETS AND CONSUMPTION PATTERNS IN SRI LANKA: APPLICATION OF A DAIRY CONCEPTUAL RESEARCH FRAMEWORK

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SUMMARY: This study is the first part of a comprehensive appraisal of the Sri Lankan dairy sector. The methodology employed is based on a Conceptual Framework for Development Oriented Dairy Research that combines different levels of analysis of secondary and primary data for each of the four main components of the sector; consumption, processing, marketing and production. It centres on the principle that viable dairy systems are necessarily demand-driven, which requires that to achieve an accurate overview, demand and market factors should be assessed at the same time as any examination of farm-level production. This article thus presents the results of the demand analysis, and is complemented by a second article addressing the production results from the same study. The discussion and the conclusions are based on a combination of secondary information, a Rapid Appraisal (conducted by a team of interdisciplinary researchers), and an island wide survey conducted in 1999 capturing 3525 households in 20 of the 25 administrative districts in 6 major agro-ecological zones.

The results show that while the per capita consumption of milk and milk products in Sri Lanka is low compared to other countries in South Asia, since 1981 it has grown from 13 kg/year to about 36 kg/year currently. Some of this increase consumption has occurred through growth in the informal or local market (28% of the current total) which suggests that formal collection systems are not serving farmers adequately, perhaps because of over-rigid pricing regimes, or because supplies of liquid milk to consumers are inadequate or too expensive or inappropriately marketed. Even conservative projections indicate future strong increases in demand particularly for liquid milk due to continued GDP growth, which will present good opportunities for domestic smallholder dairy producers. Currently relatively little milk is retained by producers for home consumption (15%) - most is sold in liquid form (78%) or made into curd/yogurt (7%), indicating a high degree of market orientation. The study found that farm-gate milk prices, which were low relative to other countries, were cited as major constraint to increased production. Formal collection centre price averaged 11.60 Rs/l, while the informal market price averaged 15.20 Rs/l. On the demand side, only some 30% of households reported consumption of liquid milk, and most of those were dairy producers. Most households reported a preference for powdered milk, however 15% of households also said that liquid milk was not available. Results from the household survey suggested that consumption of liquid milk increased with higher income (unlike that of milk powder), suggesting that over time, as incomes grow, demand could shift towards liquid milk. This shift would strongly favour domestic producers, and efforts towards accelerating that change should be considered.

INTRODUCTION

An estimated 75 percent of the cultivable land area (2 million hectares) in Sri Lanka is small holdings, 90% of which are less than 2 ha of land, and 33% of which have livestock (MLDAEI, 1997). Smallholders thus dominate the agricultural sector. In 1996 agriculture provided income to 70% of Sri Lanka’s population, and contributed 18.4% of the GDP (Anon, 1996). The total farm population is estimated around 10-11 million, with an estimated 3.5 million keeping livestock, 70% of whom are rural farmers (Anon, 1998). The livestock sector contribution to the GDP has been estimated at about 6%, much lower than in Pakistan and Philippines, where the livestock sectors contribute 18% and 30%, respectively.

A move towards self sufficiency will provide additional nutrition to the population, and generate important income and employment, while saving the foreign exchange

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currently spent on the dairy imports required to fill the
gap between domestic production and consumption. The
Government's aim is to substantially increase the level of
milk production and collection in the medium and long
term (MLD&EI, 1997), partly due to the relatively high
level of milk powder imports.

Based on the statistical data, milk production has
apparently grown significantly since 1981, however,
reported or formal milk collection has fallen from 54% to
32% of production (MLD&EI, 1998). This could imply that
most of the growth in dairy production has gone to supply
the informal or unregulated market. This may also reflect
inadequacies in the formal milk marketing system,
including price policies, as well as limited marketing of
fluid milk. Prior to the study reported here, island wide
surveys had not been carried out to capture the role played
by the various stakeholders involved in the producer to
customer milk/dairy marketing chain. A Dairy Sector study
initiative thus arose from a shared interest by the Ministry
of Livestock Development and Estate Infrastructure and
the National Dairy Development Board (NDBB) of India,
to review progress in the Sri Lanka dairy sector with a
view to identifying strategies for continued development.
Due to its experience in this type of research, the
International Livestock Research Institute (ILRI) was
requested to participate in the study.

The overall objective was to bridge information gaps to
assist and accelerate dairy development in Sri Lanka. The
specific objectives were to:
1. Highlight the nature and distribution of dairy
production, processing, marketing and consumption;
2. Identify the potential for the further development of
the dairy sector and the primary constraints which
impede the potential; and
3. Suggest areas that should be targeted for investment,
and policy and technological interventions and
research in support of the development of the dairy
sector.

The main areas targeted for the study were the zones
typically used in differentiating agricultural systems in Sri
Lanka: Up-country, Mid-country, Coconut Triangle, and
the Dry Zones.

METHODOLOGY

The methodology used in this study was based on
ILRI's Conceptual Framework for Dairy Research (Rey et
al., 1993), further refined through Dairy Rapid Appraisals
carried out by ILRI with its collaborators in Uganda and
Tanzania. The approach centres on the principle that
viable dairy systems are necessarily demand-driven,
requiring that each of the four sub systems; consumption,
processing, marketing and production and their
interactions are assessed simultaneously. Thus the focus
is on market-orientation, and the analysis begins by
considering current and potential market demand, as any
significant expansion or development of the dairy sector
will depend on effective demand. Further, given that dairy
systems are shaped by the interaction of technology,
economics, and policy, an interdisciplinary approach was
needed, and this is reflected in the make-up of the research
teams. This approach was taken in the appraisal, with a
view particularly towards testing current assumptions
against the available facts, as their validity may be
undermined by contrary evidence, or because the
dynamics of the sector have rendered them outdated.

The appraisal composed of the following parts:
a review of previous studies and secondary
information on the dairy sector
b) interdisciplinary qualitative rapid appraisal (RA or
 "sondeo") survey, during which the appraisal team
leaders (livestock ministry officials, extension staff,
researchers and ILRI and NDBB scientists)
interviewed key informants including farmers, market
agents in the main production and consumption areas
to gather qualitative information,
c) a structured producer and consumer survey in the
rural and urban areas of Sri Lanka to quantify
production parameters, market linkages and dairy
consumption habits.

The structured survey was conducted in 1998 to
generate estimates of dairy production and consumption
parameters and fill in some major data gaps in production
and consumption in Sri Lanka. This study covered 3525
households in 20 districts of the 25 districts nationally.
The sample design was:
1. Stratification was done by Grama Niladari (GN)
Divisions (the smallest administrative unit) in the
study districts. The number of GN Divisions sampled
in each district was proportionate to the districts
estimated population.
2. Sampling of GN Divisions in a given district was based
on a random selection.
3. Within a GN Division, one household in every ten
was randomly selected from the GN household list;
as a result households with and without livestock
were surveyed.

Heads of sampled households with livestock were
interviewed to capture dairy production and consumption
information, and those without livestock for consumption
information. Trained graduate enumerators carried out the
interviews.

RESULTS AND DISCUSSION

Demand prospects

Secondary data sources indicated that the changes in
human population and income were the major
determinants of demand for milk and processed dairy
products. The overall population growth has slowed from an annual rate of 2.8% in the early 1950’s to around 1.2% in the 1990’s (Anon, 1998). This slow population growth in itself is not likely to provide a major impetus for growth in dairy demand. Strong per capita income growth can, however, provide that increase in demand. In the past, income growth per capita was relatively low, averaging 2% per annum or less. However, since 1990 economic growth has averaged 4-5% annually.

Based on the data from the household income and expenditure surveys (1990-91) conducted by the Department of Census & Statistics (1993; and 1975-1994), expenditure elasticities for milk and dairy products were derived (Table 1). Given that expenditures in the long run generally equate to income, these are useful substitutes for income elasticity estimates. The overall expenditure elasticity for dairy products (Milk and Milk Products) is 1.17, which is relatively elastic since it is greater than 1. This suggests that a 1% increase in household income would lead to a greater than 1% increase in expenditure on dairy products, meaning that relatively more is spent on dairy products as household income goes up. Rural expenditure elasticities were higher than urban elasticities for dairy products (1.31 compared to 0.83). This may be a result of lower income levels in rural areas, and thus more dairy expenditure response to increases in income, or due to overall lower rural dairy consumption. These rural/urban differences are consistent with those found in studies in India (Abdulai et al., 1998; unpublished data).

Thus if there is economic growth of 4% or more per year, demand for liquid milk in urban and rural areas and for milk products in urban areas can be expected to grow substantially. Based on these demand parameters and others related to population growth, projections were made for the period 1998-2010. Table 2 shows the underlying parameters used for the projections. At a 4% rate of real GDP growth, the elasticities suggest that income and population growth alone will generate an increase in aggregate demand for milk and dairy products of slightly over 100% by 2010, from about 698,000 MT in 1997 to over 1,400,000 MT in 2010. This represents important opportunities for domestic producers to increase production and sales.

Although imports form an important share of the dairy market, they remain susceptible to macroeconomic factors. Based on estimates of the cost of importing, repackaging and distributing milk powder, changes in world powder prices and local exchange rates can significantly alter import competitiveness. As shown in Table 3, a 10% rise in world WMP prices is estimated to raise the cost of packaged powder at the wholesale level by 8.9%. Similarly, a 10% devaluation in the Rupee/$ exchange rate, which, for example, occurred between January and September of 1998, would raise wholesale costs by 9.1%. Although currently important in the Sri Lanka dairy sector, imports will remain susceptible to these macroeconomic factors.

On the supply side, the future determinants of milk production are the number and composition of cows and buffaloes and their average productivity. Attempts to estimate these measures, however, are hampered by lack

| Table 1. Estimated expenditure elasticity of demand (double-log) for milk and milk products |
|---------------------------------|-----------------|-----------------|-----------------|
| Overall                         | 1.19            | 1.18            | 1.17            |
| Elasticity                      | 0.75            | 0.94            | 0.95            |
| Urban                           | 1.33            | 0.79            | 0.83            |
| Elasticity                      | 0.73            | 0.93            | 0.95            |
| Rural                           | 1.09            | 1.33            | 1.31            |
| Elasticity                      | 0.69            | 0.91            | 0.91            |

Source: Estimated from the Household Income and Expenditure Survey (1990-1991), Dept. of Census and Statistics

<table>
<thead>
<tr>
<th>Table 2. Underlying parameters used for dairy demand projections</th>
</tr>
</thead>
<tbody>
<tr>
<td>National population (1996)</td>
</tr>
<tr>
<td>Urban/rural dairy product consumption ratio</td>
</tr>
<tr>
<td>Urban population growth rate (%)</td>
</tr>
<tr>
<td>Rural population growth rate (%)</td>
</tr>
<tr>
<td>Annual decrease in population growth rate (assumed) (%)</td>
</tr>
<tr>
<td>Rural population percentage (%)</td>
</tr>
<tr>
<td>Urban elasticity of demand for dairy products</td>
</tr>
<tr>
<td>Rural elasticity of demand for dairy products</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 3. Estimated sensitivity of domestic milk powder prices to changes in whole milk powder (WMP) world prices and exchange rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost category</td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
<td>World Whole Milk Powder: FOB</td>
</tr>
<tr>
<td>Freight, clearance</td>
</tr>
<tr>
<td>2.5% stamp, 10% duty, 4.5% defense levy</td>
</tr>
<tr>
<td>Repackaging and distribution cost margin</td>
</tr>
<tr>
<td>Rs/400 g package wholesale price</td>
</tr>
<tr>
<td>Sensitivity to 10% exchange rate change</td>
</tr>
<tr>
<td>Sensitivity to 10% WMP price change</td>
</tr>
</tbody>
</table>

Source: Dairy industry
of reliable data. Based on official data (MLD&EI, 1998), cattle and buffalo numbers (estimated at 1.64 M and 0.76 M, respectively, in 1996) have been generally declining, but overall milk production figures show an increase (Ibrahim et al., 2000; unpublished data). These trends suggest an annual decrease in cattle and buffalo numbers of 1% and 2.7% respectively over the period and annual milk productivity increases per herd-animal (all animals, not differentiated into cows, bulls etc.) of 4.5% and 4.1% respectively. Such supply projections, however, do not take into account price changes that may be driven by the large expected increases in domestic demand, by policy changes, or by changes in world dairy product prices. Some of these will be discussed under the assessment of consumption patterns.

Milk and dairy product consumption

Since the opportunities for domestic smallholder producers will depend on the nature of growth in domestic demand, household consumption patterns was examined first. The consumer survey examined milk and dairy product consumption, sources of supply, and other characteristics such as household incomes.

The average sample households comprised of 4.5 persons and had an average monthly income of Rs. 6047 (Rs. 1332 per capita) which is comparable to an estimate based on official figures of Rs. 5019 (at the time of the survey, the Rs./US$ exchange rate was approximately 75). Overall, 58% of the households in the sample districts buy some liquid milk and/or milk products, 48% and 70% in case of producers and non-producers, respectively.

Dairy expenditure patterns

Households were classified into quartiles based on reported incomes. Table 4 shows some of the expenditure pattern results. The fourth quartile, with the highest income, can be seen to represent 48% of all household income. An average household spends about Rs. 262 (4.3% of the household income) on liquid milk and milk products, of which about 20% is spent on liquid milk, another 62% on milk powder and the remainder on other milk products. As one moves from lower to higher income quartiles (Q1 to Q4), expenditure on liquid milk and milk products rises sharply (from 140 to 494 Rs/month), but not as a percentage of household income, which instead falls from 5.6 to 4.2%. Q4 households account for nearly half the market for dairy products. A very limited market exists for specialised dairy products like condensed milk and cheese. These results reflect clearly the expenditure elasticities estimated earlier, as incomes rise, consumption of dairy products rises even faster.

One notable result is that, while expenditure on milk powder as a percentage of income declines at higher quartiles, expenditure on liquid milk more than doubles, from 0.5% to 1.1% of income. In economic terms, this suggests that consumers perceive milk powder as an inferior food commodity, in that it’s consumption declines with income. On the other hand, liquid milk is shown to be a superior food commodity. This result indicates that as per capita income rise in Sri Lanka, demand is likely to shift increasingly to liquid milk (assuming preferences remain the same). This has important implications for the opportunities for domestic milk producers.

**Liquid milk market and consumer behaviour**

Across the districts, some 12% of the households bought liquid milk though the frequency is much higher in districts like Colombo (52%) and some areas in the upcountry (41%) where most milk is produced. An average household buyer bought around 0.5 litres of milk a day at an average price of Rs. 29.30 a litre (all types of milk and all forms of packaging included).

Given an estimated number of 3.8 million households nationally (17.2 million persons) and the consumption parameters obtained through the survey, the total quantity of liquid milk marketed (both formally and informally) in these 20 sample districts was estimated at 209,410 litres a day, valued at Rs. 6.1 million. Consuming households reported that over 50% of the purchased liquid milk

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households</td>
<td>%</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>100</td>
</tr>
<tr>
<td>Total income</td>
<td>%</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>100</td>
</tr>
<tr>
<td>Expenditure: Milk &amp; Products</td>
<td>%</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>100</td>
</tr>
<tr>
<td>Income/Household</td>
<td>Rs/M</td>
<td>4,188</td>
<td>4,188</td>
<td>4,188</td>
<td>4,188</td>
<td>6047</td>
</tr>
<tr>
<td>Expenditure: Milk &amp; Products</td>
<td>Rs/M</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>6047</td>
</tr>
<tr>
<td>- % of income</td>
<td>%</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>100</td>
</tr>
<tr>
<td>Liquid Milk</td>
<td>Rs/M</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>6047</td>
</tr>
<tr>
<td>- % of income</td>
<td>%</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>100</td>
</tr>
<tr>
<td>Milk Powder</td>
<td>Rs/M</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>6047</td>
</tr>
<tr>
<td>- % of income</td>
<td>%</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>100</td>
</tr>
<tr>
<td>Milk Products</td>
<td>Rs/M</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>6047</td>
</tr>
<tr>
<td>- % of income</td>
<td>%</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>100</td>
</tr>
</tbody>
</table>
was used for making tea/coffee, 43% was converted into milk products such as curd or used as cooking ingredient, and 5% was directly consumed by adults, leaving some 2% for the children below 7 years of age. Only 4% of the sample households reported buying liquid milk daily, another 7% bought occasionally. The relatively frequent reported use of milk as a cooking ingredient is thought to indicate some misunderstanding by respondents, since the use of milk in cooking is not considered widespread. Respondents may have meant by this that they use milk in tea/coffee. As for the reasons of never buying liquid milk, 41% stated that they were milk producers themselves, 35% preferred milk powders while 15% stated non-availability as a major reason. Over 15% of the respondents rated the presently available quality of liquid milk as "poor", while over 15% stated that they could not afford to buy liquid milk. The relatively high ranking of non-availability of liquid milk and reported poor quality may be indicators that markets for liquid milk are not currently meeting demand, and could be significantly expanded.

Per capita consumption of liquid milk was estimated at 106 g/day or 39 kg/year (0.5 litre/day/household). An analysis of liquid milk consumption in terms of income reveals that the wealthiest households form the bulk of the liquid milk market. One-third of the households in this category buy liquid milk and in quantity they account for 69% of the market. As noted, with increases in income, the frequency of households buying liquid milk increases, as does quantity bought and expenditure.

**Milk powder market and consumer behaviour**

An estimated 69% of the households in the sample districts reported buying milk powders. An average family bought about 1.12 kg of milk powder a month (a 30% variation was observed in the average quantity bought) at an average price of Rs. 211/kg. Unlike liquid milk, little inter-district variations were observed in the milk powder price. Respondents did not report significant complaints about the quality of milk powders they buy, 90% rated the available products as either "very good" or "good".

In terms of income quartiles, the frequency of households buying milk powder increased with higher incomes as did the average quantity bought and amount spent.

**Other milk product consumption**

Every third sample household reported buying some other milk product. Curd, yoghurt and flavoured milk powders were most frequent products bought, followed by butter and, then cheese. Approximately 12% of the sample families bought curd (usually in earthen pots), on an average they purchased 1.7 kg a month at an average price of Rs. 82/kg. The frequency of buyers was much higher in some districts, particularly in the capital (59%). Similarly, 12% of the households buying yoghurt reported an average quantity of 1 kg per month at an average price of Rs. 88/kg.

**Discussion of milk consumption results**

Before reviewing these consumption findings, it should be noted that liquid milk is only a partly-tradable commodity, and that in the minds of most consumers, toned or reconstituted milk is not a perfect substitute. Since most dairy trade is in the form of powder or other products, imports usually have difficulty competing in countries where there is a strong tradition of fresh liquid milk. Strong demand for fresh liquid milk nearly always translates into comparative supply advantage for local producers. Because of this fact, two key findings from the consumption survey point to growing opportunities for domestic dairy farmers in Sri Lanka. The first is that the survey showed that a significant proportion of households often had difficulty finding fresh liquid milk. This suggests that the liquid milk market is currently not fully exploited by domestic processors. Second, the analysis shows that liquid milk demand and consumption increases with household income. Given the continued growth in the Sri Lankan economy, this promises to be a boost to the prospects for local dairy farmers.

**Milk Collection and Marketing**

In 1996 the amount of reported milk collection across Sri Lanka was 100 million litres (MLD&EI, 1997), 13% more than in 1995. Of the 100 million, 54% was collected by the government milk parastatal processor (MILCO), and the rest by international and domestic private processors, mainly for the production of powdered milk. The total estimated milk production for 1996 was some 331 million litres, indicating that only about 30% of the total milk production was handled by the formal milk sector. Until the current study there have been no estimates of the informally (directly) marketed milk production.

As in other South Asian countries, the formal milk collection system in Sri Lanka revolves around collecting small quantities of milk from a large number of smallholder farmers scattered over relatively wide areas for centralised pasteurization. The "informal" or raw milk market consists of sales directly to individual consumers, hotels and restaurants, and to private milk collectors who then sell milk either to formal collection centres or to customers and institutions. The term "informal market" is used here to describe raw milk or indigenous processed dairy product markets, which may or may not be officially, sanctioned at some level. For example, although raw milk traders may pay license fees to local authorities, they are considered here to be outside of the "formal market" which refers to marketing of dairy product processed utilizing non-traditional technologies.
Producer price of milk

For most of the formal dairy industry in Sri Lanka the producer price of milk has been based on the fat and solids non-fat (SNF) content of milk. The average nominal price for farm milk (4.3% fat, 8.4% SNF) was Rs. 10.54/litre in 1994 (Anon, 1994), but in 1998/1999 it varied by milk collectors on the basis of market trend. The household survey results (Table 5) indicated that the average per litre producer price varied from Rs. 11.80 to Rs. 15.60, depending on the agency to which it was sold. The best price was received from "other households" (Rs. 15.60) and "hotels" (Rs. 15.30), while substantially lower prices are paid by "collection centres" (Rs. 11.50-11.80), "private traders" (Rs. 11.80) and "others" (Rs. 12.60). Those sections of the informal market to which the producer could sell directly to consumers or institutions offered the highest prices, and contributed importantly to farmer profitability. One also observes high inter-district variation in the prices offered by the informal market, with a coefficient of variation of up to 33%. These differences are generally explained by distance or proximity to the market and production density, and suggest that the informal market more efficiently incorporated transport costs than the formal collection centres, which tend to subsidise producers further remote from processing plants.

Consumer and producer milk prices were obtained from various secondary sources (Anon, 1992; Anon, 1995; Statistical Abstracts, 1996), and adjusted for inflation to yield real prices (base=1990). In real terms, while the producer price has moved in a narrow band in recent years, the real consumer price has in fact declined during 1994-97, a period which saw continued increases in milk powder imports as demand rose with income growth. This suggests that producer prices were less affected than consumer prices by variations in the levels of powder imports. One reason for this might be that domestic milk production partially contributes into the liquid milk market where reconstituted powder is not acceptable as a good substitute. Regardless, the results suggest that even under increasing powder imports, producer prices are robust.

Producer household milk disposal

Of an average of 6.53 litres of milk produced per day by each cattle- and or buffalo-keeping household, about 24% (about 1.6 litre per day), was reportedly consumed by the producing household (Figure 1 and Table 6). Most of the rest (67% of that produced) is sold in liquid form, with 9% made into curd. A small amount, less than 1%, is made into yoghurt by the producing household. Some 77% of the household production is thus apparently sold, mostly in liquid form, reflecting a high degree of commercialisation of dairying and hence plays a role in offering regular income to the producing household.

As shown in Table 5, most milk is sold to formal collection centres (45%) while the rest is split between other households (25%) and private collectors (20%). It is also interesting to note that many of the households either do not milk their cows in the evening or preserve the evening milk with peroxide until the next day. The RA confirmed that both these practices were evident, and the reason being that milk collection is done only in the morning, especially in remote areas where the milk production density is low. Households were asked how frequently their milk was tested. Of those households who responded to this question (over 400), 59% said they were tested regularly, 24% said periodically, and 17% said their milk was never tested. It is not clear, however, whether those who didn’t respond experienced testing. Overall, 23% of farmers reported being members of milk co-operatives. Testing of milk for fat and SNF at some market level was observed to occur in nearly all market systems, either dairy testing of individual farmer milk, or bulk testing. Even where daily or individual testing was not practised, farm-gate prices clearly reflected accepted

Table 5. Milk disposal outlets reported, amount disposed per day (Litres) and milk prices (Rs/Litre)

<table>
<thead>
<tr>
<th>Description of disposal outlet</th>
<th>Morning N*</th>
<th>Morning Litres</th>
<th>Morning Rs/L</th>
<th>Evening N</th>
<th>Evening Litres</th>
<th>Evening Rs/L</th>
<th>Sales (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other households</td>
<td>378</td>
<td>3.5 (±3.1)**</td>
<td>15.0 (±5.2)</td>
<td>38</td>
<td>5.2 (±5.4)</td>
<td>15.0 (±5.2)</td>
<td>25</td>
</tr>
<tr>
<td>Hotels</td>
<td>61</td>
<td>5.9 (±4.7)</td>
<td>15.3 (±5.4)</td>
<td>14</td>
<td>9.0 (±5.3)</td>
<td>15.3 (±5.4)</td>
<td>6</td>
</tr>
<tr>
<td>Private collector</td>
<td>152</td>
<td>7.4 (±8.0)</td>
<td>11.0 (±4.3)</td>
<td>59</td>
<td>6.0 (±6.0)</td>
<td>11.0 (±4.3)</td>
<td>20</td>
</tr>
<tr>
<td>Milk collection centre</td>
<td>324</td>
<td>8.4 (±9.7)</td>
<td>11.0 (±1.9)</td>
<td>51</td>
<td>7.6 (±5.1)</td>
<td>11.0 (±2.0)</td>
<td>45</td>
</tr>
<tr>
<td>Others</td>
<td>40</td>
<td>7.0 (±3.9)</td>
<td>12.0 (±2.2)</td>
<td>33</td>
<td>5.1 (±3.8)</td>
<td>12.0 (±2.2)</td>
<td>4</td>
</tr>
</tbody>
</table>

Figures reported are for cattle-keeping household only, as differentiation of milk into cattle and buffalo is unknown.
* N = number of households reporting specified type of sale
** Figures in parentheses are Standard Deviations
Table 6. Milk disposal from milk producing households, mean litres per day and percent of production

<table>
<thead>
<tr>
<th></th>
<th>Litres/day</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated production/HH/day</td>
<td>6.53±6.34</td>
<td>100</td>
</tr>
<tr>
<td>Family consumption</td>
<td>1.56±1.15</td>
<td>24</td>
</tr>
<tr>
<td>Liquid milk sales</td>
<td>4.36±4.12</td>
<td>67</td>
</tr>
<tr>
<td>Curd making</td>
<td>0.59±2.25</td>
<td>9</td>
</tr>
<tr>
<td>Yoghurt making</td>
<td>0.05±0.8</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

HH- House hold

fat and SNF levels in all systems visited, so that prices in the dry zones were significantly higher than those in the other areas, in spite of the higher transportation costs. These provide an excellent incentive to increase off-take particularly in extensive production areas where high-fat genotype animals predominate.

**Milk Collection**

In general, producers who are not able to sell directly to consumers or retail outlets must rely on either private (informal) milk collectors, co-operative milk collection, or formal milk collection centres linked to processors. Distance from major urban markets may or may not affect market access. While distance reduces the opportunity to sell directly and informally to consumers, in some areas, such as the mid-country and highlands, where milk production density is high, numerous collection agencies and milk drying plants create easy access for producers to milk markets. In other areas, such as in some of the dry zones where production densities are low, distance to markets can adversely affect market access.

Private milk collectors were an important group of entrepreneurs who collect milk from small producers and deliver it to milk buyers (shops, hotels, home delivery to consumers, major processors, chilling centres or milk collecting centres). The survey showed that the quantities of milk collected ranged from 7-8 (bicycle operators) to 2000 litres/day (vehicle operators). Private milk collectors often provided other services to farmers besides milk collection, including small loans, transport of feeds, etc, the costs of which were presumed to be reflected in the milk price offered. Nevertheless, the prices they offered were often competitive. The RA interviews indicated that these private collectors operated with limited capital. A case study (see Box 1) indicated an estimated 13% gross return to labour per litre of milk in this type of small-scale milk collection.

**Household milk disposal and market outlets**

- Curd/Yoghurt 7%
- Neighbours 15%
- Marketed Milk 78%
- Consumed 15%
- Collecting centres 40%
- Hotels 6%
- Private Traders 17%

*Figure 1. Households' milk disposal and market outlets*
Box 1. Market margins: Private collector near Kandy, selling to Mileco chilling centre

This trader collected 140 litres in the morning and 20 litres in the afternoon (160 litres daily collection). He paid Rs. 1000 monthly salary to 1 helper. He provided credit occasionally to his farmers, in the form of a Rs. 2000 per farmer during festive season. Farmers were paid a flat rate of Rs. 10 (buying price) while he was paid approximately Rs. 11.5 morning price and Rs. 13.5 afternoon price (due to higher milk fat) by the collection centre. It was assumed that he capture some 10% of the “excess milk” value. Capital costs were only the 10, 23 litre milk cans he bought, @ Rs 2800 per can, and 2 bicycles for delivering the milk @ 4000/bicycle.

The margins calculated from these figures showed that the trader earns a reasonable monthly returns to labour of about Rs 8000 per month, at the same time providing employment to one worker and providing milk collection service to farmers. That service includes collecting milk from farmer’s doorstep, which the RA found, was often a valued service. Some farmers who produced milk did not sell any, due to the opportunity cost of time spent delivering milk to collection centres and sometimes waiting for the collection vehicle. The service provided by the trader also included occasional loans to farmers, the costs of which amount to about 1% of the sale price.

<table>
<thead>
<tr>
<th>Margins</th>
<th>Rs/Litre</th>
<th>% of sale price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm-gate price</td>
<td>10.00</td>
<td>77</td>
</tr>
<tr>
<td>Wages</td>
<td>1.04</td>
<td>8</td>
</tr>
<tr>
<td>Equipment</td>
<td>0.13</td>
<td>1</td>
</tr>
<tr>
<td>Loan costs</td>
<td>0.10</td>
<td>1</td>
</tr>
<tr>
<td>Sale price</td>
<td>12.93</td>
<td>100</td>
</tr>
<tr>
<td>Gross return to labour</td>
<td>1.65</td>
<td>13</td>
</tr>
<tr>
<td>Rs/month returns</td>
<td>7,940</td>
<td></td>
</tr>
</tbody>
</table>

Formal Milk Collection

The organisation of milk procurement routes usually follows the milk production density, and this was apparent in Sri Lanka as well. Nuwara-Eliya in the upcountry zone had the highest milk production per sq. km (66 litres), followed by Colombo in the low wet zone (36 litres) and Batticaloa in dry zone east (24 litres). The Coconut triangle has the highest reported share of milk collection as well as the highest percentage of cattle and buffalo population.

A considerable degree of seasonality was observed in milk collection. The collection index varied from 86 (Nov) to 118 (July)—an increase of about 37%. October–March was the lean months while the flush occurred in May-August. Thus, to maintain a steady level of liquid milk supply, certain amount of re-constitution seems to be unavoidable.

The Milk Collection Centres (MCCs) are the primary formal collection points, often established within a collection radius of 3-5 Km serving a sufficient number of milk producers to ensure a minimum milk collection of about 100 litres/day. The main function of a MCC is receiving milk from producers/collectors and forwarding the milk to the chilling centre or processor. These are operated either directly by farmers themselves, by processors or by larger dairy co-operatives. During the survey there were 265 registered dairy co-operatives, of which 34 were medium to large district-level primary co-operatives, and 231 were smaller primary dairy collection co-operatives at the village level. From the MCC’s, milk was transported to the secondary points, the milk chilling centres, of which there were about 80 across the island, operated by the dairy processors. The capacity of the chilling centres varied from 1,500-15,000 litres per day. The small centres were often troubled by power breakdowns, and many had old equipment. The average collection cost for efficient large-scale operators were around Rs 2.50-2.70/litre (derived from data provided by the dairy industry).

Some adulteration of the marketed milk occurred at some MCCs due to inadequate supervision or testing. Some private traders and agents of the formal dairy industry tried to capture a larger margin from the milk price. As milk was usually measured by collectors in litre and half litre measures, the “extra” milk above these measures was not paid for but was received by the collector. Rough estimates suggest that in many systems such “extra” milk, for which the farmer was not paid but benefits the collector may amount to 5 to 10% of the total.

Most milk was usually collected on “morning only” basis, although in areas where the production density levels were higher, milk was collected in the evening as well. Otherwise, evening milk was often sold by farmers to the informal markets or simply consumed. In some areas, hydrogen peroxide was added to evening milk to preserve it until the morning collection. This practice has led to some controversy, and the additive was not generally considered as acceptable in milk, unlike the lacto-peroxidase system of milk preservation. Although all formal processors insisted that they discourage the practice, hydrogen peroxide was observed in use on occasions during the RA. The practice was likely to continue unless replaced with lacto-peroxidase or until milk collection systems are better able to meet the needs of the farms. The existence of such milk preservation practices points to continued constraints in the milk collection infrastructure.

During the RA, some estimates were made of margins available to dairy co-operative. Two case examples are presented in Box 2 and 3. In one case (Box 2), an important component of economic viability was direct local raw milk sales that brought in considerably higher prices.
Box 2. Market Margins: Small co-operative near Kandy

This independent co-operative collected about 1400 litres of milk per day, about half of which was sold locally through private vendors while the balance was sold to Milco. They paid approximately Rs 10.25 for morning milk and Rs 10.75 afternoon milk to farmers who delivered the milk. Costs include Rs 0.25/Litre that was taken for overheads, including salaries, depreciation, and variable collection costs, as well as fuel and a commission for the private vendor. The local sale price was Rs 14, while the Milco price received by the co-operative was about Rs 11.25 for morning milk and Rs 11.75 for afternoon milk.

The estimates indicated that the co-operative can generate a much higher margin on local sales, about 15% of sale price, than was available on sales to Milco (2%). When the total volume of milk was incorporated, these result in about 83% of the returns to the co-operative activity coming from local sales. As in the case of smallholder farmers, the local market allows dairy activity to be viable.

<table>
<thead>
<tr>
<th>Milco sale margins</th>
<th>Rs/L.</th>
<th>% of sale price</th>
<th>Local sale margins</th>
<th>Rs/L.</th>
<th>% of sale price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm-gate price</td>
<td>10.46</td>
<td>91</td>
<td>Farm-gate price</td>
<td>10.25</td>
<td>73</td>
</tr>
<tr>
<td>Transport &amp;</td>
<td>0.80</td>
<td>7</td>
<td>Transport, overhead</td>
<td>1.65</td>
<td>12</td>
</tr>
<tr>
<td>overheads</td>
<td></td>
<td></td>
<td>&amp; commission</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sale price</td>
<td>11.46</td>
<td>100</td>
<td>Sale price</td>
<td>14.00</td>
<td>100</td>
</tr>
<tr>
<td>Gross margin</td>
<td>0.20</td>
<td>2</td>
<td>Gross margin</td>
<td>2.10</td>
<td>15</td>
</tr>
</tbody>
</table>

Table 7. Number of farmers receiving input services from milk collection centres

<table>
<thead>
<tr>
<th>Type of service</th>
<th>MILCO</th>
<th>Nestle</th>
<th>Co-operatives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Members</td>
<td>Non-members</td>
<td></td>
</tr>
<tr>
<td>Cattle loan</td>
<td>47 (24)</td>
<td>5 (6)</td>
<td>61 (16)</td>
</tr>
<tr>
<td>Cattle Feed</td>
<td>34 (17)</td>
<td>7 (8)</td>
<td>44 (11)</td>
</tr>
<tr>
<td>Breeding Facility</td>
<td>18 (9)</td>
<td>4 (4)</td>
<td>22 (6)</td>
</tr>
<tr>
<td>Others</td>
<td>12 (6)</td>
<td>11 (12)</td>
<td>22 (6)</td>
</tr>
<tr>
<td>Number of households reporting sales through the collection centre</td>
<td>197</td>
<td>91</td>
<td>391</td>
</tr>
</tbody>
</table>

Other services from co-operatives and collection centres

Other services besides milk collection were reported to be widely available from milk collection centres. These include loans for purchases of cattle, supply of feed on credit, and AI, also usually on credit. Table 7 shows the proportion of farmers who reported receiving these services. Nearly half (41%) of farmers supplying milk to MILCO centres reported receiving either cattle loans or feed on credit. Similarly, some 27% of co-operative members reported receiving these services. Co-operatives even supplied some of these services to non-members, as indicated by the survey results.

Further, as indicated above, informal market agents such as private milk collectors also often offer cash loans and feed on credit. During the RA, these services were reported by farmers as important components of the services that they expected to receive along with milk collection. This combination of services is typical of dairy co-operatives in other countries as well, and is generally considered one of the bases of the comparative advantage of co-operatives over other market agents.

Milk Processing

In Sri Lanka, the milk processing industry comprises of (a) liquid milk processing of locally produced milk and (b) re-packing or re-combination using imported milk powder, including combining of local milk and imported milk powder, and (c) drying plants to produce powder from local milk. The main products are pasteurised milk, milk powder, condensed milk, curd, milk drinks, ice cream and yoghurt. Information gathered during the RA revealed that nationally, the total processing capacity owned by private sector was about 450,000 L/day, of which some 30-40% was used. The government parastatal industry holds an additional capacity of 220,000 L/day but it used only 50% of its capacity. Processing capacity was thus under-utilised, partly as a result of strong competition from powder imports.

Because of the relatively low tariff on imported dairy products (10-15%), and low packaging/distribution costs and retail margins, consumers enjoy relatively low cost milk. The cost of locally produced milk powder was equivalent to US$ 0.35-0.41/litre.

In spite of apparently low retail prices, local entrepreneurs engaged in small-scale dairy processing successfully. One case study from the RA (see Box 4) illustrates the margins of a small-scale processor of simple dairy products such as yoghurt. When weighed against minimum monthly wage of Rs. 3500, these margins seem attractive.

Market channels for dairy products

By combining the information from the various sources accessed through the Appraisal, a flow diagram of the dairy market
Box 3. Market Margin: Dairy Co-operative Society in Central Province

A relatively large dairy co-operative society in Central Province collects on average some 6,300 litres/day. It had its own Nestle-supplied coolers. The milk was sold to Nestle, except for around 1,000 litres/day, which was sold locally. The cooperative paid Rs. 10.75 to farmers, and obtained a price of Rs. 12.50 from Nestle, and Rs. 14 from local sales.

Unlike most milk collection agents, it provided extension services to its farmers through the employment of 3 field officers (@ Rs 320/month, each). They provided training to farmers in animal husbandry, feeding, etc., in order to help raise milk production.

The estimates below show that the co-operative was able to generate a margin of about 2% from its activities and pay a dividend to farmers of Rs. 0.05/lit, while bearing the costs of extension agents. Again, local sales help economic viability by raising the average sale price to Rs. 12.73 from the price of Rs. 12.50 available from Nestle.

<table>
<thead>
<tr>
<th>Average margins</th>
<th>Rs/Lt.</th>
<th>% of sale price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm-gate price</td>
<td>10.75</td>
<td>84</td>
</tr>
<tr>
<td>Transport</td>
<td>0.95</td>
<td>7</td>
</tr>
<tr>
<td>Chilling</td>
<td>0.37</td>
<td>3</td>
</tr>
<tr>
<td>Wages &amp; overhead</td>
<td>0.34</td>
<td>3</td>
</tr>
<tr>
<td>Sale price (average)</td>
<td>12.73</td>
<td>100</td>
</tr>
<tr>
<td>Dividend</td>
<td>0.05</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Gross return: 0.27

Box 4. Market Margins: Small dairy processor near Kandy

This entrepreneur made yoghurt, curd and popsicle tubes, which he distributed locally by motorcycle to retail outlets. Some of the product was retailed directly from his premises. The milk used, around 600 L/week, was bought from the local dairy co-operative at a price of Rs. 14/L. About 150 litres were used for yoghurt, the rest split about evenly between the two other products. The materials used for packaging, such as curd pots and yoghurt packages, were bought locally. The simple processing equipment cost an estimated Rs. 25,000. The other main capital cost was the motorcycle used to transport the product. The costs reported below do not include own wages or cost of house he rents (in which he and his family also reside), so that returns were viewed as returns to labour and that portion of the premises used for the enterprise.

<table>
<thead>
<tr>
<th>Average margins</th>
<th>Rs/Litre</th>
<th>% of sale price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk cost</td>
<td>14.00</td>
<td>30</td>
</tr>
<tr>
<td>Supplies</td>
<td>10.35</td>
<td>22</td>
</tr>
<tr>
<td>Equipment</td>
<td>0.23</td>
<td>0</td>
</tr>
<tr>
<td>Transport &amp; motor</td>
<td>3.35</td>
<td>7</td>
</tr>
<tr>
<td>Interest</td>
<td>0.07</td>
<td>0</td>
</tr>
<tr>
<td>Sale price</td>
<td>46.79</td>
<td>100</td>
</tr>
<tr>
<td>Gross margin per litre (return to labour &amp; premises)</td>
<td>18.79</td>
<td>40</td>
</tr>
</tbody>
</table>

Gross margin/ month (Rs/month) | 21,170

channels was prepared for the Sri Lankan dairy sector (Figure 2). Farm-level surveys gave information on the relative importance of primary market channels, market agents provided market flows, and consumer surveys indicated the relative shares of the final retail channels. Combined, these sources allowed the full market channel diagram to be determined. The RA survey indicated that milk producers retained about 15% of their production for family consumption, with the rest is sold locally (mainly to neighbours and traders, in almost equal proportions) or to the collection centres. Thus, 52% of the marketed milk was eventually formally processed, before reaching the consumer in liquid or other product forms. Significantly, however, approximately 34% of the marketed milk was not formally processed, and are marketed either raw or as indigenous products such as curd. While this informal or unregulated market is important, it remains small in comparison to most developing nations, such as in India where it is estimated to comprise 85% of marketed milk production (Dairy India, 1997).

Total dairy imports in 1997, on liquid milk equivalent basis, was estimated to represent 43% of all milk available (including producer home consumption), and was an addition to 85% of the milk available from domestic milk production. Imports represent 69% of the formal, processed milkmarket.

Discussion of milk marketing results

In common with many developing countries, the study found that in Sri Lanka the market for dairy products is split between the regulated market selling Western-style processed products, and the informal or unregulated market supplying raw milk and traditional products. In Sri Lanka, the informal market was estimated to account for 34% of domestically marketed milk. Because of the higher prices available to farmers through the informal market, it played an important role in maintaining the economic viability of dairy farming. Additionally, as shown in Box 2, most of the profits from small market agents came from local informal sales. Another issue that should be kept in mind is the effect on employment of the two market types. Box 1 shows that handling of a minimum of 160 liters of milk daily provided full-time employment to two people. This is in comparison to formal processing channels that rely heavily on mechanisation, and often handle 1000 liters or more daily with two employees. Issues of public health
Milk/Dairy Channels in Sri Lanka (% of production)

Domestic Production (100%)
- 40% Collection centres
- 44% Local sale
- 16% Home Consumption

Traders
- 15%
Homes
- 6%
Local sale
- 17%
Neighbours
- 7%
Curd Yoghurt
- 2%

Processed: 52%
Unprocessed/local: 34%

Nestle
- 11%
Milco/Kiriya
- 20%
Others
- 20%
Local/rak milk products
- 13%
Consumers (56 kgs LME's house/year)
- 34%

Imports
- 10%

Figure 2. Dairy channel flow diagram, expressed in terms of % of domestic milk production (LME's). Note that imports are additional.

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This is the fact that a smaller proportion of milk produced was collected (32% compared to 54% in 1981), suggesting growth in the informal sector, which is likely to be driven by strong demand for the fresh and traditional products that the informal market supplies. From a planning and policy point of view, these findings suggest that if greater attention is given to developing fresh milk products and liquid milk markets, the position of domestic dairy farmers versus imported products will improve. Such measures could include steps to assist small market and informal market agents to improve the quality and scale of their enterprises.

CONCLUSIONS

The combination of research approaches employed in the dairy sector appraisal allowed an examination of key issues at different levels. In summary, the expected continued growth in Sri Lankan GDP is expected to lead to a doubling of demand for dairy products by 2010, compared to 1990-1996. The study point to several reasons why the increasing demand for milk will present good opportunities for smallholder domestic dairy producers. Although milk imports play an important role in the dairy sector, imports have maintained approximately the same market share since early 1980's (about 45% of available dairy products), and analysis suggested that imports will always remain vulnerable to trade and macroeconomic conditions. Imports also have difficulty in competing for markets that demand fresh milk products. At the consumer level, there was found to be unmet demand for liquid milk, and further that the demand can be expected to grow faster than overall dairy demand as household incomes rise. Related to


IMPACT OF DROUGHT ON HEALTH STATUS OF CATTLE IN KATANA VETERINARY SURGEON'S RANGE

Chitranjane Thevathasan, B.V.Sc., M.Sc.

Government Veterinary Office, Kolonnawa

Summary: Diseases encountered in cattle during dry and wet seasons in the Katana veterinary range during the period 1999 to 2001 are discussed here. The effect of drought was significant (p<0.05) on the incidence of vitamin & mineral deficiencies and Ephemeral fever. Infectious bovine keratoconjunctivitis and cracks/blisters on teats were found only in dry period. The occurrence of nutritionally related diseases such as, general weakness & recumbency and disorders of newborn calves was high during the dry period compared to the wet period, but the difference was not significant and their occurrence was mostly around the beginning of the wet period.

INTRODUCTION

Fibrous feed such as natural grass and fodder are the major sources of nutrients for bovines. Animals in Sri Lanka depend mainly on low quality natural grasses and weeds available along roadsides, abandoned paddy lands and other vacant lots. The year round availability of feed resources depends on the rainfall pattern.

The drought climate affects availability of feed both quantitatively and qualitatively. Due to the high cost, the farmers do not supplement the feed with concentrates to overcome the shortfall in nutrition. This affects the nutritional status, which may possibly lead to clinical illness.

In order to study the impact of drought on health, a retrospective study was carried out with the records of cattle cases encountered during a three year period 1999 to 2001 at Katana Veterinary surgeon's range.

MATERIALS AND METHODS

Katana Veterinary surgeon's range where the study was carried out is in the coconut triangle zone at an elevation of 7-10 m from sea level. The temperature in general range from 27-30°C and the rainfall pattern is bimodal (Figure 1).

The cattle population in year 2000 was nearly 2659 (Anon, 2000) and were mostly cross breeds of Jersey, Australian Milking Zebu and Australian Friesian Sahiwal and a small number of local breeds.

Cattle were managed semi-intensively and the average herd size ranged from 1-6. The cattle farmers were mainly coconut or other agricultural farmers. Cattle are usually allowed to graze under a tethered system during daytime and tied in the farmer's premises at night. These cattle farmers do not usually practice night feeding. The typical fodder base is pasture under coconut and post harvest crop fields. Usually, concentrate feeding is practiced only during lactation.

The records of bovine cases treated during 1999-2001 were used for this study (N=451). The dry months were identified by the mean monthly rainfall recorded for the years 1999, 2000 and 2001 (Department of Meteorology, Colombo). A rainfall recording below 25% of the expected rainfall for a month is considered as a dry month by the Department of Meteorology, Colombo (Rajapakse, Personal communication, 2002). The diseases/disorders recorded in these dry periods were grouped to observe the type and pattern of disease occurrence. The disease occurrence during the dry and wet seasons was compared statistically by considering weighted number of cases for a period of 12 months and applying the data to Karl-Pearson's chi-square test with Yate's correction.

RESULTS AND DISCUSSION

The diseases/disorders recorded in dry and wet months of the year 1999-2001 are shown in Table 1. The total number of dry months in the years 1999, 2000 and 2001 were 7, 8 and 10, respectively. Compared to 1999, the rainfall in 2000 and 2001 was very low and the usual rainy periods in these two years remained relatively dry. The lowest rainfall was recorded in 2001 (Figure 1).

The number of bovine cases recorded in 1999, 2000 and 2001 were 90, 196 and 165, respectively. Out of a total of 451 cases treated between 1999-2001, 340 cases were during the dry months, which indicated that the incidence was significantly higher in the dry months compared to wet months (p<0.05).

The main health problem observed was general weakness and recumbency but the affected animals
Table 1: Incidence of bovine cases treated during 1999 - 2001

<table>
<thead>
<tr>
<th>Diseases</th>
<th>Number of cases in Dry months</th>
<th>Number of cases in Wet months</th>
<th>Chi-square value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>340</td>
<td>111</td>
<td>6.23*</td>
</tr>
<tr>
<td>General weakness &amp; recumbancy</td>
<td>33</td>
<td>10</td>
<td>1.29</td>
</tr>
<tr>
<td>Vitamin &amp; mineral deficiency</td>
<td>33</td>
<td>5</td>
<td>5.01*</td>
</tr>
<tr>
<td>Infectious bovine kerato conjunctivits</td>
<td>17</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Cracks/blisters on teats</td>
<td>9</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Disorders of newborn calves</td>
<td>7</td>
<td>2</td>
<td>1.21</td>
</tr>
<tr>
<td>Omphalitis</td>
<td>11</td>
<td>2</td>
<td>1.41</td>
</tr>
<tr>
<td>Ephemeral fever</td>
<td>25</td>
<td>5</td>
<td>5.81*</td>
</tr>
<tr>
<td>Gastro-intestinal disorders</td>
<td>66</td>
<td>34</td>
<td>0.43</td>
</tr>
<tr>
<td>Accidental injury</td>
<td>20</td>
<td>5</td>
<td>1.19</td>
</tr>
<tr>
<td>Clinical mastitis</td>
<td>20</td>
<td>7</td>
<td>0.29</td>
</tr>
<tr>
<td>Non specific fever</td>
<td>22</td>
<td>6</td>
<td>1.04</td>
</tr>
<tr>
<td>Tick infestation</td>
<td>12</td>
<td>2</td>
<td>1.74</td>
</tr>
<tr>
<td>Respiratory infection</td>
<td>10</td>
<td>2</td>
<td>1.1</td>
</tr>
<tr>
<td>Milk fever</td>
<td>6</td>
<td>3</td>
<td>0.19</td>
</tr>
<tr>
<td>Retention of placenta/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utero-vaginal prolapse</td>
<td>8</td>
<td>6</td>
<td>0.81</td>
</tr>
<tr>
<td>Metritis</td>
<td>4</td>
<td>4</td>
<td>1.08</td>
</tr>
<tr>
<td>Miscellaneous diseases</td>
<td>38</td>
<td>17</td>
<td>0.69</td>
</tr>
</tbody>
</table>

Total period in months: Dry months = 25, Wet months = 11
*(p<0.05)

Figure 1: Mean Monthly Rainfall
Impact of drought on health status of cattle

...maintained a good appetite. This debility could be the result of severe feed scarcity, limitation of available drinking water and low dry matter intake. One month after the commencement of the rainy season, there is sufficient growth of grass in the grasslands. This may be the reason for the occurrence of the deficiency diseases during the first month of the wet season. According to Radostits, Blood & Gay (1994), the occurrence of health problems in the drought period could be mainly due to inadequate nutrition, the deficiency of essential nutrients and water deprivation which may lead to severe dehydration. In drought, grasses mature quickly and the crude protein content declines with a drastic reduction in essential nutrient content and digestibility (Abeygunawardana & Siriwardana, 1999). Flamengbaum (1998) has stated that the dry matter intake of cattle in hot climate is low because of the heat stress. All these factors may have had an effect on the health of the animals, which explains the higher disease occurrence in dry months compared to the wet months.

The effect of drought was significant (p<0.05) on the incidence of vitamin and mineral deficiencies, and Ephemeral fever. The incidence of general weakness and recumbency, vitamin A deficiency and disorders of newborn calves, omphalitis, gastrointestinal disorders was higher during the dry period than during the wet season. However, the difference was not statistically significant and most of the cases occurred during the beginning of the wet season. The insufficient pasture availability during the first month of the rainy season may be the reason for this. Further studies are needed to substantiate these findings.

The vitamin and mineral deficiencies were mostly confined to vitamin A deficiency (60.5%) and Pica (39.5%). Symptoms observed such as rough coat, corneal opacity and night blindness was suggestive of vitamin A deficiency. Pica could be the result of low phosphorus intake during drought. Hypovitaminosis A and E occur in prolonged drought due to lack of green feed (Radostits et al., 1994; Abeygunawardana et al., 1999). Vitamin A deficiency cause damage to peripheral nerve roots (Radostits et al., 1994) resulting in paralysis of skeletal muscles. Vitamin E deficiency also causes muscular dystrophy. These conditions ultimately result in recumbency (Radostits et al., 1994). Low phosphorus intake during drought periods lowers the efficiency of carotene conversion to vitamin A (Radostits et al., 1994). Disorders like retained placenta and prolapse of the vagina/uterus were also noticed in dry periods. Retained placenta was seen at the beginning of the wet season also. This condition could be attributed to the deficiency of vitamins and minerals due to lack of green feed. Vitamin A deficiency leads to placental degeneration, which results in birth of dead or weak young and retained placenta. Vitamin E deficiency is also a cause for retained placenta (Radostits et al., 1994). Poor body condition of the animal is a cause for vagino-cervical prolapse (Stephen, 1971). Hypoalkaemia or malnutrition predisposes to prolapse of the uterus in cows (Plenderleith, 1986).

Diseases/disorders of newborn calves such as leg weakness, lethargy and off milk were observed to be high during the drought period. Due to poor maternal nutrition, the colostrogenesis is impaired with a greater risk for infectious diseases in the newborn (Radostits et al., 1994). This could explain the high incidence of omphalitis observed during the dry months. Heat stress during the late pregnancy limits the development of uterine growth of the foetus and placental mass. As such, the nutritional requirements of the cow should be met adequately to alleviate detrimental effects of heat stress (Flamengbaum, 1998).

Infectious bovine kerato conjunctivitis (Pink eye) was observed during the dry season. It was seen in a herd where 4 out of 6 cattle were affected at a time. Pink eye is common during dry periods (Abeygunawardana & Siriwardana, 1999), which may result from hypovitaminosis A. High incidence of eye diseases in cattle was seen during summer due to direct exposure to sunlight, high prevalence of flies, dust & higher humidity (Chakrabarti, 1994; Bandaranayake, 1954). Pan (1989) observed that 50% of the eye conditions in cattle occurred in hot dry period. The incidence of Bovine Ephemeral fever was significantly high during the drought period. Balachandran (1965) reported an outbreak of this disease during a rainy season in 1962 in Jaffna where 80 animals were affected during a period of 3 months. The high incidence of Ephemeral fever observed during the dry period in the present study is in contrast to the observation of Balachandran (1965). Mosquitoes transmit the causative agent of this disease (Abeygunawardana & Siriwardana, 1999). As such it is necessary to study whether these mosquitoes are prevalent in the dry season in the Katana area.

Some cows suffered from blisters/cracks of teat skin and the teats were red and tender to touch. Teat blisters/cracks have been reported to occur due to hot sunny weather (Radostits et al., 1994; Peter Jackson, 1996).

During the long dry spells, there is scarcity of green feed and water. Therefore, the animals become ill due to starvation and water deprivation. This problem causes great economic losses due to reduced milk production, low fertility, cost of treatment and premature culling of the animals. Even though it is a common problem every year, farmers don't resort to establish pasture/ fodder.

Although the economic impact has not been assessed in the present study, it became obvious during the study that the farmers face considerable economic loss due to drought. Therefore to overcome feed shortages during dry periods, farmers should attempt to establish improved varieties of pasture or fodder and tree fodder legumes such as Ipi Ipi, Glyricidia or even Erythrina. These farmers...
can resort to forage conservation and night feeding of their cattle. Feeding of non-conventional fibrous feed such as agricultural crop residues and agro-industrial by-products is also beneficial. To avoid detrimental effect of heat stress, the animals should be provided with shelter and plenty of drinking water during the hot sunny weather.

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Department of Census and statistics, Ministry of Planning, Colombo.


CARBOHYDRATE ENGORGEMENT IN TWO GOATS

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INTRODUCTION

Carbohydrate engorgement (CE), also known as rumen overload, grain overload or lactic acidosis is a severe form of indigestion in ruminants associated with an intake of a large quantity of highly fermentable carbohydrate feed such as grain, bread or brewery by products (Radosits, Gay, Blood & Hinchecliffe, 2000; Jones, Hunt & King, 1997). All ruminants are susceptible to CE, but it is most commonly encountered in cattle, especially in animals managed in feed lots in North America and in dairy cattle fed on a high level of grain (Radosits et al., 2000; Rebhun, 1995). Accidental access to grain stores or the intentional overfeeding of rapidly fermentable carbohydrate could also lead to CE. In Asian countries where carbohydrate based food in the form of rice or wheat flour preparations constitute the staple diet of humans, it is not uncommon to intentionally feed large quantities of leftovers of such food to ruminants, especially after a social or religious function. In this regard, De Silva, Gomis, Horadagoda & Pushpakumara (1998) made a preliminary report of CE in cattle in Sri Lanka following ingestion of a large volume of leftover rice or bread. The purpose of this report is to record the occurrence of CE in two goats under similar circumstances.

CLINICAL FINDINGS AND TREATMENT

Two goats were presented to the large animal hospital of the Faculty of Veterinary Medicine and Animal Science with a complaint of complete anorexia and severe depression prevailing for 2 days. One (animal no 109) was nine month old Sannen crossbred male goat (body weight approximately 25 kg) while the other (animal no 110) was a six month old doe of the same breed (body weight approximately 12 kg). The history revealed that both animals were fed from a basinful (weight approximately 2.5 kg) of leftover ‘string hoppers’ (a steam cooked, wheat or rice flour based preparation), following a 31st night celebration.

On clinical examination, animal no 109 was more severely depressed of the two goats. The animal was dehydrated as evidenced by the sunken eyes and loss of skin turgor, and remained on sternal recumbency with the head lowered or turned towards the flank. The pulse was weak and temperature was slightly reduced (37.8°C). There was tachycardia and tachypnoea, while the oral and ocular mucosa were pale. There was ruminal atony together with distension of the abdomen, which was soft on palpation. Animal no 110, was depressed but responded to stimulation to stand. It too showed abdominal distention and mild dehydration. Further, tachycardia and tachypnoea were also present and the temperature was 38.3°C.

Based on the history and clinical signs, a tentative diagnosis of CE was made and treatment instituted accordingly. This included immediate intravenous fluid therapy with Hartman’s solution (PT Otsula, Java, Indonesia), intramuscular administration of 1 ml of antihistamine [‘Avil’ – Pheniramine maleate], Hoechst Rossul Vet (Pvt) Ltd, Mumbai, India] and a broad spectrum antibiotic at a dose rate of 1ml/25 kg [‘Urim Penstrap’ – procaine penicillin, 250mg/ml, dihydrostreptomycin as sulphate & procaine hydrochloride 20mg/ ml; Troy Laboratories Pvt Ltd., NSW, Australia).

NECROPSY FINDINGS AND LABORATORY INVESTIGATIONS

Despite treatment, animal no 109 died 4 hours later. At post mortem examination, the carcass was severely dehydrated as indicated by the stickiness of the subcutaneous tissues. Haemoconcentration was evident by the presence of firm clots of blood in the veins and the chambers of the heart. The fore-stomachs in general, and the rumen and reticulum in particular, were markedly engorged with a greenish fluid that had a porridge-like consistency with a strong fermentative odour. The mucosa of both rumen and reticulum had sloughed off revealing areas of brownish-red discoloration. The entire small and the large intestines were also filled with fluid similar to that of the fore stomachs.

The pH of the ruminal fluid was 4.93 (pH meter; Kent EIL 701S, Kent Industries Measurement Ltd., UK) immediately after opening the rumen. Direct light
microscopic examination of ruminal fluid revealed a complete absence of live protozoa. A direct smear of ruminal fluid stained by Gram’s method as well as a direct culture on blood agar, followed by Grams staining showed only Gram positive cocci. Samples of tissues were taken from the rumen, reticulum, kidneys and liver for histopathology. The histological sections revealed an acute, multi-focal severe rumenitis and reticulitis with diffuse infiltration of polymorphonuclear leukocytes (Figure 1). Further, there was vacuolation of the rumen epithelial cells (Figure 2). There was evidence of acute tubular nephrosis in the kidneys while the changes in the liver were unremarkable.

The clinical condition of animal no 110 improved after a second injection of antibiotic (1 ml/25 kg, ‘Illium Pentrap’). This animal was discharged a day later after it was found to have recovered completely.

**DISCUSSION**

In general, most farmers in Sri Lanka are unaware of the implications of feeding highly fermentable carbohydrates to domesticated ruminants. It is assumed to be a good husbandry practice and it is customary to feed cattle with rice during certain festivals. Feeding small quantities of fermentable carbohydrates is no cause for alarm but providing large quantities to ruminants that had never been previously exposed to such volumes can have serious consequences, even leading to death.

The pathogenesis of CE has been well documented in cattle where the disease is frequently reported (McGavin, Carlton & Zachary, 2001; Radostits et al., 2000). In brief, the ingestion of excessive amounts of highly fermentable carbohydrates disturbs the rumen microbial flora by promoting the growth of gram-positive bacteria, *Streptococcus bovis* and *Lactobacillus* species that produces lactic acid and volatile fatty acids (VFA) through fermentation of carbohydrates resulting in a lowering of pH to levels below 5 (normal 5.5 to 7.5) and elimination of cellulolytic bacteria and protozoa. The increased acid concentrations causes a chemical rumenitis, ruminal atony, and sloughing off of the epithelium. Further, the lactic acid and VFA causes a marked increase in rumen osmolality leading to an influx of water into the rumen ensuing in serious clinical consequences associated with severe dehydration and acidosis.

The clinical signs in the present case corroborates well with that described for CE cattle and goats (Radostits et al., 2000; Smith & Sherman, 1994). Diarrhoea has been described as a usual feature in CE consequent to increased fluid accumulation in the rumen and reduced colonic absorption of water. In the present investigation however, diarrhoea was not a clinical feature. On the contrary animal no 109 did not pass any faeces until death, while animal no 110, passed formed faeces with the improvement of the clinical condition. It is likely that ruminal atony may have led to the absence of diarrhoea, which is also recorded as a clinical feature of CE in some instances (Radostits et al., 2000).

One of the important criteria in the diagnosis of CE at necropsy is the demonstration of large quantities of carbohydrate material such as grain in the rumen contents.

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**Fig 1.** Acute, severe, diffused rumenitis with polymorphonuclear leukocyte infiltration (arrows) of the epithelium (H&E) (x30)

**Fig 2.** Vacuolation of the rumen epithelium in chemical rumenitis caused by lactic acidosis (H&E) (x30)
In the present case, however, the carbohydrate source or ‘string hopper’ could not be demonstrated although its ingestion in large quantities was clearly stated by the owner. It is possible that the soft, highly fermentable nature of ‘string hoppers’ had yielded itself to rapid fermentation and eventually dissolved into the rumen fluid. The likelihood of such a situation is great given that the post mortem examination was performed almost 60 hours after the feed had been consumed. The mucosal sloughing in the rumen and reticulum in the present case is inconclusive as a change strictly associated with CE, since the rumen mucosa often detaches easily in animals that have been dead for a few hours (McGavin et al, 2001).

According to Smith & Sherman (1994) a low pH (below 5), and a preponderance of gram-positive bacteria are strongly suggestive of CE in goats and these observations in the present case support the diagnosis of CE. In the case reported herein, ulceration and erosions of the rumen due to acidosis were not present although these have been reported as common findings that could allow infection by opportunistic pathogens, leading to hepatic abscessation (Andrews et al, 1999). In cattle, Fusobacterium necrophorum is a common bacterium responsible for bacterial rumenitis (Rebhun, 1995) while mycotic rumenitis is also another complication of CE (McGavin et al, 2001). In goats, Corynebacterium pseudotuberculosis has been isolated from liver abscesses following toxic damage of the rumen epithelium in CE (Smith & Sherman, 1994).

The rationale for the treatment of CE involves rehydration and reversal of the acidosis and resulting mucosal injury. In this context, antibiotics limit the progression of fore-stomach mucosal injury and consequent complications by bacteria while antihistamines help to minimize the effect of histamines produced in CE that could lead to laminitis and lameness. Withholding of concentrates and the provision of free access to drinking water is recommended but some authors advise withholding water for 12-24 hours from the onset of engorgement (Radostits et al, 2000). Antacid are suggested at the early stages to prevent the progression of the condition (Smith & Sherman, 1994).

It is most likely that animal no 110, being the smaller of the goats, could have only consumed a lesser quantity of ‘string hoppers’ as both animals had eaten off the same basin. Early treatment of CE is effective as may be the case with animal no 110. In contrast, the pathophysiological changes of CE in animal no 109 may have advanced to the extent where the treatment had little effect on the recovery.

Creating awareness among the farmers on the implications of feeding of large quantities of fermentable carbohydrates to ruminants, especially during festival seasons is an important step in the prevention of CE in Sri Lanka and other Asian countries. If ruminants are to be given fermentable carbohydrates, for example when available as a by product of industry, it is necessary to introduce such feed gradually over a period of time in order to allow the rumen flora to adapt to the feed.

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REFERENCES


Short communication

EFFECT OF DIAZEPAM AS AN ANAESTHETIC ON GUOPY (POECILLIA RETICULATA)


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Anaesthesia in fish is necessary for transportation, clinical examination and treatment, surgical interventions and for experimental purposes. Several immersing compounds have been tested for their anesthetic efficacy on fish, including MS 222, phenoxethanol, benzocaine, carbon dioxide, halothane, isoflurane and clove oil (Bowser, 2001). This communication describes the efficacy of diazepam as an anaesthetic for fish.

Two hundred ml of ketamine solutions each containing 50, 75, 100, 125, 150, 175, 200 and 225 ppm of injectable diazepam (Diazepam injection 5mg/ml. Lab. Renaudin, France) were prepared. Ten, 3 months old Guuppy (5 males and 5 females) obtained from a commercial aquarium were introduced separately into solutions of different strength. The fish were refrained from food for 6 hours prior to the experiment. The Mean Time taken for the fish to Loose Equilibrium (MTLE) (inability to maintain balance and/or swim straight) were measured. After they were immobilized they were removed individually from anaesthetic solutions on to a wet towel and their lengths were measured using a vernier caliper. This process lasted approximately 30 seconds. Subsequently, the anesthetized fish were introduced into clean water and time taken to regain the consciousness (Recovery Time, RT) was measured. The Guuppy, were monitored closely for 48 hours after the experiment in order to observe any after effects.

The arithmetic mean of the time taken to loose equilibrium (MTLE)

An initial gradual increase in the MTLE was noticed up to 75 ppm Diazepam, followed by a gradual decrease with increasing concentrations (Line A in Figure 1). Once the concentration increased above 150 ppm, the rate of reduction in

MTLE decreased and a satisfactory MTLE (of 2-4 minutes) was observed between 150-225 ppm.

Recovery Time (RT)

The recovery also followed a similar pattern. A gradual increase in RT was noticed in fish which were in 50 and 75 ppm solutions, and the RT gradually reduced in fish which were in concentrations above 75 ppm (Line B in Figure 1). The RT for fish which were in solutions between 150-225 ppm was 1-4 minutes. The RT of those in higher concentrations was similar. No difference was seen between the two sexes and complications were not seen in any of the fish.

Diazepam concentrations between 150-225 ppm can be successfully used to induce anaesthesia in Guuppy for brief periods.
with relatively short induction and recovery period, with no complications. This would be ideal for purposes of handling, treatment and minor surgical interventions. Furthermore, injectable diazepam is readily available and is relatively cheap. The oral formulation of diazepam cannot be used for this purpose due to its insolubility in water resulting in pasting of particles on gills of fish. However, further studies are needed if diazepam is to be used on other aquarium fish to induce and maintain general anaesthesia.

REFERENCES

ASSOCIATION

New President

Dr. (Mrs) H.M.S.P. Herath, the new President of Sri Lanka Veterinary Association has been a longstanding member of the Association. Her contribution to the Association commenced in 1982 and she has held several posts in the executive committee including the post of Secretary in 1991/92.

Dr. Herath was educated at Maliyadeva Girls School, Kurunegala. After graduating from the Faculty of Veterinary Medicine & Animal Science, University of Peradeniya in 1975, she joined the Dept. of Agriculture and served as a field veterinarian from 1975.

One of her earliest interest was Artificial breeding of livestock in which field she obtained her post graduate qualification from the Royal Veterinary college of Sweden in December 1987. She did her masters in Animal Breeding & Genetics in 1982 at the Post graduate Institute of Agriculture, Peradeniya. As an Assistant Project Officer in the Animal Breeding Division from 1982 – 1990 she was involved in upgrading and cross breeding of cattle in Sri Lanka. She was the Deputy Provincial Director, Central Province from 1993 – 2002. At present she is the Director of Animal Breeding in the Department of Animal Production & Health.


She has traveled widely to attend seminars, conferences, workshops and study tours. Finland, Sweden, Denmark, Norway, India, Malaysia and New Zealand are some of the countries she has visited. She had the rare opportunity to represent the women professionals by being an invited speaker at the 2nd Pan Commonwealth congress held in Bangalore in 1998. She spoke on “Women in Extension & Development in Livestock farming & Veterinary Services in Sri Lanka”.

Dr. Herath has taken a keen interest in Commonwealth Veterinary Association activities. Presently she is the Commonwealth Veterinary Association Councilor for Sri Lanka for the year 2003/2004 and serves the CVAA as Regional Representative for Asian region and will continue until 2006.

She has been an active member of the Editorial Board of Sri Lanka Veterinary Journal from 1992 – 2000.

She was an elected member of the Veterinary council of Sri Lanka, a statutory body established under the Veterinary Surgeons & Practitioners act of 1956. She has the distinction of being the first Lady President of the Veterinary Council of Sri Lanka in 1993.

Dr. Herath is the General Secretary of the Alumni Association of University of Peradeniya for the Year 2004/2005.

Fifty fifth Annual convention

The 55th Annual convention and scientific sessions of the SLVA were held at Hotel Taj Samudra, Colombo on 30th and 31st May 2003. Dr. A. Shaktihale, President SLVA presided at the inaugural sessions.

H.E. Mrs. Marie-France Pagnier Dunavan, Ambassador of France to Sri Lanka and the Maldives was the Chief Guest. In her speech H.E. the ambassador mentioned that ‘The future of Dairy Development in Sri Lanka’ the theme of our seminar is an important and sensitive topic. H.E. the ambassador further said that the Medical researchers have now proved the necessity for the consumption of dairy products on a regular basis by children as well as the elderly and that there are products available in hundreds of different types and forms for human consumption.

H.E. the Ambassador recalled France as a renowned country for the quality and the diversity of milk production and the Dairy Industry with 25000 dairy farms having 4 million dairy cows producing almost 23 billion liters of milk; 32% of the milk production is exported (22% to the European Union and 10% to other countries). Further the assistance given by the France government to foreign countries in Europe, Africa and Asia was also elaborated.

H.E. the Ambassador wished that some guidelines and proposals initiating positive inputs for the future of Dairy Development in Sri Lanka to be drawn up at the end of the day and gave her best appreciation to the Veterinary Association and its members for the precious work they contribute to the Sri Lankan Society.

The following presentations were made at the Theme seminar ‘The Future of Dairy Development in Sri Lanka’.
1. ‘Dairy Industry in Sri Lanka’ - Mr. Cubby Wijethunge, Vice President, Corporate Affairs & Director Nestle Lanka.

He highlighted the plight of the local industry over 22 years and the achievements of Nestle over the period. His presentation was full of answers for the questions such as, Is there a motivation to fresh milk production? What are the impediments? What are the main problems? How can we develop the industry? He stressed on the danger of having 10% import tariff, which encourages importers to demand FCMP market and that the local processors face a daunting task to compete with the importers.

2. ‘Future of Dairy Development in Sri Lanka-A foreigner’s perspective’ by Mr. Mathew Oldham, Managing Director, Indian Subcontinent of New Zealand Milk (Pvt) Ltd.

As a BOI approved company, New Dale Dairies (Pvt) Ltd., process 10000 L of milk from 1300 farmers. Farmers are paid Rs 18/ litre of milk. According to him the future of the industry depends on the production of high quality of milk with high quality. He emphasized on farmer level education, building of infra structure, establishment of more chilling centers, taking care of welfare of their staff, well planned net work of milk collection and distribution of products. A fair payment mechanism should be developed in terms of rewarding farmers who produce better quality milk. He stressed on promoting use of local milk for value added products and increasing opportunities for consumers for more choice and more convenience in access to dairy products. It is essential to have a situation analysis and the Dairy Development in future should be a strategically planned one.

3. ‘Experience in Dairy Development in Sri Lanka’ by Dr. Jagith Punjratth, Managing Director, Cargills Quality Dairies (Pvt) Ltd.

The paper was presented by Mr. Rathnayake. It gave details in exploitation, deception and duplicity in milk collection, negative effects of promotion of milk powder and advertisements etc. He highlighted experiences in consequences in competitiveness of rich and poor producers. He mentioned that the success of the industry in Japan depended mainly on high tariff levied on importation. He is of the opinion that unless radical changes are made in the industry one cannot expect a success in dairy industry in future.

Association Dinner

The association dinner which was held on the 30th May 2003 at the Hotel Taj Samudra was well attended. The third Prof. S.T. Fernando Memorial Oration, the awards presentation and the induction of the new President were the special events at the dinner.

Presentation of awards

Special Awards were presented to Dr. S.B. Dhanapala, Dr. K. Balachandran and Dr. M. Kopalasundaram for outstanding services rendered to the Veterinary Profession. H.E.Mme Marie – France PAGNIER – DUNKAN presented the awards.

3rd Prof. S.T. Fernando Memorial Oration

Prof. N.P. Sunil Chandra, Professor of Microbiology, Faculty of Medicine, University of Kelaniya delivered the third Prof. S.T. Fernando Memorial Oration on the subject of ‘Control of Rabies in Sri Lanka: Lesson through the lens of History’.

DEPARTMENT OF ANIMAL PRODUCTION AND HEALTH

Dr. S.K.R. Amarasekara, was appointed Director General of the Department of Animal Production and Health with effect from 1st June 2003. We wish him all success.

COMMONWEALTH VETERINARY ASSOCIATION

The 3rd Pan Commonwealth Veterinary Conference was held from 27th-30th June 2003 at Wellington, New Zealand. Both past and present Presidents Drs. A Shakthivate and Dr. H.M.S.P. Herath of SLVA were invited for the conference.

Dr. H.M.S.P. Herath as a CVA Councilor for Sri Lanka submitted the country paper on ‘The Veterinary Profession in Sri Lanka’. The theme of the conference was ‘Animal welfare, Island Nations and Bio security’. These subjects are of major issues for the developed countries. There were 67 CVA delegates from different Commonwealth countries. A total of nearly 600 delegates participated in the conference.
DAIRY FARMING IN WESTERN PROVINCE, SRI LANKA: II-ECONOMIC OPPORTUNITY OF CATTLE AND BUFFALO FARM HOLDINGS

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Many scientists and animal production and health personnel accept that the efficiency of current dairy and buffalo production at the field level is far below the potential. However very few studies were conducted to estimate the actual income, expenditure and potential loss of the small holder dairy operations.

Therefore, this study was conducted in the Western Province (WP) to estimate the current production level, income and expenditure and the true economic opportunity (eg. potential income the smallholder could earn) of a selected cluster of smallholder dairy and buffalo farms in the province. A sample of 82 farmers was purposively selected from six veterinary ranges (Attanagalla, Mihirigama, Kelaniya, Udahamulla, Bandaragama and Negombo). Information on land extent, family size, herd size breed type, production level, reproductive performance, management systems and income and expenditure was collected. To estimate the economic opportunity cost three parameters, namely (i) age at first calving (AFC), (ii) lactation length (LL), and (iii) milk production per cow per day (MY/d) were used. Data were analyzed using a software package developed by FAO/IAEA. The estimated values of the three parameters were compared with the targets established (based on the work done here and elsewhere) for the said parameters.

The average farm holding in the cluster of cattle is characterized by (i) 3.5±0.97 family size, (ii) 0.42±0.42 ha land area, (iii) 7.0±5.34 animals per herd, (iv) genotype of >75 percentage of Bos taurus blood, (v) 5.13±1.98 liters of milk yield per day per animal, (vi) 252.2±76.78 days of lactation length, (vii) 17.0±4.74 months of calving interval and (viii) 38.0±37.79 months of age at first calving. The average farm holding in the cluster of buffalo is characterized by (1) 3.5±0.97 family size (2) 0.42±0.42 ha land area, (3) 7.21±3.42 animals per herd (4) genotype of >75 percentage of exotic blood, (5) 4.63±1.55 liters of milk yield per day per animal, (6) 237.11±119.02 days of lactation length, (7) 17.93±7.40 months of calving interval and (8) 45.0±10.09 months of age at first calving. The targets established for cattle for AFC, LL and MY/d were 30 months, 305 days and 10 liters, respectively. The targets established for buffalo for AFC, LL and MY/d for buffalo were 42 months, 315 days and 8.5 liters, respectively. The analysis showed the average cattle farmer has the opportunity to improve his income by Rs 44/=, 107/= and 251/= per day by decreasing the age at first calving, increasing the lactation length and milk yield per day respectively. Same analysis showed that the average buffalo farmer has the opportunity to improve his income by Rs 37/=, 190/= and 303/= per day by decreasing the age at first calving, increasing the lactation length and milk yield respectively.

Therefore any average cattle and buffalo farmer have the opportunity to increase the income by Rs 304 and 410/= per day respectively by resorting to management practices that would reduce the age at 1st calving, calving interval and increase the lactation length and daily milk yield.

ANALYSIS OF THE COST OF MILK PRODUCTION IN RATNAPURA DISTRICT

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The success of dairy farming, as a form of business depends on profitable milk production and marketing. The price of milk depends on various factors such as demand, supply, cost of production, location of the area and marketing channel. Profitability in the dairy industry has been considered to rest on the difference between the cost of production per litre of milk and the average farm
gate price of milk. The objective of this study was to suggest a reasonable and appropriate price for a litre of milk produced by dairy farmers in Ratnapura district considering the cost of production of milk.

A field survey was conducted using a pretested questionnaire on the cost of milk production in the area. Two hundred and fifty dairy farmers were selected for the study by using simple random sampling method.

The highest amount of cost has been for labour estimated to be 50.1% of the total cost while 36.7% of the total cost represents the feeding cost. The rest of the cost is due to other operational costs, like cost of depreciation of initial investment (3.04%), cost of veterinary services (2.42%), cost of building repairs (0.9%), cost of death and losses (5.5%) and breeding and miscellaneous costs (1.4%). The cost of production of a litre of milk by an average farmer when his family labour costs are included and excluded were Rs. 14.32 and Rs. 5.87 respectively. The average price paid to all farmers surveyed was Rs. 13.14 per litre of milk. It greatly varies with fat content of the milk. The average her size of the area was 4 animals per farm and the average milking cows per farm were 2.35.

**CESS ON IMPORTED MILK PRODUCTS: HOW IT CAN BE UTILIZED TO MAKE THE DAIRY INDUSTRY SUSTAINABLE?**

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Value and quantity of imported milk products during 1990-2000 indicate that the quantity of imported milk products has decreased gradually while the price has increased four fold. Therefore the importation has had no significant impact on the per capita availability of milk. In 1982 the local production was 66% of the requirement while the imports were only 34%. In 2002 the local production has dropped to 43%, while imports had increased to 57%. Therefore, the gap between the local production and imports is widening. Developments in the dairy sector have failed to keep pace with the increasing demand. Recent studies have identified that inadequate farm gate price, payment not based on the quality of milk, low keeping quality of milk, inefficiency in the milk collecting system, unavailability of good quality roughages, higher prices of cattle feed, scarcity of good quality breeding cows, reduction of grazing land are the major problems related to the dairy industry in Sri Lanka.

Only few of the problems listed above have been acknowledged. Increase of farm gate price for milk would cause increase of consumer price, which will indirectly affect the milk consumption. A cess on imported milk products and using part of it on the improvement of the industry would create enthusiasm among dairy farmers. The cess could be used to establish milk-collecting centers to promote evening milk collection which is not practiced at present in most areas. Purchase of equipment required for implementation of an island wide individual milk sample testing, a monthly incentive of Rs. 1000/- to the primary level milk collecting centers which establish the individual milk testing facility, direct incentive to the farmers who supply milk to the formal market, payment of an incentive of Rs. 1.00 per litre of milk on the microbial quality of milk, provide breeding stock at a subsidized rate, establish small-scale milk pasteurization units to process milk locally, provide financial support for research and development in dairy sector, to establish communal pasture lands in identified areas, supply rural schools with pasteurized milk free of charge to improve the nutrition of the school children, provide incentives to local feed manufacturing entrepreneurs who utilize local feed ingredients to produce cheaper animal feeds, provide credit facilities and tax concessions for all kind of machinery used in the dairy sector are other suggestions to utilize the proposed cess on imported milk products.

**PREFERENCE FOR AYRSHIRE BREED AMONG UP-COUNTRY SMALLHOLDER FARMERS**

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Ayrshire is a dairy breed introduced to Sri Lanka and has been maintained as a prominent dairy breed especially in the up-country region. However, according to the present breeding policy guidelines this breed has been suggested to be phased out until such time the semen is available for artificial insemination. Therefore, the place of this breed in the dairy farming community had to be understood properly before drawing any recommendation on maintenance of this breed.

A survey was conducted in three Ayrshire rearing areas of the up country (Bandarawela, Haputale, and Wellimada) to find out whether there is any significant reason among small scale farmers to remain with Ayrshire and their crosses (more than 75% of Ayrshire characters) compared to other dairy breeds and crosses (Friesian, Jersey and their crosses). Sixty farmers rearing Ayrshire or its crosses were questioned. The survey was carried out during August 1999 using a structured questionnaire. Average herd size in the farms surveyed was 4 cattle. Other than Ayrshire, Friesian, Jersey and their crosses...
were the other cattle types found in those farms. About 20% of farmers had only Ayrshire and its crosses.

Among the 60 farmers, 78% revealed that the most preferred type of cattle was Ayrshire or its crosses. Preference of 42% of farmers for Ayrshire and its crosses was due to the higher fat content in milk compared to Friesians. About 20% of farmers preferred Ayrshire due to high milk yield. The average milk yield per day was around 7.5 l/day among the farms surveyed. Good temperament (10%) and hardy nature (7%) of Ayrshire were other reasons indicated by the farmers.

Ninety-four percent of the farmers experienced no difference among the breeds and crosses with respect to age of sexual maturity. The rest indicated that calving interval of Ayrshire is lower among the breeds and crosses surveyed.

In summary, high fat content, high milk yield and easy maintenance were the main reason for the preference to the Ayrshire breed over the other breeds.

**USE OF PCR IN IDENTIFICATION OF DOG AND BUFFALO MEAT**


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PCR assay was developed for the differentiation of dog meat from mutton and identification of buffalo meat. This type of meat is believed to be used for the adulteration of mutton and beef. By PCR amplification 376 bp bands were observed for 5 dog breeds used in the study and these primers did not cross reacted with DNA of goat under the tested reaction conditions. (Dog specific primers 5’ATGAACCAACATTCCGAAAACCCAC3’ & 5’TGGCTATGGTTGCGAAATAATAGTACA3’). A band of 242 bp was observed for all four buffalo breeds tested and the primers did not cross reacted with DNA of cattle, pig, sheep and goat (Buffalo specific primers 5’TAGGCATCTGCCTAATTCG3’ & 5’ACTCCGATGTTTCCATGTTTCT3’). A band of 649 bp size was observed for all animal species when DNA was amplified with the universal primers (5’TAGGCGAATGGAATATCATTCCGTTTGAT3’ & 5’CAAAATCCTCAAAGGCGTATTCCTACGC3’) and that indicated the presence of mitochondrial DNA in the samples. Further the results indicated that this technique was sensitive enough to identify rotten, boiled and even dried buffalo meat. Under these PCR conditions, the DNA of bacteria, which is involved in decomposition of meat, did not amplify with both universal and specific primers.

**STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS IN SWINE INDUSTRY IN SRI LANKA**

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Department of Animal Production and Health

Swine industry has not shown a rapid growth during past few decades in Sri Lanka. There are various reasons associated with the slow development of the sector. The objective of this paper is to review the strengths, weaknesses, opportunities and threats (SWOT) in swine industry in Sri Lanka. The information was derived from surveys and regular monitoring activities by the division of livestock planning and economics.

The strength of the swine industry include high income generation within short period, low feed cost, high feed conversion efficiency ratio of the species, good scavenging system for broiler farmers, low labor cost, low initial cost for a farm and high dressing percentage in pigs.

Religious taboos, non availability of formal retail marketing system, difficulty in storage of meat because of high fat content, traditional thinking about pigs, lack of formal farmer training and lack of small scale meat processors are weaknesses associated with the sector.

High consumer preference towards pork, high price for swine meat, developing tourist sector in the country, emergence of meat-processing sector for pork and high demand for meat due to increasing per capita income in the country can be regarded as opportunities.

The threats preventing the progress of the sector include environmental issues due to smell and sound, zoonotic diseases, negative impact on human health and government trade policies such as meat importation.

If appreciable improvement in growth of the swine industry in Sri Lanka is to be achieved the issues impeding the growth of the swine industry needs to be carefully considered in order to instigate appropriate remedial measures.

**THE LEATHER INDUSTRY IN SRI LANKA: AN ASSESSMENT OF WASTE PRODUCTION**

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The leather industry of Sri Lanka is considered a potential avenue for earning foreign exchange and generating employment opportunities. While there are tremendous advantages in developing this industry
further, one drawback is the production of vast quantities of waste which may have deleterious effects on the environment. Hence the main objectives of this study were to assess the amount of waste produced by the tanneries, investigate the methods of waste disposal and possible utilization of tannery waste.

Data related to the year 2000 was collected from four major tanneries located in Colombo and Gampaha districts by interviewing the managers of the tanneries.

In Sri Lanka there are several tanneries including six major tanneries. The tanning process generates heavily polluted waste water and solid waste. Actual waste production per day by one major tannery with the hide utilization capacity of ten tons per day has been calculated by Central Environment Authority as 350 m³ of waste water and 3750 kg of solid waste. Using the data on hide utilization capacity by each tannery, and assuming an average weight of a hide of cattle, buffalo and goat as 14 kg, 17 kg and 2.5 kg respectively the amount of waste produced by the other tanneries was estimated. According to this estimation four major tanneries together produce 630 m³ waste water and 6750 kg of solid waste per day. At present waste water is released into the river and solid wastes are dumped at waste disposal sites without reutilization.

Solid waste can be reutilized efficiently by manufacturing by-products such as leather board, gelatin, glue, tallow, grease, dog chews bones and animal feed. However, feed companies are reluctant to invest because of high investment cost, lack of uniformity of components and suspicion of chemical residue. A government proposal aimed at upgrading the leather industry envisages the relocation of all tanneries in the “Batta aha” industrial park in the Hambantota district. When this becomes a reality all the waste would be available in bulk quantity at one site and investment on waste reutilization will be profitable.

CONSTRAINS IN DAIRY SECTOR AND IT'S EXTENSION SERVICE

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Self-sufficiency in milk production is the ultimate goal of the dairy development program in Sri Lanka. There are many dairy sector related problems yet unresolved. Farmer education has a significant impact on solving many of the field level problems efficiently. In this context, field
extension officers attached to the provincial DAP&H play an important role. Updating the technical knowledge of the extension staff is a prerequisite of the farmer education programs.

Series of island wide training programs were conducted to train 369 officers in the 8 provinces. Pre evaluation of the participants' knowledge was carried out using questionnaires on the fields of breeding, nutrition and management of cattle & buffaloes.

Out of the 20 questions in animal breeding only 4 questions have been answered correctly by more than 50% of the participants. The two questions on body condition score had been answered correctly by only 2.7 and 5.8% of the participants respectively. On cattle management the percentage of participants giving correct answers for each question was within the range of 5.5 – 33.9%. On cattle nutrition, out of 10 questions only one question had been answered correctly by more than 50% of the participants. These findings indicate a serious problem at the field level. There is a need for updating the technical knowledge of the field extension staff periodically.

Based on the presentations made by the participants during the training period, several common problems related to feeding, breeding, marketing and health care were identified. Significant improvement of the dairy sector will not be possible without permanent solution for the problems identified.

IMMOBILIZATION OF FREE-RANGING SLOTH BEARS (MELURUSUS URSINUS) IN SRI LANKA

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Eight species of bear are distributed through North and South America, Europe, and Asia. Sloth bears (Melursus ursinus) are restricted to the Indian subcontinent and Sri Lanka. We report the first case of immobilization of free-ranging sloth bears at Wargomuwa National Park in Sri Lanka. The capture and immobilization was conducted as part of an ongoing research project on the ecology of the sloth bear with the objective of obtaining morphological data, marking the animals for identification and fitting them with radio collars for subsequent monitoring and data collection. This report evaluates the immobilization protocol used to anesthetize six adult sloth bears (3 males and 3 females) captured during June and July 2002.

The bears that were captured overnight were anesthetized the subsequent morning. Anesthesia was
by injection of 4.0 mg ketamine hydrochloride/kg body weight and 2.0 mg/kg xylazine hydrochloride administered to the nape or thigh area using a pole syringe. Following immobilization, the bears' eyes were lubricated and covered to avoid corneal abrasions and reduce visual stimulation and sound was kept to a minimum. The heart rate was taken from the left thoracic area and respiratory rate and per rectal temperature monitored. Observation of limb movements and palpebral reflexes were used to monitor the degree of anesthesia. Bears were weighed, measured, ear-tagged, tattooed and radio collared. Blood samples were taken and physical and reproductive condition recorded. Supplementary doses of ketamine-xylazine were given intermittently to permit safe handling. Yohimbine hydrochloride (0.05 yohimbine/mg xylazine hydrochloride) was administered intravenously via the sublingual, brachial or medial saphenous vein to reverse anesthesia.

An average of 4 minutes elapsed following injection to obtain a satisfactory level of anesthesia. Mean heart rate, pulse rate and temperature during anesthesia were 63/min, 18.5/minutes and 101.6°F respectively. Mean handling time was 6.1 minutes. Recovery from anesthesia ranged from 3-154 minutes following yohimbine administration.

Yohimbine reverses the effects of xylazine and not ketamine, which may be one of the main reasons for the long recovery period in some animals. A shorter recovery time may be accomplished by reducing handling time and avoiding supplementary doses of ketamine-xylazine. Further studies are required to better understand the recovery process.

EFFECT OF SCAVENGING PERIOD ON THE PRODUCTION PERFORMANCE OF CROSSBRED CHICKEN

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In spite of rapid growth observed in the commercial poultry sector, the consumers are much concerned over the presence of chemicals and adulterants in the poultry products. Under this context the village chicken remains as a steady supplier of highly appreciated food while supplementing income for the rural poor. However, the traditional system of rearing village chicken has threatened with the limitation of land for scavenging. Intensive or semi intensive management need additional inputs and supplementary feeding. Past research has revealed that supplementary feeding is not cost effective as the village chicken is not in its optimum production levels. Thus the genetic improvement of the village chicken is the only way to compensate the additional cost of supplementary feeds. Hence, a study was carried out to investigate the suitability of crossbred village chicken under restricted scavenging with supplementation.

Crossbred day old pullets of CPRS Brown sire and village hen were reared under 2-4 hr restricted scavenging (GP1) and free range scavenging (GP2) systems. Birds in both groups had the access for supplementary feed.

Age at first lay was 227 and 182 days while monthly egg production per hen was 12 and 18 in GP1 and GP2 respectively (p < 0.05). These results indicated that restricted scavenging with supplementation limit the potential benefits of crossbred chicken.

Brooding is an essential biological phenomenon in the village chicken. Crossbreeding has resulted in reduction in broodiness. Birds of GP2 had significantly lower brooding period (10 ± 3 days) compared to that of GP1 (17 ± 6 days). Higher egg production in GP2 may be due to reduced brooding period which may adversely affect the hatchability of eggs and survival of chicks. Therefore, genetic upgrading of village chicken for higher production will not be an appropriate alternative for the problem of reducing the scavenging area.

A STUDY OF SMALL SCALE POULTRY PRODUCTION SYSTEM IN RATNAPURA DISTRICT

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This study set out to describe the main poultry rearing systems on farms in Ratnapura district with a view to increasing the benefits to poultry rearers. The systems studied were small scale commercial (SSC) and village backyard poultry.

A total of 300 rearers of chickens (90 village and 210 SSC) were studied across 4 veterinary ranges in districts of Ratnapura, Balangoda, Kalawana and Godakawela. Data collection was by formal and informal interviews using a pretested questionnaire, group interviews, direct observation and a seminar.

SSC enterprises in Ratnapura constitute about 80% of total poultry farms and provided 45% of the total eggs and 75% of chicken meat. Government has promoted SSC enterprises with a view to improving standards of living by providing employment for rural families.

Ninety five percent of respondents kept single species of poultry (94% chickens and 1% ducks) while the remaining 5% kept more than one species. Most rural estate
households in district kept village poultry. Rural families kept village chickens to supplement diet and as a source of income. Sixty six percent of the rearers owned 1-25 birds and mean flock size across the villages was 18 birds. Village hens produce 3 clutches (15 eggs/ clutch) in a year and hatchability was estimated to be 75%. Of all the chicks that hatched from a clutch size of 15 eggs, an average of 7.7 chicks managed to reach maturity.

Low input husbandry methods contributed to high mortality in village chickens. However, the main constraint to village chicken rearing were Coccidiosis, IBD, Colibacillosis and losses from other factors, especially predation. Traditional disease control remedies predominated.

The major constraints to increase productivity in SSC enterprises were irregular and poor supply of feeds and chicks, lack of transport, poor sitting of enterprises and unorganised marketing. Thus, improvement of SSC rearing requires both support from government and policymakers, as well as training of farmers. There is need for new extension strategies that encourage farmers and scientists to work together to develop village chicken rearing.

A PRELIMINARY STUDY ON THE PRESENT STATUS OF SMALL-SCALE SELF-MIXING POULTRY FEED MANUFACTURERS IN THE NORTH-WESTERN PROVINCE OF SRI LANKA

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The ever escalating cost of poultry feed has become one of the major constraints in commercial poultry industry in Sri Lanka. The cost of feed represents about 70% to 80% of the cost of finished poultry products. Despite the fact that there are 3 leading large scale poultry feed manufacturers in the country supplying the market, in recent past, many medium and large scale poultry farmers have initiated formulating and mixing their own poultry feed. Some of them manufacture additional amount to sell it to the surrounding small holder farmers. Majority of the small and medium scale poultry feed manufacturers (self-mixers) are concentrated in the North Western province of Sri Lanka.

A study was conducted to investigate the present status of the small scale self mixing poultry feed manufacturers in the North Western province through a field survey followed by a proximate analysis of feed samples collected from both manufacturers and user farmers.

All the poultry feed types produced are in mash form and the layer-grocer feed is the most common. The average nutrient content and hygienic standards are not up to satisfactory level and the performances of the birds were comparatively inferior.

Although the layer-starter feed carries an average nutrient composition, layer-grocer and layer-layer feed rations showed considerable variation. The energy-protein ratio in the layer-grocer and layer-layer feeds was about 14-19% lower and the sulphur containing amino acids was 8% lower in layer-layer feed than the recommended levels. Ash content was 40% higher than accepted level in layer-grocer and layer-layer feeds. Calcium levels in layer-layer feed were twice the recommended levels.

Prevalence and spread of infectious poultry diseases such as Gumboro and Salmonellosis were higher in the area. Gout, the metabolic disease in growers and layers in early stages, was observed in 33% of farms. Indiscriminate use of various antibiotics of which some of them are not indicated for prophylactic use and mostly in high doses in layer feed was a common occurrence.

The cost of production of layer feeds was about 19% less than the price of layer type commercial products. On average, self-mixed feed users enjoy a margin of about 30 cents/ egg over commercial layer type feed users during egg production phase.

A STUDY ON FISH ROE

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Fish roe or mass of eggs of the female fish is considered as a delicacy and a good source of essential fatty acids. But this has not been exploited by the large scale manufacturers in Sri Lanka.

By a questionnaire based survey, baseline information about fish roe availability, types and consumption pattern were gathered from 150 purposively selected persons in Gampaha, Kandy and Galle districts. In addition data on methods of improvement of flavor and preservation of roe were gathered. Fifty house wives from Gampaha and Negombo districts were personally interviewed and recipes on fish roe dishes were collected. Protein and moisture analysis were done on marine fish roe, namely Carangids, Spanish Mackerel and Yellow Fin Tuna collected from Negombo market, and two fresh water fish roe, Common Labeo and Common Carp collected
from lakes in Gampaha district. Three important fatty acids namely eicosapentaenoic (EPA), docosahexaenoic (DHA), and arachidonic acid were analysed by gas liquid chromatographic technique.

From the selected sample of people more than 68.6% showed a positive response to consumption of fish roe. Interesting methods on improvement of flavor such as careful separation of eggs with out contamination from gall bladder contents, washing of roe with coconut water or lime juice, wrapping of the egg sac in papaw or alocasia leaves were identified. Response from house wives were encouraging and many types of recipes were collected.

The protein content varied from 9–20.3% on fresh weight basis. Samples contained EPA, DHA and arachidonic acid. Fish roe can be included as a source of essential omega-3 fatty acids in the diet. Fatty acids profiles of fresh water fish roe (arachidonic 3.5%, EPA 0.9%, DHA 9.9%) and marine fish roe (arachidonic 3.9%, EPA 3.5%, DHA 10.7%) differed, indicating that the EPA percentage was low in the fresh water fish roe.

Fish roe industry can be developed not only as a potential source of income but also as a foreign exchange earner.

**STUDY OF THE EFFECT OF ARTEMIA, MOINA AND CONCENTRATED FEED ON THE GROWTH OF GUPPY (POECILIA RETICULATA) - RAINBOW VARIETY FRY UPTO FINGERLING STAGE**

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Guppy (Poecilia reticulata) is one of the ornamental fish species with high demand all over the world. Its contribution to the ornamental fish export in Sri Lanka has shown an upward trend. But the efficiency and the effectiveness of the commercial cultivation of guppy have been affected because the guppy fry has to be fed with a live feed at the very initial stage of growth for best results. Artemia nauplii, though expensive, is widely used live feed in commercial cultivation. Hence, it is important to find out an alternative live feed for guppy fry. Moïna can be used as an alternative.

Guppy fries in mean length of 8.30±0.06 mm and mean weight of 6±0.01 mg of same variety and from same brood stock were fed with Artemia, Moïna and concentrated feed ad libitum in cement tanks (26”x15”x14”) for 3 weeks and their lengths and weights were measured individually every week without replacing the samples. Mean lengths (mm) and weights (g) of Artemia fed guppies were 10.82±0.03 mm, 0.013±0.001g on 7th day, 13.85±0.04 mm, 0.032±0.003g on the 14th day and 18.90±0.35 mm, 0.088±0.003g on the 21st day respectively. Similarly, with Moïna fed group the mean length and the weight were 11.23±0.03 mm, 0.013±0.001g on 7th, 13.60±0.03 mm, 0.028±0.002g on 14th and 18.16±0.04 mm, 0.077±0.005g on 21st day. In concentrated feed fed group measurements were 10.83±0.29 mm, 0.010±0.001g on 7th, 11.33±0.04 mm, 0.016±0.001g on 14th and 14.44±0.30 mm, and 0.036±0.002g on the 21st day.

Statistical analysis revealed that there were no significant difference (Tukey’s pair wise comparisons, P>0.05) in mean lengths and weights of guppies fed with all 3 feeds during the 1st week. But concentrated feed fed guppies mean lengths and weights were significantly lower than (Tukey’s pair wise comparisons, P<0.05) the two live feeds fed guppies in the 2nd and 3rd weeks. Also on the 2nd and 3rd weeks there were no significant difference (Tukey’s pair wise comparisons, P>0.05) between Artemia and Moïna fed guppies on their mean weights and lengths. Percentages of mortality of guppies fed with all the three types of feeds were not significantly different (Chi-Square Test, P>0.05), during the study period.

The results of the feeding experiment have shown that Artemia nauplii can be replaced by Moïna during fry to fingerling stage of guppies.

**PROTECTION AGAINST DIETHYLNITROSAMINE INDUCED HEPATOCARCINOGENESIS BY AN INDIGENOUS MEDICINE COMPRSED OF NIGELLA SATIVA, HEMIDESMUS INDICUS AND SMILAX GLABRA**

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The ability of a decoction comprised of Nigella sativa seeds, Hemidesmus indicus root and Smilax glabra rhizome to prevent diethylnitrosamine (DEN) induced hepatocarcinogenesis was examined in male Wistar rats using the medium term bioassay system of Ito, based on two step model of hepatocarcinogenesis.
Carcinogenic potential was scored by comparing the number of foci, area of foci/ sq.cm and staining intensity of glutathione S-transferase P form (GST-P) positive foci and number of cells/cm² of the foci in the livers of rats treated with the decoction (test 1 and 2) or garlic (positive control, control 2) with those of the corresponding group (DEN control, control 1) of rats given DEN and distilled water. Control 3 was the negative control, which received distilled water only. There were 10 rats in each treatment and the experimental period was 10 weeks.

Decoction dose 1 (4g/kg/day) corresponded to the normal therapeutic dose administered to adult humans while dose 2 provided 6g/kg/day calculated on the basis of relative surface area. DEN was administered intraperitoneally at a dose of 200 mg/kg body weight.

Treatment with decoction dose 1 reduced the following parameters significantly: (a) the number and area of GST-P positive foci (b) number of cells/cm² of foci (c) staining intensity of GST-P positive foci (P<0.01) compared with animals in control 1. Treatment with decoction dose 2 resulted in a further significant reduction in the above parameters (P<0.001). The reduction mediated by dose 2 was similar to that produced by garlic (20 mg/kg/day). Positive control group showed a statistically significant reduction of GST-P positive foci in all 3 parameters tested (P<0.001).

The results indicate that the decoction could be administered as an adjunct in the treatment of carcinomas especially at the terminal stages of illness when the conventional treatment fails in a subject.

ECTOPIC CARTILAGEOUS AND OSSIFIC NODULES IN THE LUNGS OF BROILER CHICKEN AFFECTED WITH ASCITES AND RIGHT VENTRICULAR FAILURE

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The occurrence of ectopic cartilaginous and osseous nodules has been described in mammals and birds. An increased incidence of these nodules have been observed in an earlier study in a selected group of broiler chicken affected with Asciites secondary to Right Ventricular Failure (ARVF) reared under experimental conditions. In this study, the incidence of these nodules was observed in a population of broiler chicken affected with ARVF from a commercial broiler operation. Twenty-three broiler carcasses affected with ARVF and forty-five apparently normal carcasses from a thirty-eight days old, commercial broiler flock in the mid country region of Sri Lanka were selected. Stained histological sections of the right lung were prepared, and examined under the light microscope. The incidence of nodules was determined by counting the nodules seen in a graticular area.

There was a significant increase in the incidence of nodules in the lungs of ARVF affected birds than the control birds. The ARVF affected lungs had 91.3% nodules compared to 52.3% of the control group. The ARVF affected lungs had 7.86 nodules per section compared to 2.77 in the control group. The nodules in the ARVF affected lungs varied from osseous (58%), mineralized cartilaginous (19.3%), hyaline (18.7%) and fibrous cartilaginous (2.1%) types. The nodules in the control group consisted of hyaline (32.5%), fibrous cartilaginous, osseous (19.3%) and mineralized cartilaginous (3.1%) types. These hyaline, fibrous and mineralized cartilaginous nodules were generally circumscribed while the osseous nodules varied widely in shape and outline. The increased incidence of these nodules in ARVF affected lungs may be due to osseous metaplasia of mesenchymal cells in the parenchyma as an adaptive response to cellular hypoxia. This may be further supported by the presence of more than one nodule type in a single nodule and the active fibrosis in ARVF affected lungs.

ANALYSIS REPORT ON POULTRY DISEASES PRESENTED TO THE VETERINARY RESEARCH INSTITUTE FOR THE YEAR 2002


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The results of routine poultry postmortem examination carried out by the Veterinary Research Institute of the Department of Animal Production and Health for the year 2002 were analysed. A total of 455 cases were submitted for disease diagnosis. The diagnosis of the conditions was based on clinical history, autopsy, isolation and identification of pathogens and serology. The disease encountered expressed as a % of total cases examined were: E. coli infection 20.9%, Infectious Bursal Disease 18.3%, Salmonellosis 11.3%, Cocciidioidis 10.6%, Yolk sac infection 4.9%, Staphylococcal arthritis 5.8%, Vitamin E deficiency 4.4%, Marek's disease 2.9%, Avian encephalomyelitis 1.8%, Avian leukosis 1.6% and sudden death syndrome 1.0%.

Apart from the above diseases following diseases were reported in less than 1% of the total cases; Infectious coryza, Aspergillosis, Ascitis syndrome, Chronic
respiratory disease, Worm infestation, Infectious bronchitis, Newcastle disease, Fowl pox, Gout, and Chleken anaemia. The disease profile did not differ much from that reported for 2001. This information will be beneficial to personnel, who involve in the poultry industry to plan the vaccination, feeding and management practices.

SURVEY ON AEROBIC BACTERIA AND PARASITES OF DOMESTIC PIGEONS (COLUMBA LIVIA DOMESTICA) IN SELECTED LOCATIONS IN THE CENTRAL PROVINCE

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Domestic pigeons (Columba livia domestica) are bred and reared in Sri Lanka under isolated or crowded conditions for various purposes. Apart from few health conditions, most of the diseases affecting pigeons in Sri Lanka are not known at present. In addition, pigeons are implicated as harbouring about 40 zoonotic pathogens, which are transmitted to human through faeco-oral route. Therefore this study was carried out to determine the prevalence of aerobic bacteria and parasites occurring in the faeces of pigeons. A total of 42 faecal samples from 11 flocks of caged pigeons from three divisional secretarial areas (Matale, Akurana, Ukwela) of Central Province were collected and screened for aerobic bacteria and parasites by conventional techniques.

Of the samples examined, 10 genera of bacteria were isolated and identified. All the samples yielded non-haemolytic E. coli, Proteus, Klebsiella, Pseudomonas and Bacillus species. Twenty-three percent of samples were positive for Staphylococcus while 19%, 14% and 5% were positive for haemolytic E. coli, Yersinia and Salmonella species respectively. Prevalence of Streptococci, Staphylococci, haemolytic E. coli and Salmonella was significantly higher in Akurana area (P<0.001) compared to other areas surveyed.

All the tested flocks were positive for Eimeria oocysts and the counts varied from 8000 - 75,000 oocysts per gram of faeces. Twenty percent of birds had 1,9000 oocysts of faeces, 54% had 10,000 - 49,900 oocysts of faeces while 21.4% had > 50,000 oocysts of faeces. Most prevalent Eimeria species was Eimeria labbena (47.39%) followed by Eimeria tropicalis (38.44%) and Eimeria colombae (14.16%). Amongst the divisional secretarial areas surveyed, significantly high mean oocyst count was observed in Akurana area (P<0.005). Five percent of the sampled pigeons (n = 5) showed greenish diarrhoea with high oocyst counts (74500 oog).

Of the samples examined, a great majority (73.8%) had nematode eggs in faeces. Fifty percent of samples had egg counts between 100-499 epg. Five percent and 14.3% of the samples contained between 500-990 epg and >1000 epg, respectively. Strongyle type eggs were present in 52.4% of samples while 33% and 23.8% of the faecal samples contained Capillaria and Ascaris type eggs. Significantly high faecal egg counts was observed in Ukwela area (P<0.05).

This is the first study that documents the aerobic bacteria and parasites occurring in the faeces of domestic pigeons of Sri Lanka. The data obtained from this study could be used as a guide to improve the management practices of pigeons of the country. Further studies are needed to determine the role of these isolated organisms in the health of human, livestock and poultry.

PRELIMINARY INVESTIGATION OF TAPEWORM CYSTS (METACESTODES) OF GOATS IN COLOMBO MUNICIPALITY ABATTOIR AND EXPERIMENTAL INFECTION OF TAENIA MULTICPS IN THE DOG AND GOAT

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Goats are one of the main food animals of humans and carnivores and act as intermediate host for most tapeworm spp, particularly Taenia hydatigena, Taenia multiceps and Echinococcus granulosus of which the metacestodes are cysticercus tenuicollis, coenurus and hydatid cysts respectively. Metacestodes occur as fluid filled cysts in visceral organs, brain, muscle and body cavities of ruminants. Generally, coenuri occur in the central nervous system in sheep (coenurus cerebralis) and extraneural to the central nervous system in goats (coenurus gaigeri). The adult cestode stages occur in the definitive host, carnivores. Humans too may act as intermediate hosts for certain cestodes.

This study was designed to identify and determine the prevalence of metacestodes present in goats slaughtered at the Colombo municipal abattoir and accordingly to estimate the occurrence of adult tapeworms in dogs. The animals slaughtered at the abattoir represent animals from Northern, North Western and North-Central provinces. The survey was carried out for a period of one month where 1875 caprine carcasses were examined. From
82 (4.37%) carcasses 164 metacestodes were recovered, of which 163 were cysticercus tenuicollis and one was a coenurosis. No hydatid cysts were found.

The two types of metacestode found in the survey were used to infect four dogs experimentally, via the oral route. The tapeworm species that developed from the cysts were identified as Thystigenna and Trichiceps and was used to further confirm the metacestode type.

Trichiceps eggs contained within the gravid segments that passed in faeces of the experimentally infected dogs were used to infect a goat kid via the oral route, to further ascertain the predilection site of the coenurosis. Postmortem of this goat kid yielded 156 cysts all of which had an extra central nervous system predilection. Therefore it is possible that this strain of Trichiceps is an extra C.N.S. strain, but confirmation requires experimental infection of more animals and molecular-biological studies.

INVESTIGATION OF SUDDEN DEATHS AMONG CROWS (CORVUS SPLENDENS) IN COLOMBO MUNICIPALITY AREA

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An incident of sudden death of crows (Corvus splendens) in and around the premises of the Embassy of the United States of America and the Ministry of Defence was reported on 30th October 2002. Postmortem samples from a crow revealed that the death was due to poisoning by carbofuran.

A similar incident was reported 2 months later in and around the premises of the army hospital and the Ministry of Defence in Colombo. About 50 carcasses of crows were seen. In both places, birds were seen to have suddenly dropped from the trees and die within a short time period.

Postmortem were carried out on above birds and samples of proventriculus, gizzard, duodenum, liver, kidney and spleen were taken sealed and sent to the Government Analyst for toxicological investigation. Samples were also sent for histopathological examination.

Smears of tissue samples taken from air sacs, proventriculus, liver, kidney, spleen and duodenum were made on 6 mm well slides using cotton wool swabs. These smears were stained with Giemsa and examined under the phase contrast microscope for inclusion bodies of Chlamydia pneumoniae.

Postmortem findings observed were discoloration and enlargement of the liver and congestion of the intestines. Histopathological investigation revealed marked congestion in kidney and liver tissues. No necrosis or inflammation was observed.

All the tissue smears were negative for inclusion bodies of Chlamydia pneumoniae.

Contents of proventriculus and gizzards were analysed for heavy metals, cyanide, common poisons such as organophosphates, carbonate and paraquat and diquat. The results were negative. A conclusive diagnosis could not be reached as other samples were inadequate for further tests.

Similar to the previous incident, deaths of crows were not noticed after a few days. Therefore a tentative conclusion could be drawn that this incident to be poisoning with carbofuran.

RIGHT VENTRICULAR HYPERTROPHY AS A MEASURE OF ASCITES AND RIGHT VENTRICULAR FAILURE IN BROILER CHICKEN

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Ascites secondary to Right Ventricular Failure (ARVF) is a metabolic disorder seen in fast growing broiler chicken, characterized by Right Ventricular Hypertrophy (RVH). Right Ventricular dilatation and hypertrophy occurs as responses to increased workload caused by increased oxygen demand or hypoxia, and proceed to Right Ventricular Failure (RVF) and ascites. The ratio between right ventricular mass (RV) and total ventricular mass (TV) has been used as an objective parameter in measuring RVH, RVF and ascites. The experimental studies done to assess various aetiological factors have used wet, flabby and oedematous hearts to obtain RV and TV.

With the objective of determining the relationship and accuracy of the ratio with ARVF in natural cases under commercial condition, fifty-seven hearts from affected carcasses of a 38-day-old flock in the mid country were collected. Fifty-two hearts from apparently normal carcasses collected randomly from the same batch served as the control group. The hearts were suspended and fixed in formalin to achieve ideal hardening and preservation of morphology. The right ventricle was carefully dissected out from the left ventricle and septum, and RV and TV were obtained. The RV: TV ratio < 0.250, 0.250 – 0.299 and > 0.299 were classified as normal, mild to moderate, and severe RVF respectively. In the ARVF affected hearts 100% had RVF. The control group had
13.46% normal RV: TV ratio while 86.52% had RVH. The striking discrepancy in RV:TV of the control group may indicate that they are in the process of developing ARVF. Although the RV: TV ratio can be used as an objective measure of RVH, RVF and ascites, comparison with apparently normal hearts may not be accurate as they also showed evidence of RVH.

A SURVEY ON HELMINTHES INHABITING THE STRAY DOG POPULATION ROAMING THE COLOMBO MUNICIPALITY

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Stray dogs harbour many helminths that are harmful to themselves, rest of the dog population as well as to the human population. Studies in this field have been conducted in different parts of the country, but the type of helminths inhabiting may vary from place to place. It was with the objective of finding the genera of helminths inhabiting stray dogs, their prevalence and intensity and the association with host factors such as age, sex and coat colour, this study was conducted in the Colombo Municipality area. The spectrum of species may be narrower due to its urbanized nature.

Out of the 510 dogs that were destroyed at the Colombo Municipality dog pound during 14th October 2000 and 10th January 2001, examination of a random sample of 61 dogs revealed that 54 dogs (89%) were infected with one or more helminth species while 7 dogs (11%) were free of helminth infections. Five genera of helminths, namely Ankylostoma (70.49%), Dipylidium (16.39%), Dirofilaria (18.03%), Spirocerca (18.03%) and Toxocara (31.14%) were identified.

Significant relationships were observed between prevalence of all five genera and age of the host. Prevalence of Toxocara (p<0.001) and Dipylidium (p<0.05) showed a positive relationship with host age while Ankylostoma (p<0.05), Dirofilaria and Spirocerca showed a negative relationship.

When the most susceptible age group for each helminth genus was considered, prevalence was higher in helminths with direct life cycles (>75%) than that of helminths with indirect life cycles (<33.33%), indicating a limited availability of intermediate hosts within the Colombo municipality.

A significant relationship was also observed between the prevalence of Dirofilaria and the white coat colour of the host (p<0.001).

‘VETERINARY PRACTICE MANAGER’ (VPM) FOR SMALL ANIMAL CLINIC

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Ten years back small animal clinics were equipped with 1 or 2 tables with veterinary surgical instruments. There were only 20-30 clients per week attending the clinic. At present, as more and more people want to rear healthy dogs and cats, clients seek professional methods in veterinary practice. This situation has forced veterinarians to have an integrated set-up which include a clinic, dispensary, surgery and well managed record keeping system. In any reputed small animal clinic, there are a large number of records, which are maintained manually, a very time consuming task prone to many errors.

With the revolution of Information Technology (IT) in the world including developing countries, medical and related areas are invaded by IT. This approach enhanced record keeping methods, which provide efficient output/result to the end user.

VPM is a software program which was analysed, designed and developed by veterinarians to fulfill the current demand in the field. This software integrates clinic activities, dispensary and accounting procedures which are necessary to the small animal clinic.

VPM is equipped with many advance features, is user friendly and password protected access for both system and database. VPM contains following modules: animal history, clinical findings and differential diagnosis entries, treatments, follow-up procedures, drug storage management, income-expense entries, managerial reports, loss-profit statement and email facilities.

VPM is not a diagnostic software. VPM is developed according to local demands and is a virtual manager for veterinarians, which makes record keeping easy and indicates the status of the clinic at any given time. This is another valuable product of veterinary informatics, a rapid developing field in Sri Lanka in the agricultural sector at present.

ESTABLISHMENT OF MAJOR CAPSID PROTEIN GENE BASED PCR ASSAY FOR THE DETECTION OF PORCINE CYTOMEGALOVIRUS

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Porcine cytomegalovirus (FCMV) is the causative agent of inclusion body rhinitis in pigs and considered as
an economically important disease in swine throughout the world. The virus causes abortion, respiratory disease and neonatal death and establishes the latent infection. Traditionally, the presence of PCMV in suspected clinical materials is identified by direct immuno-fluorescence test, ELISA or demonstration of viral growth in cell cultures. The successful growth of PCMV in cell cultures takes about 7-10 days and depends on the quality of the sample and the time taken for it to reach the diagnostic laboratory. In contrast, the use of polymerase chain reaction (PCR) offers fast and much sensitive results.

A PCR procedure was developed to detect PCMV DNA, based on a primer of major capsid protein gene of the virus genome. The DNA prepared from 50 blood samples from Osaka city slaughter house in Japan yielded PCR amplicon in 40 samples. One out of 5 spleens and all lung samples were found to yield PCR amplicon. The same primer pair amplified the relevant PCR product of 357 bp with the lowest amount (25ng) of PCMV OF-1 isolate template DNA and with other 7 PCMV isolates from Japan and UK. There was no amplification with DNA of pseudo rabies virus and mock-infected pigs fallopian tube fibroblast cells. Thus PCR assay would be useful for rapid screening of PCMV DNA in blood samples even in countries like Sri Lanka where the disease has not been reported.

ASTUDY ON BEHAVIOURAL PROBLEMS AND PSYCHOLOGICAL DISORDERS IN PET DOGS IN COLOMBO DISTRICT

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Behavioral problems and psychological conditions are thought to occur frequently in domestic dogs. It is a very important aspect of Veterinary Medicine, which is well-studied in other countries. The prevalence of behavioral problems or psychological disorders in dogs have not been studied in Sri Lanka.

The objective of the study was to acquire data on behavioral problems and psychological disorders in dogs in Colombo district and to assess the attitude of the veterinarians and dog owners regarding this subject area. Out of the private clinics located in this district, 20 private practitioners were questioned by personal interview and using a structured Questionnaire.

All the veterinarians interviewed are consulted by the owners regarding behavioral and psychological disorders. Veterinarians believed that dog behavior and psychology are important in having a good relationship between the dog and the owner. Only 60% of the interviewees had treated cases related to the study. Only 30% have given priority to investigate the condition.

Aggression, uncontrollable barking, abnormal ingestive behavior, behavioral problems associated with canine elimination, hyper sexuality and abnormal maternal behavior were among the behavioral problems. Separation anxiety, noise phobia and obsessive compulsive disorder were reported as psychological conditions. It was also revealed that the most common age that people adopt puppies is between 3-4 weeks which is too young an age to separate them from the bitch.

The study revealed that behavioral problems and psychological disorders are seen in the dog population in Colombo district. Even though Veterinarians are aware of the behavioral problems and psychological disorders their interest and application of the knowledge in therapy is inadequate. The results suggest that there is a need to improve the attitude and knowledge of the veterinarians on behavioral problems and psychological disorders of domesticated dogs in Sri Lanka.

SOME REPRODUCTIVE CHANGES OBSERVED IN THE GRAVID GENITAL SYSTEMS OF THE GOAT

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Reproductive systems of 75 pregnant goats in both single and twin pregnancies obtained from the Kandy municipal abattoir were examined for various reproductive parameters.

The crown rump length (CRL) at which the sex could be determined by the naked eye, the number of maternal caruncles, number of cotyledons found in the allanto chorion, volume of amniotic and allantoic fluids, ovarian dimensions, position of the corpora lutea, extent of transuterine migration of the foetus and its growth pattern were studied.

The sex of the foetus could be determined by the naked eye only in foetuses with a CRL of over 3 cm based on the scrotal prominences in the inguinal region and the penis on the ventral abdominal surface in the male, and the two labial swellings and two small teats in the female.

Of the 75 pregnant uteri, 50 had singletons and 25 had twins. Among the 50 singletons, the sex of the foetus was identified by the naked eye only in 44 foetuses which had a CRL of over 3 cms.

The number of maternal caruncles present in the uteri of single pregnancies varied from 70-164 with a mean of 111.7 ± 21.2 (n=44), whereas the number of corresponding cotyledons in the allanto chorions ranged from 56 to 153 with a mean of 103.4 ± 21.5 (n=44). In 25 twin pregnancies,
the number of caruncles ranged from 82 to 148, with a mean of 128 ± 17.4 and the number of cotyledons ranged from 73 to 136 with a mean of 119 ± 17.9.

The foetal fluid dynamics indicated that the allantoic fluid remained higher during the early stages of pregnancy up to a CRL of 5.9 cm compared with that of the amniotic fluid volume. However, when the foetal CRL exceeded 6.0 cm, the amniotic fluid volume continued to rise above that of the allantoic fluid and reached a peak at 24 to 26.9 CRL cm and then declined. It has been reported that the 100 to 110 day-old sheep foetus swallow about 120 ml of amniotic fluid per day. Hence, it is probable that this reduction may be due to the foetal deglutition of amniotic fluid and or due to the foetal urine being increasingly passed to the allantoic sac via the urachus, instead of to the amniotic compartment.

The foetal growth curve indicated that rapid foetal growth occurred after the foetus reached a CRL of 25.0 cm, and the growth rate was more or less found to be linear to the CRL.

The mean size of the length, width and thickness of the right and left ovaries in singletons were 1.6 ± 0.36, 1.2 ± 0.29, 0.9 ± 0.22 and 1.5 ± 0.36, 1.1 ± 0.30, 0.8 ± 0.22, cm respectively, indicating that the right ovaries are comparatively larger than the left. Also 54% (27) of the corpora lutea were found in the right ovaries compared to 46% (23) in the left ovary. In 72% (36) of the singletons, the foetus was found in the right horn while only 27% (14) in the left horn indicating a significant transuterine migration of the caprine foetus to the right horn and with a preference to grow in that horn. Thus, the right half of the genital system appears to be more active than the left in the goat.

CYTOLOGICAL CHANGES OBSERVED IN THE AMNIOTIC AND ALLANTOIC FLUIDS OF GOATS WITH ADVANCING GESTATION

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Like in many other mammals, the goat foetus is surrounded by amniotic and allantoic fluids. The foetus virtually lives in the amniotic fluid up to term and cells exfoliating from the foetus, amnion and the umbilical cord remain in this fluid until either they are degenerated or swallowed by the foetus along with some amniotic fluid. The cells found in the allantoic fluid are those exfoliating from the lining of the choioallantoic and some cells coming from the foetal urinary system and the urachus. A study was undertaken to determine the cytological changes occurring in these fluid compartments with advancing gestation using goats gravid genital tracts collected from the Kandy municipal abattoir.

Ten ml samples of fresh amniotic and allantoic fluids were collected from 75 gravid genital tracts. The samples were immediately spun at 3000 rpm for 10 minutes and each cell deposit was smeared onto two clean glass slides previously coated with glycerin-albumin. The smears were fixed with a mixture of 1:1, 95% ethyl alcohol and ether, for 10–15 minutes and subsequently stained by the Papanicolaou’s technique. A total of 200 – 500 cells were counted from each slide under a light microscope. These cells were categorized into various groups based on the morphological and tinctorial properties. In slides made from young conceptuses where the cell numbers were less than 200, the total number of available cells were counted. The crown rump length (CRL) was also measured to estimate the age of the foetus.

Based on the tinctorial properties, three types of cells, namely, cyanophilic, eosinophilic and orangeophilic cells were observed. In addition, based on cell size they were further classified into large and small cells, and nucleated or anucleated cells.

The cell numbers in both fluids were minimal in very young conceptuses of less than 3 cm and with advancing gestation they were found to increase both in numbers and in the attainment of different tinctorial properties. Of the different cell types found in the amniotic fluid, the cyanophilic cells were found to be the most abundant in young conceptuses reaching a maximum of 59 % upto a CRL of 15 cm before they tend to gradually decline. This reduction was followed by a concomitant rise in the eosinophilic cells ranging from 60.7 – 68.5 %, after the foetus reached a CRL of 15.0 cm probably indicating the development of foetal maturity. The percentage of orangeophilic cells was the lowest varying from 4.5 – 22.9 %.

Among the nucleated and anucleated cyanophilic cells, the former was much more abundant than the latter indicating that new cells are being continuously added. Among the large and small cell types, the small nucleated cyanophilic and eosinophilic cells were much higher in number than the respective large cell types. The cell composition of the amniotic fluid was found to show dynamical changes with advancing gestation indicating that exfoliation of cells into the foetal fluids and their demise is a continuous process.

In the allantoic fluid, over 79 % of the cells were of the cyanophilic type, right through-out the period of study, probably originating from the allantoic membrane. The maturity of the foetus is indicated by the appearance of increasing amount of eosinophilic cells. As it was difficult to obtain gravid tracts closer to term, the study was confined to conceptuses upto a CRL of about 30.0 cm.
ASSESSING THE USE OF SEMEN FOR THE ARTIFICIAL INSEMINATION IN DAIRY CATTLE IN A DRYZONE VETERINARY RANGE IN SRILANKA

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In Sri Lanka, the basic tool for upgrading dairy cattle is artificial insemination (AI). However, the AI coverage and the performances are very poor due to various reasons. Compared to the other agro-ecological zones of Sri Lanka, in the dry zone the number of AI and the performance of AI are very low. Therefore, the improvement of milk production is very marginal.

This study was conducted to assess the use of semen for AI in a dry zone veterinary range. Five hundred and seventy four AI receipts were analysed with respect to the breed of the dam and the breed of semen used for insemination.

According to the records six breeds of cow were identified (Jersey, 25.8%; Friesian, 10.8%; Crossbred, 18.3%; Sahiwal, 35.9%; Local, 8.4%; Ayshire, 0.9%). This distribution is uncommon to the dry zone where the native breeds are considered to be high. Also the level of European or Indian blood was not shown for crossbred dams.

There was a high demand for the semen of Australian-Friesian-Sahiwal (AFS) and Australian milking zebu (AMZ) (50.2%) and Jersey (34.7%) while the demand for the semen of Indian breeds was low (9.6%). The choice of semen for each breed varied. Jersey and Friesian semen were predominantly used for Sahiwal dams and AMZ, AFS semen was used for Jersey dams. These results indicate that the maintenance of the European blood level for the dry zone under semi-intensive rearing system has not been taken into consideration.

The expected blood level of the F1 calves in those AI receipts was also studied and they were 100% European (12.9%), 75% European (28.1%), 50% European x 50% Indian (31.5%), 75% Indian (24.2%) and 100% Indian (3.3%).

The study also shows that AI is mostly done for the exotic and crossbred animals and less for local breed. The use of semen for AI is not according to the national breeding policy. Predetermination of the breed of the dam prior to an AI was not properly done. The study depicts that the quality of AI is very important rather than the number of AI for the evaluation of AI performance. Therefore, planned breeding program for individual veterinary range throughout the country is necessary. Further a similar assessment for each range is recommended.

AN OPEN NUCLEUS BREEDING PROGRAM FOR DAIRY CATTLE IMPROVEMENT IN SRI LANKA

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In the subsistence (small holder) production system indigenous breeds of cattle can be managed on a rather poor diet but will be low in production potential. This system has been changed with the introduction of high producing exotic blood by unplanned crossbreeding whereby the feed has become a major problem. Furthermore high intrinsic production is physiologically antagonistic to heat tolerance, survival and fertility, resistance to diseases like mastitis and tolerance to parasites. Therefore improvement of the inherent genetic capacity of any population beyond the limits of the nutritional or disease limited environment in which the population lives can be of no advantage and often counter productive. Hence the breeding policy should be based on field data that could give us some insight on the crossbred population in Sri Lanka.

The crossbred cattle population according to 1981 census was 3%. This has increased to 40% by 1999. As such it could be safely assumed that the percent of exotic blood levels at present to be between \[ \frac{3}{10} \] and \[ \frac{4}{10} \]. A review of Bos taurus and Bos indicus has shown that mean performance improves linearly for all traits up to 50% Bos taurus inheritance (F.). As the proportion of Bos taurus genes increase further, an increased calving interval is observed, while no clear trend is seen in other traits.

Crossbreeding is widely used in dairy cattle production in the tropics as a means of exploiting heterosis. This can be explained by the higher production in the F1 of Bos taurus and Bos indicus crosses. But in the F2 and subsequent generations the heterotic effect diminishes. If there is no heterosis for important traits then there is no advantage in crossbreeding. Therefore it will be appropriate to set up a composite breed development program from superior individuals from the crossbred population already available in the country. This will be the foundation stock from which selection could be started. This system could operate around a local central dairy cattle herd, perhaps under government control but preferably controlled by local farmers. The support base population consists of the village herds, which provide selected cows to replace as many as 50% of the cows in the local central dairy herd annually. Selection from village herds will be by simple procedure mostly on assessed milking ability and fertility, with some attention to size, conformation and body condition. Where feasible, test milking may also be done. An animal breeder should carry out this selection of replacement. Bulls are bred from the
A CASE REPORT OF AN IMMUNE MEDIATED JOINT DISEASE IN A GROWING GREAT DANE

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A nine month old, male Great Dane was referred to the Veterinary Teaching Hospital, University of Peradeniya with a complaint of progressive lameness on the left hind limb. The history revealed shifting limb lameness with multiple joint oedema, which had lasted for about one month. It also had sudden hindquarter paresis at the age of two months, which had responded to treatment for hypocalcaemia.

Clinical examination revealed pyrexia (106°F), dusue atrophy of left thigh, swollen left shoulder joint, painful bilateral coxo-femoral, carpal and tarsal joints. Blood analyses revealed leukocytosis with neutrophilia and monocytosis, elevated ESR (54 mm/hr) and Ca:P imbalance (normocalcemia and hyperphosphatemia). Tentative diagnosis of poliarthritis was made, based on radiological findings of joint lesions (erosive lesions on distal metaphyses of radius and ulna) and calcium phosphorous imbalance. Symptomatic treatment with carprofen ("Rimadyl"), an antibiotic (clindamycin), local analgesia and an anabolic steroid did not show an improvement and the dog was readmitted a week later with the original complaints. Pain and oedema of joints persisted. The Ca:P imbalance was corrected probably due to the effect of local analgesic. Serum was positive for anti nuclear antibody (ANA) (by latex agglutination test) and negative for rheumatoid factor (RF). Low titres of RF could be detected only in 25% of rheumatoid arthritic dogs and it is not uncommon to detect ANA in rheumatoid arthritic dogs. These findings together with mild leukocytosis (with neutrophilia), elevated serum alkaline phosphatase and ESR, and proteinuria were diagnostic of immune arthritis (rheumatoid like). Accordingly, an immune suppressive dose of prednisolone (1mg/kg, b.i.d., po) together with a prophylactic dose of ampicillin (10mg/kg, t.i.d., po) and a local antacid ("Gelucil") were administered. Remission of clinical signs was noted by positive weight bearing, reduction in pain and oedema of joints two weeks later. Therefore, the dog was placed on a maintenance dose of prednisolone (0.5mg/kg, b.i.d., po for two weeks followed by 1mg/kg, po, every other day morning, for two weeks) for one month.

Radiographs taken after 45 days of immune suppression revealed a reduction in joint lesions. Clinical remission was further supported by a negative ANA, RF, normal ESR and Ca:P ratio. A further reduction of prednisolone (0.25mg/kg, s.i.d., po, every other day) was prescribed for another one-month period which was to be discontinued on complete remission of signs.

In conclusion, it is advisable to consider the treatment of immune mediated joint diseases in dogs which are non-responsive to NSAIDs with immune suppressants.

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IRRATIONAL USE OF NON STEROIDAL ANTI-INFLAMMATORY DRUGS IN DOGS

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Non-steroidal anti-inflammatory drugs (NSAIDs) are used in therapy for its central analgesic and anti-pyretic actions and the peripheral anti-inflammatory action. They are primarily carboxylic and enolic acids and act by inhibiting the enzymes known as the cyclooxygenase (COX). Thus they decrease the release of prostaglandins (PG) which is a potent inflammatory mediator. Although the NSAIDs have beneficial effects in therapy, irrational use of the same in small animals is not devoid of toxic effects. The objective of this presentation is to make small animal practitioners aware of these toxic effects because such toxicity manifestations are frequently encountered in canine patients referred to the Veterinary Teaching Hospital (VTH) from different parts of the country. NSAIDs had been used as analgesics and antipyretic in the cases presented. Of the 21 dogs presented to the VTH within a period of 4 months 13 were treated with NSAIDs for orthopaedic conditions. Three cases of Ehrlichiosis and 2 cases of Babesiosis, 2 for high fever of unknown atiology and in one case NSAIDs were given to relieve post operative pain.

The toxic manifestation were variable and mainly limited to gastrointestinal system which included poor
appetite or complete anorexia, vomiting, oral ulceration, haematemesis, melena, haematochezia, pale mucosa, depression, severe abdominal pain and shock in extreme cases. Three of these dogs were azotaemic too. The history revealed the use of one, two or sometimes three NSAIDs. In 14 cases diclofenac sodium had been used alone or in combination with other NSAIDs and corticosteroids.

Majority of the cases responded to the treatment with antiemetics such as promethazine or antacids combined with antibiotics (ampicillin and metronidazole). A few extreme cases had to be given blood transfusions. Necropsy findings of the four cases ranged from perforated ulcers (1) in stomach, severe erosive gastric and colic ulcers (4), renal fibrosis (2) and toxemia (2).

It should be emphasized that the practitioners should be aware of the toxic effect of NSAIDs in dogs and the owners should be properly instructed regarding oral medication. Haphazard use of NSAIDs may complicate the disease process and outcome of other treatment regimes and may result in fatalities.

EMERGENCE OF LARYNGOTRACHEITIS IN POULTRY AT WESTERN PROVINCE OF SRI LANKA

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Laryngotracheitis (LT) is not a confirmed poultry disease in Sri Lanka. In early January of 2003, a case was reported to Veterinary Research Institute from a commercial layer farm at Athurugiriya with signs related to LT. The Veterinarian who reported the case informed the clinical signs as coughing, dyspnea and expectoration of blood stained mucus from nostrils.

Twenty serum samples and tracheal swabs were collected from the suspected flock for initial screening tests. All the serum samples were subjected to Agar Gel Precipitation Test (AGPT) with known antigens and antibodies as positive controls. (SPAFAS, USA). Seven samples (35%) have shown positive reactions to LT.

The tracheal swabs and tracheal scrapings from the affected birds were inoculated to chorioallantoic membrane of 11 day old embryonated chicken eggs and incubated at 37°C for 7 days. Tiny viral plaques were observed in 70% of the chorio allantoic membranes (CAM’s) compared with negative controls at the second egg passage. Some changes were also observed in chick kidney (CK) cell cultures at the second passage. The reactions observed in cell cultures and CAM’s were very much similar to those of reactions caused by LT virus.

In order to confirm the diagnosis samples will be sent to the Central Veterinary Laboratory in United Kingdom.

In conclusion, the veterinarians in Sri Lanka should be alert on LT due to the positive serologic evidence presented here.

EXPERIENCE WITH AN ALTERNATIVE INTRAVENOUS ANAESTHETIC – PROPOFOL IN DOGS

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The General Anaesthetic (GA) procedures in dogs in Sri Lanka are generally performed by using intravenous administration of Thiopentone Sodium, despite the risks involved. The present study was performed to ascertain a suitable dosage rate, a convenient method of administration and to observe any complications during or after anaesthesia of another intravenous anaesthetic Propofol (2, 6 - diisopropylphenol) in both healthy and clinically compromised dogs under local conditions.

A total of 50 dogs were subjected to GA using Propofol in 3 phases (3, 32 and 15 dogs for phase 1, 2 and 3, respectively) for different surgical procedures by different Veterinary surgeons at the Colombo municipal dog pound, Pet Vet Clinic Colombo and a sterilization camp held in Dehiwala during September 2000 to April 2001. The induction was by intravenous injection of 1% undiluted Propofol at a fixed dose (3 mg/kg). The anaesthesia was maintained by the same drug diluted in 5% dextrose and infused intravenously via a normal saline drip set. Besides the routine clinical data pertaining to the anaesthetic care, the maintenance dose, duration of apnoea, recovery time and complications were recorded and statistically analyzed.

The findings of this study were that male dogs needed higher dose (0.436 ± 0.104 mg/kg) for the maintenance of GA compared to female dogs (0.284 ± 0.080 mg/kg) irrespective of the health condition (P<0.001). Induction of GA with intravenous Propofol was found to be smooth especially in clinically compromised animals. Recovery was quick and uneventful except salivation observed in one animal that was clinically compromised. The recovery time was not correlated with the total dose or duration of anaesthesia maintenance. However although statistically not significant, it was noted that two dogs induced following a long period (75, 85 minutes) of sedation required a higher maintenance dose (0.63 mg/kg/min) of anaesthetic agent. The data from this study suggests that
Propofol could be successfully and conveniently used for induction and maintenance of anaesthesia in dogs under local conditions of Sri Lanka.

Posters

GOAT TENURE PROJECT IN RURAL ECONOMIC ADVANCEMENT PROGRAMME, NIVITHIGALA EXPERIENCE

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2 Co-ordinating veterinary office, Ratnapura

The veterinary office Ratnapura started goat tenure project with the financial assistance of the Rural Economic Advancement Programme to improve the economic status of the rural people at Nivithigala Divisional Secretariat area in Ratnapura district. Initially, 46 goat farms were established and 138 female goats and 19 stud goats were distributed among these 46 farms on the basis of 3 female goats\(\ast\) farm and one stud goat for 3 neighboring farms. The value of female goats, male goats and the total value for purchasing goats were Rs. 289,150.00, Rs. 633,125.00 and Rs. 352,462.50 respectively. Stud goats were exchanged among farmers annually to avoid inbreeding. These goats were valued at Rs. 100.00/ kg live weight of local female animals and Rs. 125.00/kg live weight of crossbred male animals.

To establish goat farms initially, all the goats were given free. Agreements have been signed with the farmers to return 3 goats which are above 6 month of age within 3 years. These young goats were given free to some other farmers to establish 2\textsuperscript{nd} generation farms. These farmers also have to return 3 young goats and project will continue forever without spending further money to purchase new goats. Farmers have constructed the goat sheds using locally available materials. All the farmers have undergone comprehensive training programme in goat farming. All the goats distributed under the project were insured under the livestock insurance scheme and Rs. 375,32.10 were paid as insurance premium to insure goats given to establish the initial farms. Livestock insurance board has paid Rs. 265,65.00 as compensation for the death of animals so far. Proper record keeping method was developed among farmers and in the veterinary office to monitor various aspects of the programme. Constant farm visiting system was also developed to continue the project successfully. Altogether 80 goats, 19 males and 61 females, were received from the farms established initially to establish 2\textsuperscript{nd} generation farms. The value of these goats was Rs. 148,500.00. These animals were valued at Rs. 100.00/kg live weight. Twenty seven 2\textsuperscript{nd} generation farms were established with these goats so far. From the second generation farms a total of 47 goats, 11 males and 36 females were returned to establish 3\textsuperscript{rd} generation farms so far. The value of these goats was Rs. 95,600.00. Forty two 2\textsuperscript{nd} and 3\textsuperscript{rd} generation farms were established without spending government money as capital expenditure to purchase goats. The value of these goats amount to Rs. 244,100.00.

DAIRY FARMING IN WESTERN PROVINCE OF SRI LANKA: I CHARACTERIZATION OF DAIRY FARM HOLDINGS


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3. Dept. Animal science, Faculty of Agriculture University of Peradeniya

This study was undertaken to assess salient features of the dairy farm holdings in Western Province (WP), WP extends over 3.593 sq. K.m. (5.7% of the total land area) and carries 3.8% of total cattle and 0.8% total buffalo population. It is estimated that 3.5% of total householadays are engaged in livestock farming and out of this 45% families engage in dairy farming. Eighty two farmers were selected purposively from six veterinary ranges (Attaangalla, Mihirigama, Kelaniya, Udahamulla, Bandaragama and Negombo). These farmers were visited and data were collected on holding size, number of cattle, housing, breeds, milk yield per day, lactation length, herd composition, breeding data, feeding practices, milking methods, production and reproduction performances and marketing channels.

Average size of dairy farming family is 3.5±0.9 and 80% of the chief households have had primary education only. Average land size is 0.42±0.9ha and 8% of the farmers have grown pasture in their land. Majority of farmers involve in dairying as a secondary occupation. The average herd size is 7.0±5.3 and 7.2±3.4 for cattle and buffalo respectively per farm including milking, dry animals and calves. Over 95% of the herds carry animals with varying degree of exotic blood. Jersey is the most predominant breed and Freisian, Australian milking zebu (AMZ) and Australian-Freisian-Sahiwal (AFS) are also found among the herds in relatively small proportions. Over 80% of the farmers in rural areas practice semi-intensive management system. Animals are tethered most part of the day in neighbouring lands or released into paddy fields and communal grazing lands. In the evening animals are provided with concentrate mixture and cut grass and tree
fodder which are readily available in coconut estates, communal lands and along the road sides. Other farmers, mostly in urban and peri-urban areas practice intensive management system. Over 90% of the farmers use concentrates in their ration and 76% of them depend on formulated concentrates. By-products from mills such as broken rice, dhal, ommi and rice bran are also widely used. Average production levels of farming clusters are 14.0±3.5 liters per day per holding. Over 80% of the farmers rely on artificial insemination as the primary breeding tool where as buffalo farmers use natural breeding. Jersey, Friesian, Sahwal and AFS breeds of cattle and Murrha in the case of buffalo are the preferred semen types by the farmers to breed their cows. The average age at first calving is 37.6±37.7 months in cattle and 45.0±10.1 months in buffalos. The inter calving intervals are 16.8±4.7 m. and 17.4±7.4 m. for cattle and buffaloes respectively. Most of the farmers milk once a day and 59% of the farmers supply milk to informal market as they recover relatively high price (Rs. 20-30/- per liter).

THE IMPORTANCE OF THE CONSERVATION OF THE INDIGENOUS CATTLE OF SRI LANKA

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The total cattle and buffalo population in Sri Lanka is about 2 million. The majority of them are considered to be indigenous type. They are seen throughout the island but mostly seen scattered in the dry zone. The identification of the indigenous cattle and buffaloes is difficult due to improper breeding practices and importation of many breeds from time to time. Their number is gradually decreasing and attention towards them is very poor. The reduction in population of indigenous cattle in the island needs to be thoroughly investigated to initiate conservation programs.

A village level field survey was conducted to find out the factors and constraints associated with the reduction of indigenous cattle. For the study, 3 dry zone villages were selected and 3 different categories of farmers were identified. Using a structures questionnaire, information was collected and the data were analysed using computer software. The 3 categories of farmers identified were, farmers who completely gave up rearing cattle, farmers who have been keeping animals for years and farmers who have started to rear cattle very recently.

Farmers have given up rearing indigenous cattle due to many reasons such as animal theft, trespassing, dislike of the youths to look after indigenous animals under traditional way, lack of pasture land, incapability to look after animals when the owner becomes very old, lack of interest by the young generation, labour shortage, poor income, time wasting event, changes in cultural and social habits, lack of support from the government and authorities, disturbing the primary income, higher mortality rate, conflict between crop farmers and livestock farmers, warning by neighbours and other non related institute and low economic value due to inbreeding.

Based on these results appropriate suggestions could be made. All farmers who keep indigenous animals in the island should be identified and registered and records maintained. Slaughtering and castration of bull calves should be stopped. Separate farm units should be created by relevant authorities. The complete responsibility of conserving the animals should be shared by both smallholders and government institutes. Care should be taken to avoid theft and illegal killing of animals. Appropriate extension service should be carried out in order to change the belief that the indigenous animals are unproductive. In addition the valuable genetic material should be conserved in the form of live animal and cryogenic storage of sperm, oocytes, embryos, cells and chromosomes by means of gene bank.

SOME BACTERIAL PATHOGENS ASSOCIATED WITH FRESH WATER ORNAMENTAL FISH IN SRI LANKA

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Ornamental fish farming is a rapidly growing foreign exchange earner for the country. One of major constrain to the progress of the industry is diseases caused mainly by parasites and bacteria.

A total number of 2649 Guppies and 728 Goldfish cultured in 4 ornamental fish farms were tested monthly starting from August 2001 to July 2002 for a period of 12 months. Fish with clinical signs of bacterial infection such as mouth lesions, tail erosions, red patches, body lesions, high mortality etc. were selected. Heart blood or swabs from lesions of those selected fish were cultured in blood agar and TCBS (Thiosulphate Citrate Bile Salt) agar and incubated at 28°C for 24 hours.

Culturing for bacterial isolation was carried out on 249 Guppies and 114 samples. From those samples 145 Guppies and 114 Goldfish showed positive bacterial growth. Prevalence of bacterial infection during the 12 months period starting from August 2001 for Guppies and Goldfish were 5.3%, 4.2%, 5.1%, 6.2%, 8.0%, 5.6%, 5.2%, 6.1%, 5.1%, 3.9%, 5.2%, 5.4% and 14.2%, 13.5%, 18.9%, 22.2%, 24.5%, 18.0%, 18.3%, 15.6%, 14.6%, 9.6%, 10.2%, 11.2% respectively. Six bacterial infections were identified from the isolates namely Flexibacter columnaris, Aeromonas hydrophila, Pseudomonas sp., Vibrio anguillarum, Mycobacterium sp., and Streptococcus sp. with
prevalence rate of 46.8%, 31.0%, 17.9%, 2.7%, 0.68%, 0.68% in Guppies and 36.8%, 23.6%, 16.6%, 17.5%, 2.6%, 2.6% in Goldfish respectively.

Through out the year bacterial infections were more or less uniform and slightly high in December in both species while *Flexibacter columnaris* is the most common pathogen in fresh water ornamental fish.

A COMPARISON OF THE CATTLE INDUSTRY BETWEEN SRI LANKA AND JAPAN

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The cattle industry in Japan consists of 2 clearly defined sectors namely dairy and beef. Therefore different species are reared according to the purpose but in Sri Lanka the sectors are not clearly defined. The total dairy cattle population in Japan is about 1.7 million and the total beef population is about 670019. Among the dairy breed Holstein is the most popular (> 99%). The majority of the beef population consists of Japanese black (> 93%).

The total cattle and buffalo population in Sri Lanka is about 2 million and the majority of them are indigenous type reared under free grazing system, especially in the dry zone. They are not dairy type. Although there are 1.7 million dairy cattle in Japan, the annual milk collection is 8514 thousand tons with a lactation yield of about 8000-12000 kg/head. In Sri Lanka the annual collection is 63724 tons with an average lactation yield of 1000-1500 kg/head. Compared to Japan, Sri Lanka has a long history regarding the dairy sector. But this low production has remained for years though several attempts were made to increase the production level and the expected improvement has not been reached so far. This may be associated with many interrelated factors like lack of proper national plan, unsuitable recommendation, poor nutrition and poor management, use of traditional low technology etc. However in Japan the milk production progressively increased from 6504457 tons in 1980 to 864555 tons in 1997. This improvement could be associated with the use of high technology, appropriate breeding programme and other factors.

The main breeding method is Artificial Insemination (AI) and it is practiced by more than 90% farmers throughout the country. In addition the use of embryo transfer technique (ET) as a breeding tool is practiced by approximately 10% of the farmers. More importantly, the conception rate due to AI is over 90% whereas due to ET is about 50-60%. This is completely different from Sri Lanka where the major breeding method is not AI or ET. The AI coverage of Sri Lanka is less than 10% and use of ET is nil. Also the conception rate due to AI is below 30%.

The self-sufficiency rate in Japan is about 70% but in Sri Lanka it is about 20%. Milk consumption in Sri Lanka mainly depends on the import of milk or milk products and causes severe burden to the economy.

In Sri Lanka the number of cattle farmers, their herd size and milk production is on the decline. In Japan although the number of farmers or farm holds had reduced the herd size and the production has steeply increased. The typical rural farmer in Japan keeps 100-1000 heads and maintains them only with family labour. The farm is highly equipped and maintained with high technology. Majority of them do it as their primary occupation and most of them are agricultural graduates and are over 60 years of age. But in Sri Lanka the majority of cattle farmers are not well educated. Farms with more than 100 heads hire outside labour. Sri Lankan farmers do not practice high technology and their primary occupation is not dairy farming. Similar to Japan most of our dairy farmers are near or above 50 years of age.

PULLORUM DISEASE (PD) AND FOWL TYPHOID (FT) CONTROL PROGRAMME IN POULTRY BREEDER FARMS OF SRI LANKA


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According to the past records of the Poultry Service Unit, VRU, Salmonellosis in poultry has emerged in 1998 after a lapse of several years. Thereafter the incidence has been on the increase during the period 1999-2002, both in commercial and breeder farms.

In 2001 July, a program to control PD/FT in poultry breeder farms was launched by a committee appointed by Director General, Department of Animal Production and Health, in order to produce Salmonella free chicks in the country. Technical assistance for the project was provided by VRU, in addition to production of stained *S. pullorum* antigen for whole blood agglutination test.

During the period April 2002-December 2002, a team from VRU visited 12 poultry breeder farms either to detect the carrier birds or for verification of the status of the salmonellosis in farms. Five farms were visited for verification whereas the others were to detect the carriers. A total of 34,653 testing were done within the period. Out of the 12 farms tested 5, 3, 2 and 2 farms were from Central, North Western, Western and North East provinces respectively. In 3 farms where subsequent testing were performed it was observed that the number of carrier birds were to the level of 1% less. Further one breeder farm has fulfilled the requirements to apply for certificate of PD/FT controlled status which is to be issued by the Department.
of animal production and Health. The results of this control program are promising and have shown the possibility of controlling salmonellosis in poultry breeder farms in the country.

**CHARACTERIZATION OF PASTEURELLA MULTOCIDA ISOLATES FROM CATTLE AND POULTRY BY SDS PAGE**

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In Sri Lanka the most important infections caused by Pasteurella multocida are Haemorrhagic Septicaemia (HS) in cattle and buffalo and fowl cholera in chicken. Serotype B:2 is responsible for HS in Asian countries while the main serotypes involved in fowl cholera have been A:1, A:3 followed by A:4. Although the most common method used to differentiate P. multocida strains is serotyping, information on other methods of characterization of Sri Lankan isolates are scarce.

The relationship between different serotypes of P. multocida and their protein profiles were determined by examining 46 P. multocida strains representing serotypes B:2, A:1 and A:3. Thirty-four isolates were selected from the culture collection at Bacteriology Division, VRI, while the rest were obtained from Indian Veterinary Research Institute, India.

The protein profiles of the isolates were determined by SDS PAGE. Western blotting was performed on selected 14 strains using anti sera prepared against P. multocida serotypes B:2, A:1 and A:3, to investigate any specific immunological reactions.

In SDS PAGE it was observed that the protein bands of 105, 95, 83, 53, 46 and 38 KDa were common to all P. multocida isolates examined. Proteins with approximate molecular weights of 28.9 and 40 KDa were expressed particularly by Sri Lankan strains of serotype A:1 and A:4 while isolates of serotype A:3 expressed a protein band at 28.8 KDa specifically. In western blotting several proteins from the examined 14 P. multocida strains showed reactions commonly with all 3 types of sera. Six particular proteins from Indian B:2 isolates reacted with B:2 antiserum whereas those proteins were not observed in Western blottings of local isolates. Certain other proteins of the examined strains were recognised by both A:1 and A:3 sera. The specific proteins expressed by different serotypes of P. multocida in SDS PAGE and western blotting may be useful in producing vaccines and should be studied further.

**EVALUATION OF THE PERFORMANCE OF ARTIFICIAL INSEMINATION IN SWINE NUCLEUS HERD AT HORREKELLY NLDB FARM**


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2. National Livestock Development Board

Artificial insemination was introduced at the NLDM farm to upgrade swine nucleus herd of Landrace and Large White utilizing deep frozen semen imported from USA during the year 2001. This study was mainly done to analyse the performance and feasibility of using frozen semen in upgrading of swine in Sri Lanka.

The program started in August 2001. Initially insemination was done on problem breeders at the farm on a pilot basis. Later this was introduced to other sows and gilts in the farm according to the breeding program. In 2001 (January to December) a total of 16 sows were inseminated, out of which only 3 conceived with one insemination (18.75%). In 2002 a total of 19 sows conceived with one insemination out of a total of 45 animals inseminated (40%). The overall conception rate was 34%. Monthly analysis of performance showed a wide variation in the conception rate (0-100%). The lowest conception rate was seen in the very first month of AI program and then the conception rate gradually increased with a sudden drop in August 2002. The highest rate was reported in October and November 2002, where all 4 sows inseminated conceived with one insemination (100%). The variation in conception rate could be due to factors affecting AI such as personnel skills, heat detection, time of insemination, animal factor, environment and management. Therefore it appears feasible to use AI as a herd improvement tool in Sri Lanka efficiently.

**SOME OBSERVATIONS ON A GRAVID OLEVACEOUS KEEL-BACK (ATREIUM SCHISTOSUM)**

U.L.D. Jayantha

47, Saman Mawatha, Ganga

An adult female, Olevaceous Keel-back (Atreium schistosum), (Diyabaria in Sinhala), killed in a road accident was collected from Kalametiya (N 06°05'53.8" and E 080°49'51.7") in Hambantota District on 5th March 2003 at 21.35 hrs. This aquatic colubrid had a stout, cylindrical body and was 650 mm long from head to tail. Anterior 35% of the snout-vent length (SVL-505 mm) had been crushed
following the accident, but the rest of the gravid body was well intact.

The snake was dissected to study the anatomy. The egg strand (16 eggs) started from the level of 25% of the SVL; skeletal muscles and viscera of the anterior body (up to 177 mm) had been distorted together with first four eggs. Rest of the eggs was clearly enclosed in the transparent, membranous uterus, which extended up to the cloaca. Gravid uterus occupied a majority of coelomic space pushing other visceral organs to a side. Scanty coelomic fat bodies were observed among the organs. Eggs were removed without much difficulty from the uterus and found to be remarkably sticky. Egg surface was chalky white, moist and glistening; the shell was membranous. Compared to the typical elliptical snake eggs, the eggs of *A. schistosum* had a mean length of 18.30 mm and a mean diameter of 14.66 mm, (n=12), and appeared much closer to an ovo-cubical shape. One punctured egg oozed out milky, viscous material. A few eggs clumped after placing on soil.

ERRATUM


Letter to the Editor: Fur mite infestation in guinea pig (*Cavia procellus*)

Second column, line 4 & 5: to read as- Same treatment was repeated seven days after the first treatment.