6. Action Plan (Activities)

6.1. CRP Phase I – Training on rumen molecular probes and characterization of rumen ecology

This phase will be for 30 months and include a training workshop in anaerobic microbiology, and molecular ecology methods for the rumen, followed by investigations of rumen ecology in terms of quantifying populations of methanogens, fibre degrading bacteria, protozoa, and fungi protozoa as a function of various diets representing those used by farmers (roughage based diets followed by increase in nitrogen supply in the form of protein and/or non-protein nitrogen) and industry (a complete diet; concentrate-based diet) in the region. These investigations aim at studying interaction between different groups of microbes and shift in the microbial population with change in diet. The goal would be to maximise the efficiency of microbial protein synthesis, lower emission of methane, and characterize the microbial population representing these changes. These studies will be conducted in vitro and then in vivo with one or two of the promising dietary options resulted from the in vitro studies. In vitro techniques are widely used for characterizing feed resources and have provided scientists useful information before undertaking expensive, resource-demanding and time-consuming in vivo studies, however mechanisms underlying their use with respect to changes in microbial population as a function of diet are little known. Another aim of the in vitro studies planned in this project would be to obtain a better insight into the changes induced by various diets and their relationships with widely used in vitro parameters used for evaluating feed resources in vitro. The use of rumen molecular techniques in conjunction with conventional approaches such as measurement of methane by GC, apparent and true dry matter digestibility, and efficiency of microbial protein synthesis using purine as a marker or $^{15}$N incorporation in in vitro and urinary purine derivative methodology in in vivo studies will be undertaken. This will result in innovative approaches to reduce methane emission and increase microbial protein and energy supply to animals from fibrous feed resources using dietary manipulation approaches.

6.2. CRP Phase II – Interventions to reduce methane emission and understanding relationship between methane emission and methanogen number

Any attempt to reduce methane emissions from livestock is unlikely to be adopted unless production efficiency is at least maintained if not enhanced. The challenge therefore is to devise strategies, which reduce methane emissions from ruminants and improve production efficiency. Approaches such as development of inhibitors for methanogens (e.g. synthetic or plant secondary metabolites), dietary approaches (e.g. use of polyunsaturated fatty acids or ingredients containing these acids), vaccination against methanogens, supplementation strategies, etc. have the potential to achieve this objective. The use of rumen molecular techniques and the measurement of methane by GC in in vitro and by sulphur hexafluoride (SF6) tracer or simple respiratory chamber (gas mask or head box) technique in in vivo, apparent and true dry matter digestibility, and efficiency of microbial protein synthesis using purine as a marker or $^{15}$N incorporation in in vitro and urinary purine derivative methodology in in vivo will be undertaken. Methanogens, fibre degrading bacteria and fungi and protozoa as a group will be monitored through Real Time PCR and probing approaches. A strategy based on in vitro examination of various potential approaches for reduction of methanogenesis, followed by in depth in vivo evaluation of the promising approaches will be followed. Another interesting aspect is the establishment of correlation between methane production, methanogen numbers and expression of key enzymes in methanogenesis using molecular techniques to quantify rumen methanogens and enzyme expression. This information could lead to the development of a simple tool based on the methanogen number or enzyme expression, for investigations on strategies being developed and tested for methane reduction, without the need to measure methane emission, which is complex, time consuming and requires substantial resources.

After completion of the project, the description of the approaches, methodologies and guidelines for methane measurement, methane reduction and enhancement of animal productivity, demonstrating clear economic and environmental benefits will be made available to national authorities, farmer organizations and industry for use in implementing these tools on a larger scale.

The second phase will be for a duration of 3 years.