HELMINTH CONTROL USING LOCAL RESOURCES IN SMALLHOLDER PRODUCTION SYSTEMS OF ASIA

G.D. GRAY[1], M.R. KNOX[2] and C. CARGILL[3]

[1]*POB 290, Kingscote, SA 5223, Australia.*
[2]*CSIRO Livestock Industries, Armidale, NSW 2350, Australia.*
[3]*SARDI, Roseworthy Campus, University of Adelaide, Roseworthy SA 5371, Australia.*
Email: dougiegray@bigpond.com

Abstract. Practical helminth control in smallholder systems needs to match technical options with local knowledge, locally available animal and feed resources and the needs of both producers and consumers. Despite extensive research over many decades the uptake of new technology in these systems has been slow and limited to few farmers with access to good technical support. Investment by small holders is constrained by lack of regular market signals for livestock and livestock products. Examples of effective helminth control in cattle, buffalo, sheep, goat and pig systems show that effective control is possible using local resources and knowledge. Livestock systems in Asia are changing rapidly through industrialisation of production and consolidation of supply chains and retail markets, but smallholder systems, which are resilient and multipurpose, will remain important in rural areas and in peri-urban environments. They also provide a significant pathway for the poor to build assets and generate income. Helminth control in these systems will always vary greatly between farmers and systems and will need to be relatively simple and tailored to locally available resources. The public sector will continue to provide advice on appropriate genetics, to regulate drug importation, use and quality, and ensure novel helminth control options are investigated for local application and promotion to livestock producers. The private sector has the complementary role to develop clear market signals for livestock and livestock products, and make anthelmintics available in appropriate packages. Improved helminth control has the potential to increase the profitability and sustainability of all components of the livestock sector.

INTRODUCTION

Helminth parasites constrain livestock production throughout Asia through lost production, increased mortality and reduced reproductive efficiency. Accurate economic figures, especially from the smallholder systems that predominate in the region, are difficulty to obtain when production is rarely expressed simply as 'offtake' with monetary value as in most temperate and more commercially oriented systems. Examples in the literature of the costs of helminths include US$3b per year for liver fluke infections ruminants globally (FAO 1994) and US$13m per year for nematodes in small ruminants in Indonesia alone (McLeod, 2004). More speculative estimates suggest losses due to clinical and subclinical helminth infections probably equal the present output of ruminant industries in some areas (Knox & Steel, 1996).

The potential for research outputs to be applied in control programs to reduce these figures is high, but the constraints on their application are equally high: for example the cost, access and quality of anthelmintics, and limited knowledge to apply chemicals, improved management and breeding options.

Underlying these practical constraints is the nature of the relationship between many tropical livestock keepers and their livestock. Traditionally, livestock have been a secondary activity for smallholder producers whose primary occupation has been the production of rice, cereal grains, vegetables or fruit. While this may be changing rapidly in some countries, the incentives for many producers to invest cash in strategic control programs is still very low and helminth control is only undertaken when clinical disease is observed. Most production systems are not exposed to clear market signals, so a conventional benefit-cost approach to understanding the potential for better helminth control has not been productive. It is most likely for this reason that the extensive research that has been conducted on, for example, *Toxocara vitulorum*, *Fasciola gigantica*, and other gastrointestinal helminths, has apparently had low adoption and little impact beyond the areas where research activities have been undertaken.

The purpose of this paper is to draw attention to some examples of effective control of helminths in smallholder production systems in tropical Asia. Using these examples some general principles are suggested on how to develop effective control programs using local resources that include local materials, local knowledge and local technical support, and with minimal inputs and interventions from outside the production system. These examples illustrate the relatively narrow range of options available for practical application from the wide rage of possibilities available in the scientific literature.

Case Study 1. Nematode control in goats through farmer participation in research

The conventional research and development pathway is for technical approaches to be designed by researchers and extension agencies for dissemnination and application by farmers who receive training and other technical support. Inclusion of the farmer in more than just the application of the technology, but also in the development of ideas and technical options and their evaluation, involves a different approach to the research and development process. 'Participatory' is often applied to this process that involves farmers and other stakeholders who influence farmers and are affected by their successes and failures. Their involvement is not just as recipients of technology but as active contributors to research and development. One such approach has been described in detail in the Philippines (Alo, 2004). In the Philippines case, where effective Helminth control has provided a springboard for significant expansion of the smallholder goat sector, The technology options that were developed to be feasible, available and affordable by some farmers, and then more widely adopted are:

Use of effective chemicals, incorporating knowledge of correct use and of alternative delivery methods such as feed blocks. Quarantine drenching is an appropriate strategy only for institutions and large commercial suppliers of stock.

Improved nutrition including the use of tree and shrub leaves to reduce intake for ground-based and contaminated feeds; and plants with possible direct or indirect anthelmintic effect and cut-and-carry methods especially during times of heavy rain or heavy pasture contamination.

Grazing Management: improved housing to reduced stress through better ventilation, shelter, manure and feed management, rotational grazing and management of areas around housing which are contaminated by dung.

Controlled Breeding includes timing of breeding to have young susceptible kids and lambs when helminths can be best managed; increasing management when deciding to use new genetics, especially 'upgraded' or 'improved' bucks and rams.

Among these, through a participatory process of testing and evaluating these options, controlled breeding has been the least successful. This outcome is location specific and other farmers working with other researchers in other farming systems are likely to come to different conclusions and develop modified technologies.

Case Study 2 Nematode control in cattle

Control options from applied research
The nutritional status of grazing livestock impacts directly on the animal's ability to respond to infectious agents (Reddy & Frey, 1990; Knox *et al.,* 2003). Where nutrient deficiencies occur, reduction in the immunological response to infection with nematode parasites can result and larval establishment and survival are likely to increase (Koski & Scott, 2001). Any nutritional intervention (protein meals, grain, leguminous crop residues, tree leaves) targeting the particular deficiency, whether protein, energy, vitamins or minerals, will therefore, assist in enhancing or re-establishing the level of immune response to infection. Urea-molasses blocks (UMB) have been introduced as a low cost option of providing non-protein nitrogen, energy and minerals to complement the predominant feed resource of fibrous roughage. The provision of non-protein nitrogen (NPN) in the diet can compensate for nitrogen deficiencies of roughage based diets and enable increased productivity from this feed resource (Leng, 1991). Evidence from studies with young sheep have also demonstrated that supplementation with urea can achieve similar qualitative benefits in reducing the effects and level of infection with parasitic nematodes to that achieved with protein supplements (Knox, 2003). Further benefits can be derived in some production systems by the inclusion of anthelmintic medication in the UMB formulation to control nematode parasite infections (Knox, 1995).

Evaluation by smallholder farmers
The use of UMB has also been widely promoted for improving the nutrition of beef and dairy cattle owned by small-holder producers throughout South and South-East Asia (FAO 1991; IAEA, 2006). Local adoption has relied on the key principles of low cost supplementation with readily available sources of nutrients applied through simple technology. Preparation of UMB varies with availability of ingredients and blocks vary from compressed or chemically hardened blocks to loose mixtures of nutritionally beneficial components. Substitution of alternative sources of readily fermentable carbohydrate for molasses also occurs where molasses is costly or seasonally unavailable. Use of these supplements in smallholder beef and dairy systems in South and Southeast Asia have resulted in substantial benefits in terms of increased liveweight gain, milk production and farmer income as well as reduced intercalving interval (IAEA, 2006).

Impact on parasite control and on the farming system
Recent studies have also shown that the use of UMB alone can lead to reduced faecal helminth egg count (FWEC) in some circumstances suggesting enhanced immunity to nematode parasite infection. In Bangladesh in dairy cattle fed a diet of rice straw, rice polishings and cut-and-carry grasses, the use of UMB for 45 days reduced FWEC (600 vs 1000 epg; $p<0.01$) and increased liveweight gain (42 vs -24 g/day; $p<0.01$) and milk production (3.0 vs 2.0 L/day; $p<0.01$) compared to unsupplemented control animals (Ahktar *et al*, 2006). These authors also showed that by addition of 0.5 mg fenbendazole/kg to the UMB formulation FWEC could be reduced to 0 and liveweight gain and milk production further increased to 57g/day and 3.42 L/day, respectively. Similarly, in Vietnam in young dairy heifers fed a diet of cut-and carry grasses, rice straw and 1kg/day commercial feed concentrate, the use of UMB for 90 days reduced the percentage of animals with positive FWEC from 100% to 62.5% and increased their liveweight gain from 283 g/day to 374 g/day (Doan et al., 2006). These authors also showed that by addition of 0.5 mg fenbendazole/kg to the UMB formulation the percentage of animal with positive FWEC could be reduced to 25% and liveweight gain further increased to 513 g/day.

In many small-holder systems the cost and/or availability of commercial anthelmintics preclude their routine use. In these systems, farmers sometimes rely on traditional herbal remedies for nematode parasite control. Recently in Myanmar, Daing and Win (2006) showed weekly bolus dose of dried *Ananas comosus* (pineapple) or *Momordica charantia* (bitter gourd) leaves mixed with molasses reduced FWEC by 96% and 94%, respectively. Further work by these authors showed that inclusion of dried *A. comosus* leaf in their UMB formulation reduced FWEC by 60-80%. Further to this, Ahktar et al (2006) showed that a single bolus dose of *A. comosus* reduced FWEC in lactating dairy cattle in Bangladesh by 97% while presentation in a UMB reduced FWEC by up to 85% and increased liveweight gain and milk production to 97g/day and 5.45 L/day compared to UMB alone (72g/day and 4.75 L/day, respectively). Similar studies in Vietnam (Doan *et al,* 2006) with *A. comosus* in UMB in young beef heifers resulted in a reduction in FWEC by 68% and an increase in liveweight gain to 471g/day compared to an untreated control group which grew at 78 g/day.

Scenario for future control

Future control in small-holder beef and dairy systems should capitalise on the abundant information on the nutritional benefits offered by UMB in its various presentations since enhanced nutrition has an obvious impact on reducing nematode infection. In situations where nematode infection is more evident, the use of anthelmintics should be considered to further improve productivity from available feed resources. Local availability and cost of commercial anthelmintics will determine the best alternative for use in a particular environment. Where commercial anthelmintics are not available or too costly, the use of ethnoveterinary alternatives like the leaves of *A. comosus (pineapple)* may prove beneficial provided that efficacy can be established in the local environment.

Case Study 3. Liver fluke control in grazing cattle and buffalo

Control options from applied research.

Until recently, many recommendations for the control of *Fasciola gigantica* have been based on successes and failures of methods used in temperate countries to control *F. hepatica*. These methods include strategic anthelmintic treatment, grazing management, application of molluscicides, and fencing off or draining swampy areas. The relevance of these approaches to control of *F. gigantica* in the tropics have been questioned and control options are being developed on the basis of a sound understanding of the transmission of *F. gigantica* in tropical production systems. These systems are often characterised by the intensive production of rice irrigated or naturally flooded rice paddies. Regional recommendations have been made for some developing countries (FAO, 1994). These recommendations include treatment at the end of a period of ecologically reduced activity of the parasite and snail intermediate host, followed by treatment 1 to 2 months after the expected peak of infection in hosts; and an additional treatment in heavily infected areas or where infection may be acquired throughout the year. The overarching general recommendations are:

- *strategic application of anthelmintics, elimination the parasite from the hosts at the most convenient time for effective prevention of pasture contamination;*
- *reduction of the number of intermediate host snails through drainage and other agricultural practices:*
- *reduction of the chances of infection by efficient farm and grazing management.*

These sound recommendations do not specify which practices are most likely to lead to reduction in snail numbers (the second general recommendation), or which efficient farm and grazing management practices are likely to be technically effective and which are environmentally, economically and socially acceptable. In the last decade, through a number of linked projects in Asia, significant progress has been made in elaborating which practices are both effective and practical.

To be appropriate for the low-input smallholder-based systems of most of tropical Asia, control measures for *F. gigantica* should be low-cost, readily-available and applicable with little disruption to existing agricultural practices. Chemotherapy remains an important tool for control and efficacy against *F. hepatica* is a strong indicator of efficacy against *F. gigantica* (Spithill *et al*., 1999). However there is less certainty about efficacy in host species other than cattle and in field situations where low quality feed may have an impact on the biological activity of a chemical given orally. There is evidence that dose rates of triclabendazole in buffalo need to be double that of cattle and that feed with high roughage content increases drug effectiveness (Sanyal & Gupta 1996a, b).

Evaluation by smallholder farmers: a Cambodian example

Based on recent regional research the government of Cambodia has made a concentrated effort to develop a control program for liver fluke comprising a three year training and extension program combined with evaluation by scientists, extensionists and farmers. In addition, a GIS model predicting the prevalence of fasciolosis was validated in Kampong Cham province and has been used to estimate the need fro fluke control (Sothyra *et al*., 2004). The technical options in the program include control of drinking water, grazing management improved dung management and use of drugs, with the addition of a new pour-on formulation of triclabendazole (Genesis TM) which

A two year control program was evaluated in two villages with several hundred large ruminants to compare the impacts with similar villages in which no control program was implemented. Importantly, the study was integrated with control of other major endemic diseases of cattle and buffalo, namely haemorrhagic septicaemia (HS), foot and mouth disease (FMD) and toxocarosis (infection with the nematode *Toxocara vitulorum*) to provide broader incentives for farmers to participate.

Impact on parasite control and on the farming system

The benefits of control well exceeded costs in areas where the prevalence of fasciolosis was high (>60%) and would result in substantial profits for farmers per cow per year in the order of $50-100 US. Parasite prevalence, as indicated by faecal helminth egg counts, remained around 40% in the villages with no control programs and reduced to between 2 and 5% in the villages with the control program. The control program resulted in approximately a 30kg per annum increase in bodyweight and 10% more births during the study.

Case Study 4. Nematode control in pigs

Parasites constrain pig production in Papua

Pigs are important socially and economically in much of the Pacific and native breeds are raised predominantly in a free-grazing, foraging system. Their growth is poor and investment in feed, animal health and controlled reproduction is minimal. A trial in 5 villages in the province of Papua showed that mean growth in treated weaners increased from 19 to 48 g per day and death rates fell from 40% to 10%. In later studies (Putra *et al*., 2004) a wide range of nematode eggs were identified from pigs in similar circumstances including *Trichuris suis, Metastrongylus, Physocephalus sexalatus, Ascaris suum, Ascarop strongylina, Macracanthoryncus* and *Strongyloides ransomi*. No *Trichinella* were detected in muscle but 5 (13%) pigs were sero-positive. Thus parasites are abundant, constrain growth and increased mortality.

Parasite control based on confining pigs and dunging areas

To reduce risk to pig and human health a system of confinement of pigs has been developed (Syahputra *et al.,* 2007) to reduce access to toxic plants, provide access to high protein forage plants to supplement diets, and increase parasite control by incorporating dunging areas and rotational foraging. Confinement reduces access by pigs to human and dog faeces. Fodder trees as “live fences” provide an extra source proteinaceous forage. To assess the value of dunging areas in reducing parasite infections two groups of six pigs were used in each of two experiments. One group of pigs were injected with a single dose of doramectin and a second group was left untreated. Pigs were housed overnight in separate pens and released into a dunging area for 30 minutes before being released to feed. The dunging area is a special place for pigs to dung and urinate when released from house in the morning and primarily limits access to parasite eggs. Two types of dunging areas are used: the first simply a covering of stones which stops pigs digging up the soil; the second a slatted wooden platform outside the house through which dung will fall or be pushed.

Growth rates over the six months of the trials were greater in the treated groups (223 g/day vs 86 g/day) while mortalities decreased from 33-50% in the control groups to 17% in the treated groups. As anticipated the faecal helminth egg counts of the main nematodes present were negligible in the treated group for most of the trial.

In the absence of regular access to anthelmintics an approach using medicinal plants to reduce or limit the build up of parasite burdens has been considered base on a review of the literature and information provided by Udayana University (Damriyasa pers com). Three plants were initially chosen: papaya fruit and seeds (Carica papaya), betel nut (Pinang or *Areca* nut) and pineapple leaves. In initial trials both betel nut and papaya have reduced egg counts to levels considered to be below clinical significance.

Scenario for Future Control

There is scope for incorporating a range of plant material in the control programs, including the seeds of papaya fruit and betel nut . Underpinning the use of dunging areas and the occasional use of anthelmintics is knowledge by both farmers and their extension advisers on the hazards of leaving pigs exposed to nematode eggs in faeces.

Future options for the use of local resources

The above examples demonstrate a common theme that the main elements of a locally effective control program combine with occasional use of anthelmintics, good management of sources of reinfection (especially dung) and improved feeding. Adoption of even these simple interventions depends on improved market signals and incentives for smallholders to invest their cash, time and other resources in helminth control. Ethnoveterinary approaches have potential and at the local level are more likely to make use of relatively unprocessed plant materials such as pineapple leaves or papaya seeds. For this to be most effective, further knowledge needs to be gathered of efficacy of local ethnoveterinary alternatives in areas where application is likely to occur. There remains considerable risk for increased exposure of livestock to helminths by the introduction of breeds that are more susceptible to infection than locally adapted alternatives. In most countries in tropical Asia there also remains considerable scope to improve quality, quantity, price and supply of chemical anthelmintics to improve accessibility by smallholder livestock producers.

DISCUSSION

Asian livestock systems are changing rapidly through industrialistaion of production and consolidation of supply chains and retail markets. Smallholder systems, however, will remain important in rural areas and at the margins of cities and towns. Smallholder livestock systems are resilient, multipurpose and remain a significant pathway for the poor to build assets and generate income. Helminth control in these systems will always be variable and needs to be relatively simple and tailored to locally available resources. Public agencies will continue to have important roles in all livestock sectors by providing advice on appropriate genetics, controlling drug importation, use and quality, and ensuring novel helminth control options are investigated for local application and promotion to livestock producers. The private sector has the complementary role to develop clear market signals for livestock and livestock products, and make anthelmintics available in appropriate packages. All agencies need to recognise smallholder systems as part of an integrated livestock sector which can be made more profitable and sustainable through better helminth control.

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