

# Using forecast models to control Fasciolosis in Nepal

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## Executive Message

- Fasciolosis caused by liver fluke parasites is a major threat to livestock resource poor farmers and causes serious losses in cattle, buffalo, sheep and goats in countries like Nepal where farmers lose over US\$ 20 million worth of production each year.
- This project has identified a mathematical (ARIMA) model that accurately predicts the threat of fasciolosis in temperate countries and could be modified, using local data on climate and disease, to predict potential outbreaks in Nepal.
- This type of prediction would help many resource poor farmers to maintain livestock in good health by identifying when to treat their animals in advance of a disease outbreak.
- This would then allow animals to be ready and able to be used in cultivating land at critical times (prior to the rains) as well as being more productive in their output of meat, milk and manure. All of these factors would enhance farmers' livelihoods.
- Poor farmers will save money by only treating when necessary and the environment is less likely to be polluted if fewer drugs are used.



Fasciolosis is a major problem in cattle, buffalo, sheep and goats

## Background

### The problem

Fasciolosis is a disease mainly of domestic ruminants (and also affects humans) caused by liver fluke parasites *Fasciola gigantica* and *Fasciola hepatica*. The former is more common in the tropics and causes serious losses in cattle, buffalo, sheep and goats and thus poses a major threat to resource poor farmers. In Nepal it has been estimated that farmers lose over US\$ 20 million worth of production because of poor animal health, low reproduction and deaths from fasciolosis. Damage, sometimes fatal, is caused in the host animal by the parasite migrating through the body to the liver. This organ is often

subsequently condemned in abattoirs and cannot be sold for human consumption. In Nepal buffalo and cattle are used extensively in ploughing and providing fertiliser for cropping small farms. Here the impact of fasciolosis is extremely serious and poor animal health means not only poor crop production, but also contributes to land erosion.

The ability to control liver flukes would give considerable benefits to poor farmers.

The parasite lives part of its life in aquatic snails which act as an 'intermediate' host. These live in and around wet areas, such as water holes. When farm animals come to drink they are likely to pick up the parasite. To achieve effective control, programmes that include the accurate identification of suitable target areas, followed by

the use appropriate prophylactic strategies are essential.

### Why forecasting might help

One exciting approach is the use of predictive models which forecast the incidence of diseases for the coming year. These models have already been used successfully in temperate climates for some time. If farmers could forecast a disease outbreak they could either take action to dose their animals with anthelmintics or use chemicals to kill the snails, which are the intermediate hosts of the parasite. These measures would prevent serious outbreaks affecting their animals. Because all drugs are expensive for poor farmers to buy, treating animals only when a threat occurs, means money is not wasted. Strategic use of chemicals also means that they are less likely to pollute the environment. Accurate predictions are therefore important.

Prior to this project little work had been done on adapting predictive computer models to forecast fasciolosis outbreaks in tropical climates. Climate (rainfall & temperature) is specifically linked to disease levels because snails, and the parasites themselves grow and reproduce quicker under

warmer wetter conditions. The rice paddy fields of Nepal are ideal breeding grounds for them. Incorporating information from geographical information systems (GIS) would thus greatly enhance any model.

### Objectives

This project aimed to develop a predictive model for forecasting fasciolosis in tropical environments where the host snails would prosper. The work concentrated on Nepal but also looked at the situation in Peru and Kenya. All three countries have fasciolosis problems.

Specific scientific aims included:

- Collecting relevant data on the disease and the climate.
- Identifying any relationships between disease prevalence and climate
- Incorporating the data into existing models and modifying them for this specific project
- Testing the model with new climatic data.

Country	Parasite	Livestock affected
Peru	<i>F. hepatica</i> .	Cattle/humans
Kenya	<i>F. gigantica</i> (widespread) <i>F. hepatica</i> .(highlands)	Cattle, sheep, goats Sheep
Nepal	<i>F. gigantica</i> (widespread) <i>F. hepatica</i> .(over 2500m)	cattle, buffalo, sheep, goats Cattle buffalo, yaks, goats, sheep

### Types of Liver fluke found in the project countries.

### Highlights

This project looked at slightly different circumstances of host /parasite relationships in the three countries involved.

#### Work Undertaken

##### 1) Reviewing the existing forecast models from temperate countries

The researchers reviewed a number of models that relied on there being a close association between the weather and disease epidemiology. One model developed by a group of researchers in Northern Ireland (McIlroy et al) appeared to offer most potential for adaption for use in tropical environments. It used liver condemnation statistics and five key weather variables to predict

likely fasciolosis threat. The model employed an auto-regressive integrated moving average (ARIMA) process, whereby the most recent time series of the annual prevalence of fasciolosis was regressed against retrospective values. The researchers checked the method against data from abattoirs and found that about 70% of the variation in fasciolosis prevalence could be explained by the previous year's occurrence. The rest of the variation was explained by the weather variables; mean summer wind speed, mean summer rainfall, mean summer temperature, mean spring wind speed and mean spring temperature. The model was extremely accurate (99%) when compared with actual observed results.

##### 2) Geographical Information Systems.

Geographical information systems integrate computerised mapping with database management which makes them ideal tools for the study of disease epidemiology. The researchers looked at a model from Louisiana, USA, which gave an accuracy of between 80- 90% on disease prediction. They hoped it might be possible to link the disease patterns and geographical data for use in the construction of an 'expert system'. Such a system allows decisions to be made without an expert being on hand.

### **3) Assessment**

Researchers assessed all the models for suitability and forecasting of fasciolosis and concluded that the ARIMA model appeared to be the best contender for use in less developed countries of the tropics. Although it required slightly more meteorological data and monthly fasciolosis prevalence rates over at least five years, it was very accurate in its prediction.

### **4) Project visits country visits:**

The researchers visited the three countries involved.

#### **Nepal**

In Nepal they found a very complex situation owing to the diversity of the land, animal husbandry practices and the way in which parasites were transmitted. In the hills goats picked up the infection by grazing round rice fields, whilst buffalo became infected when fed rice straw. In the hotter plains animals picked up infection by grazing around the water holes. With no meat inspection system in place in Nepal disease prevalence would have to be based on parasite egg counts in the faeces.

The Pakhribas Agricultural Centre have produced sufficient regional data to enable identification of a relationship between weather variables and fasciolosis prevalence rates at different altitudes. This is not the case in other regions of Nepal although it might be forthcoming. The opportunity to modify the ARIMA prediction model to suit Nepal circumstances is thus a very real possibility.

#### **Kenya**

In general the distribution and epidemiology of fasciolosis in Kenya is not well-known. Extensive meat inspection records are available although they may be in an unsuitable format for the ARIMA model. Equally meteorological data are available for an extensive number of weather stations. Redevelopment of a forecast model for fasciolosis in Kenya would however have to await further information on the distribution and epidemiology of the parasite.

#### **Peru**

The situation in Peru is similar to Kenya where there is a lack of data on fasciolosis. There is ample information on meat inspection but direct access to this is politically difficult. The researchers concluded that the development of a prediction model in Peru will, as in Kenya, have to wait the provision of more information on fasciolosis.

#### **Impact**

This project has brought forward the time when a model will be available that will accurately predict the threat of a fasciolosis outbreak in Nepal. In this country there are many resource poor farmers whose livelihoods would benefit substantially from maintaining their livestock in good health. The researchers have shown that the potential exists to modify fasciolosis prediction models that already work well in temperate environments for use in tropical developing countries. An accurate model for Nepalese conditions would enable resource poor farmers and their associated extension services to protect livestock from helminths only when disease threatened. This would mean farmers would be able to minimise costs, whilst maximising the benefits, that healthy animals would bring, including higher animal productivity and improved crop productivity through timely animal traction. Such a model would go a considerable way to improving the livelihoods of poor Nepalese farmers.

#### **Next steps**

This project demonstrates the need for funding further specific research on developing an in-country predictive model for fasciolosis using local statistics on both climate and disease.