A KNOWLEDGE-BASED SYSTEM TO COLLECT AND ANALYSE FACTORS ASSOCIATED WITH PIG HEALTH DISORDERS

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L'expression clinique des maladies est le résultat d'interactions complexes entre l'organisme pathogène d'une part, et des facteurs vétérinaires, zootechniques et individuels d'autre part. Aux Pays-Bas, un système expert dénommé "Zovex" a été développé pour l'étude des facteurs associés au niveau de l'élevage à des maladies du porc et des baisses de production. Sept experts ont fourni l'ensemble des connaissances relatives aux interactions complexes évoquées. Le but de Zovex est d'évaluer l'état de santé et de bien être animal dans les élevages par l'étude des facteurs de risque en vue de diminuer les pertes résultant des problèmes de santé. Dans un premier temps, Zovex détermine les causes des problèmes de santé dans un élevage engraisseur ("résolution de problème"). Les données utilisées sont 1) des paramètres cliniques, des résultats de laboratoires, des données provenant de l'abattoir et des informations relatives aux performances de production ; 2) des informations sur les caractéristiques de l'élevage, comme la taille des lots, le logement ou le système de ventilation. La base de connaissances relative aux facteurs de risque porte sur l'hygiène, le logement, les conditions d'ambiance et la gestion de la santé. Le système produit une liste de facteurs de risque pour l'élevage étudié. La consultation s'achève par des propositions visant à résoudre ou diminuer les problèmes détectés. Zovex peut aussi servir à la gestion de la prévention, en dressant un inventaire des écarts aux normes pour un domaine donné. Dans cette perspective, les données saisies concernent les caractéristiques de l'élevage ainsi que tous les facteurs relatifs à l'hygiène de l'élevage. Zovex peut déterminer quels facteurs sont hors limite et peuvent constituer un risque potentiel de maladie. Le système produit alors une liste de ces facteurs de risque, ainsi que des recommandations pour réduire ou éliminer ces facteurs. Cet article présente les principales caractéristiques de Zovex, ainsi que les résultats d'une première étude cas / témoin de validation.

INTRODUCTION

Health, welfare and performance of production animals is influenced by several factors. These include preventive veterinary actions taken by the farmer such as vaccinations and preventive medications, housing system and allied climatic conditions in the pig unit, feed composition, hygienic circumstances on the farm and in the pig unit, and genetic potential of the pigs. With reference to enzootic diseases, clinical disease is thus the result of the complex interaction between the pathogenic organism on the one hand, and veterinary, zootechnical and animal factors on the other (Christensen and Mousing, 1992). In the Netherlands a knowledge-based system called Zovex (Enting *et al.*, 1995) was developed for on-farm analysis of factors associated with pig diseases and pig performance problems. On basis of the analysis Zovex presents an advice to optimise the pigs' environment and the farmer's health management, and in this way will help to reduce the losses from health disorders. After a circumscription of knowledge-based systems, Zovex will be described in this paper and some preliminary results of a field test will also be presented.

KNOWLEDGE-BASED SYSTEMS

Knowledge-based systems (KBSs) are computer systems that belong to the category of management support systems (MSSs). MSSs support farmers in their decision-making process concerning the input of resources (animals, materials, money, time id.) to reach their goals (Davis and Olson, 1985; Turban, 1990). Many MSS types use quantitative models to generate and test alternatives for the decision problem. KBSs, however, use qualitative expertise to support the decision or to solve the problem. Turban (1990) defines a KBS as a computer system that applies reasoning methodologies based on knowledge in order to render advice or recommendations, much like a human expert.

A KBS can be built based on the expertise of one single expert, but nowadays many decision problems are so complex that expertise of many experts is required and integrated into the KBS. In the case of Zovex seven experts were interviewed (during in total over 100 hrs) to acquire their knowledge concerning the relationship between pig health, welfare and performance problems and environmental and managerial circumstances.

DESCRIPTION OF ZOVEX

Zovex has two functions: (1) 'problem solver' and (2) 'screener'. When Zovex is used as 'problem solver' a structured analysis of health, welfare or performance problems for an individual farm is executed. The analysis is followed by an advice for solution of the problem and in the future to prevent problems. In the function of 'screener' Zovex checks in detail, irrespective of the presence of a health disorder, the pig farm preventively for

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the presence of risk factors that sooner or later may cause problems. The analysis is performed for a specific zootechnical domain and followed by an advice to reduce the effect of or eliminate the risk factors.

Zovex is restricted to weaned and finishing pigs, and to the domains health management, hygiene, housing and climate. Potential users of Zovex are people who support the farmer in his daily management concerning the health, welfare and performance of the pigs: veterinary practitioners and extension workers. To be able to use Zovex on-farm, it has been developed for implementation on the PC.

Zovex as 'problem solver'

When Zovex is used as 'problem solver' it determines the possible (zootechnical) causes of health, welfare and performance problems of weaned and finishing pigs. These problems are the major input of Zovex (Figure 1; module 'problem definition & determination risk factors'), and entered in Zovex by a (i) disease code, (ii) type and (iii) animal category:

i. The disease code is a three-digit number, in which the first digit describes the category of the problem (e.g. 4- - means respiratory disorders, and 5-- intestinal disorders), the second digit a more specified definition of the problem (e.g. 41- means respiratory disorders attended with coughing and laboured breathing, and 44- means respiratory disorders attended with sneezing), and the third digit the agent of the health problem. The disease coding system bears resemblance to the coding system as described for the Health and Production Surveillance system in Denmark (Christensen et al., 1994).

ii. The type represents the source of the information entered by the disease code: general clinical health and performance signs observed in the pig unit (type A), laboratory findings such as serological or autopsy results (type L), and slaughterhouse examinations (type S).

iii. The animal category represents whether the problem was observed in the weaned or the finishing pig unit. In this way during an analysis of a health, welfare or performance problem of finishing pigs the health status of the weaned pigs can be taken into consideration.

When the input is entered in the system, it determines a list of potential factors associated to the problem at hand and presents this list to the user of Zovex. Before these factors are analysed in detail, information about the farm and pig unit layout are retreived from a database (Figure 1; module 'farm description'). Data are related to pig unit size, housing system, type of floor, ventilation system and the allied control system, heating system, and feeding system. These data might influence the list of potential risk factors. After closure of the module 'farm description', this list is modified to the circumstances of the pig unit under investigation.

Eventually the risk factors are analysed in the modules 'health management', 'climate', 'housing', and 'hygiene'. These four domains contain very detailed knowledge to assess whether risk factors are present or absent at the farm, and to what extend they contribute to the problem. The session ends with a summary of risk factors present at the farm, and an advice how to reduce or eliminate the effect of these factors on the health, welfare or performance of the pigs (Figure 1; module 'end'). This advice can be used by the veterinary practitioner and extension worker for advising the farmer about general animal health management on the pig farm.

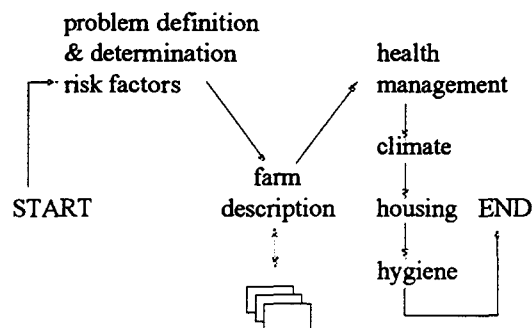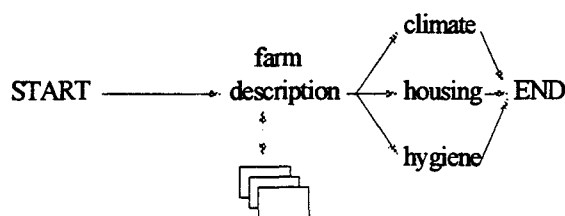Figure 1: annual EBL testing schedule for all New Zealand dairy herds

Zovex as 'screener'

When Zovex is used as 'screener' the pig farm is preventively or on fixed times checked for possible weaknesses in the field of climate, housing or hygiene. The analysis starts with the retrieval of the farm and pig unit information from the database, as described in the previous section. Then Zovex activates one of the modules 'climate', 'housing' or 'hygiene' (see Figure 2).

In case of an analysis of factors in the field of hygiene, the input consists of all data related to the number of source farms, the transport and accommodation of arrival piglets and outgoing pigs, sanitary separation of on- and outside-farm activities, entrance protection and construction of the hygiene channel, the removal of dead pigs, vermin control, application of the all in all out principle, cleaning and disinfection of the pig unit, housing of diseased pigs, water and feed hygiene, hygiene of articles of use such as spades and brooms, storing of drugs and pesticides, and the finish and abrasion of pen walls and floors. Zovex assesses the input and, if necessary, asks for additional data. The cycle of assessment and calling in for new input continues until for all potential risk factors in the field of hygiene is known if they are present or absent at the farm.

Application of Zovex as 'screener' ends with a summary of detected factors which directly or indirectly are a risk for the health, welfare or performance of the pigs, and an advice how these factors can be eliminated to prevent impair of the health status of the pigs (Figure 2; module 'end').

Figure 2: Structure Zovex as 'screener'

FIELD TEST TO VALIDATE ZOVEX

To validate Zovex as 'problem solver' in the field a case-control study was designed. The field test focuses on the capability of Zovex to detect on-farm weaknesses associated with a specific health disorder. Under Dutch circumstances the majority of individual (Elbers et al., 1990; Blocks et al., 1994) and group medical treatments (Blocks et al., 1994) are related to respiratory diseases. These disorders can be detected at slaughter: affected lungs, abscess(es) in the lungs and pleurisy. The specific disorder chosen for the validation of Zovex was pleurisy.

Design of the field test

For an individual farm ($\geq$ 300 finishing pigs) figures of the percentage of pigs with pleurisy lesions were collected in the period October 1995 until June 1996 and transformed into quarterly averages. Due to differences in the prevalence of pathological lesions among slaughterhouses (Elbers et al., 1992), absolute values of pleurisy lesions are hard to interpret. Therefore the individual herd values were indexed by comparing them to the average pleurisy percentage of the slaughterhouse: pleurisy index = (quarterly average pleurisy$_{herd}$ / quarterly average pleurisy$_{slaughterhouse}$) * 100. Twenty-five case farms were randomly selected out of a sub-population of farms having all three quarters a pleurisy index above 120, and 25 control farms out of a sub-population of farms always having a index below 80.

Case and control farms were visited in the first quarter of 1997. Risk factors of interest during the farm visits were continuous batch production versus the all in all out principle, cleaning and disinfection of the pig unit, number of source farms, climatic measurements (such as CO_2 content, NH_3 content, air velocity) and their related climatic defects (e.g. absence heating system), pen area per pig in m², mixing and moving of pigs and possible chance of PRRS infection. Within a farm two pig units were analysed with Zovex: a 'good' pig unit having almost no pleurisy problems during the last two fattening periods, and a 'bad' one having many pleurisy problems during the last two fattening periods (pleurisy lesions compared to the slaughterhouse average).

Preliminary results field test

Due to a serious outbreak of Classical Swine Fever in the southern (most pig densily) part of the Netherlands, starting February 1997, we were only able to visit six control and five case farms until now. These eleven farms stand for 22 pig units being analysed with Zovex.

Although a continuous batch production instead of application of the all in all out principle is a known risk factor for respiratory and other diseases (see Christensen and Mousing, 1992), in only three pig units (out of 22) this risk factor was present (one pig unit on a case farm, two pig units on control farms). However, 20 pig units (out of 22) were not disinfected after cleaning the pig unit between batches. Preliminary results also show that the following risk factors were more often detected by Zovex on a case than a control farm: a too small air inlet into the central corridor, the absence of a heating system in the central corridor to condition the incoming air in the pig unit, and high air velocities. The latter two factors are known to cause draught, which has a large harmful impact on the health status of the pigs (Tielen, 1974).

CONCLUDING REMARKS

Zovex is a computer system that assists veterinary practitioners and extension workers in detecting risk factors on a pig farm. Advantages of using a system like Zovex is that computers never overlook an important risk factor, and possible risk factors are assessed in a uniform way. Moreover, KBSs like Zovex make expertise available for farm advisors, while experts can devote their time and effort on problem solving measures.

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