An integrated approach to stored-grain protection in Western Australia

K.R. Dean*

Abstract

Western Australia has been successful in integrating the efforts of the major grain industry groups to develop a unique system of stored-grain management. A Grain Protection Committee formulated policies based on a 'clean pipeline' concept of delivery direct from paddock to receival point, resistance management, improvement in farm hygiene and storage, and limited use of pesticides on farms.

This farm regulatory program, operating throughout the Western Australian grain industry since 1976, has achieved remarkable success. Farm hygiene and storage has improved, and infestation levels have been reduced to manageable levels. Insecticide, and more recently, fumigant resistance has been controlled on growers' properties and in the central storage system through strategies which did not rely on insecticides for control. The resistance management component of the program extended the useful life of the organophosphate insecticides into the 1990s, saving growers about $30 million.

No major modification to existing strategy has been required to focus attention on managing phosphine resistance and eliminating insecticide residues. Western Australia is now well placed to offer residue-free grain to a market demanding more of this commodity.

Introduction

A farm regulatory program now operating in Western Australia commenced in 1976 when the Grain Weevil Liaison Committee (GWLC) decided that innovative strategies would be required to protect the export grain industry. The committee formulated insect management policies relevant to the grain industry and has guided the development of a sound strategy for insect control on farms. The initial phase of the program saw the Agriculture Protection Board (APB) 'declare' 10 species of stored-grain insects under its legislation. This allowed APB officers to inspect farms for insects, to arrange control programs—including the restriction on movement of grain off farms where a problem was located, and to collect insect samples for resistance testing (Moulden 1987).

The objective of the regulatory program was to:

- protect the central grain storage system from the delivery of grain insects off farms, particularly insects resistant to pesticides;
- minimise treatment costs; and
- delay the onset of resistance to enable Co-operative Bulk Handling Ltd (CBH), the handling authority in Western Australia, to develop alternative pest control strategies.

* Agriculture Protection Board, 3 Baron-Hay Court, South Perth, Western Australia 6151.

The GWLC, now called the Grain Protection Committee (GPC), draws members from a wide range of industry responsibility, including the Australian Wheat Board, Grain Pool of Western Australia, Co-operative Bulk Handling Ltd, Western Australian Farmers Federation, Pastoralists and Graziers Association, Flour Millowners Association, Stock Feed Manufacturers Association, Western Australian Silo Manufacturers (Inc.), Health Department of Western Australia, Western Australian Quarantine Inspection Service, the Western Australian Department of Agriculture (WADA) and the Agriculture Protection Board (APB). The APB provides the administrative support for the Committee.

The on-farm initiatives (the regulatory program) implemented through industry co-operation especially between growers, the APB and the WADA included the following.

- Establishing a 'clean pipeline', with growers delivering direct from paddock to receival point via clean harvesting and handling equipment and avoiding contact with on-farm insect harbourages. Stored grain insects are not found in standing crops in Western Australia.
- Introducing an inspection program for all grain producing farms whereby the APB would identify deficiencies in hygiene and grain storages and encourage improvement.
- APB field staff routinely collected grain insect samples from growers' properties and submitted these for resistance testing by the WADA. If resistance was detected, a confirmatory sample was submitted and the APB arranged for the problem to be rectified either by the grower or, where the problem was beyond the grower's resources, with assistance from the APB. The affected property was quarantined until cleared by the APB, to prevent the spread of the resistant strain.
- Sponsoring the manufacture and grower use of sealed farm silos to facilitate efficient and cheap grain fumigation. All Western Australian manufacturers now offer sealed silos as standard. Indeed, it costs more to purchase a non-sealed unit (C.R. Newman, pers. comm., 1993).
- Limiting the range of insecticides available to growers. Chemical companies co-operated by withdrawing all contact insecticides except maldison from the farm market. Growers could legally treat stored grain with maldison or phosphine and, more recently, with a sorptive dust (Dryacide®). The Health Department also co-operated by ensuring that no new insecticide was registered and by investigating illegal use of protectants.

The impact of the regulatory program has been previously described (Moulden 1981, 1987; Uren 1987). When the program began 22% of farms inspected were considered heavily infested with stored grain insects. By 1980 this had fallen to 6% and to 3% by 1986. Insect-free farms increased from 35 to 67% over the same period. The influence the program exerts is demonstrated by the deterioration that occurred when APB resources had to be redirected to a major locust plague in 1990 and 1991(Fig. 1).

More recently the on-farm program run by the APB was estimated to return a benefit-cost ratio in the order of 12. Benefits were shown to accrue by preventing on-farm grain losses,

limiting central storage treatment costs and enabling the State to meet export market demand (Young 1994).

Redirecting Strategy

During the period 1976-1987 the regulatory program concentrated on reducing the on-farm insect problem and managing organophosphate (OP) resistance. Since 1986 the emphasis of the on-farm program has been redirected to managing phosphine resistance and eliminating insecticide residues.

The following factors motivated these two initiatives.

- Management decisions by CBH to upgrade the central storage system and rely on controlled atmosphere (CA) storage with phosphine fumigation as the first option for insect control. These decisions were made concurrent with the APB's implementation of the farm regulatory program. CBH report that about 80% (over 5 Mt) of their permanent storages have now been sealed and that they expect to complete the sealing program by 1995-96 when about 7 Mt would be sealed (T.A.de Largie, personal communication, 1994).
- Market signals which indicate a growing worldwide demand for insecticide residue-free grain. Western Australia enjoys an advantageous marketing position over other States because of previous sound strategies adopted by the industry.

Managing Phosphine Resistance

Phosphine has been used on farms in Western Australia for grain fumigation since 1960, and insect resistance is now widespread in most species at low frequencies. The incidence of resistance is rising (Fig. 2), but the level of resistance (i.e. resistance factor) rarely exceeds two or three times the normal lethal dose, and field failures are rare (Moulden 1987). The most important part of the regulatory program is aimed at maintaining the effective use of phosphine, as the industry is now highly committed to its long-term use both on-farm and in the central storage system.

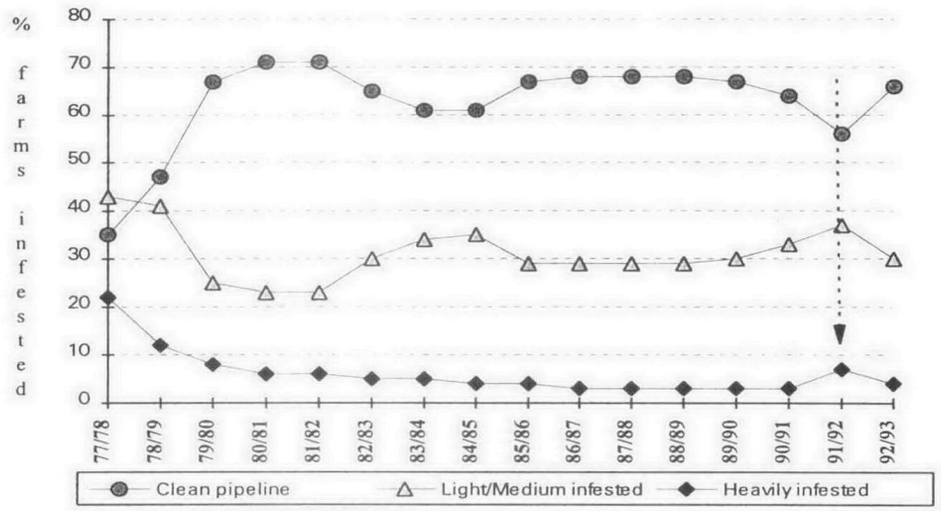

Fig. 1. Grain insect infestations on Western Australian farms 1978–93. Source: APB data base. Note that redirected APB resources during the 1990–91 locust plague (arrow) resulted in regression.

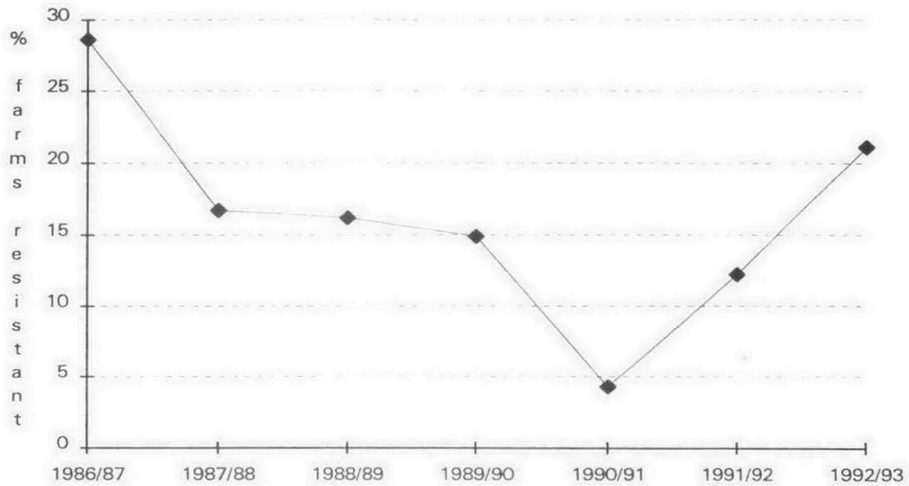

Fig. 2. Phosphine resistance in Western Australian farms 1986–93 (all species). Source: WADA and APB data base.

Because of the high standard of sealed storages built by CBH and the professionalism within the company it is most unlikely that intractable resistance will evolve in the central storages. Resistance is more likely to develop on growers' properties where the use of phosphine in unsealed and poorly maintained sealed storages, neither of which can meet concentration and/or the exposure time requirements for successful fumigation, is common. With about 8000 cereal growers consistently delivering to the Western Australian central storage system and about 12000 grain producers recorded on the APB data base, the possibility of misapplication is high.

A major State-wide survey was initiated in 1991 under the auspices of the GPC (Emery, these proceedings) to accurately determine the extent and level of phosphine resistance on farms in Western Australia. The study will also attempt to identify any relationship between grower fumigation practices, storage type and resistance. Results of this survey will be invaluable in shaping future management plans aimed at limiting the development and spread of phosphine-resistant strains of insects on growers' properties.

Western Australia has a good record of successful resistance management. Between 1976 and 1987, OP resistance was managed by restriction on farmer use of most grain protectants. This allowed CBH to continue using fenitrothion to control insects in its bulk storages, instead of the more expensive second generation insecticides. These insecticides were required when control failures due to resistance occurred. CBH had estimated savings of more than $30 million over this period (Newman 1987). These substantial savings have been passed on to Western Australian growers via reduced CBH levies and lower pest control expenditure on-farm.

Greater savings can be expected if the useful life of phosphine can be extended throughout the industry (Sexton et al. 1990). The cost differences of being able to treat grain with phosphine compared with modern insecticides is important. In 1991 the cost of CBH's insect control was about 17 cents/t using phosphine (Young 1994), whereas the cost of treatment with grain protectants was about $2/t. Savings of the order of $7 million are likely for the 1993–94 harvest of more than 9 Mt (based on treatment of 60% of the crop).

Eliminating Insecticide Residues

In 1993 the GPC advised all grain handlers that contact insecticides currently registered as grain protectants will be gradually phased out in Western Australia. Exemptions may apply to protectants used for cereal seed dressings, surface treatments and for export clients who insist on protectants being applied. This resolution was made after a review of protectants by the GPC and its technical working party, and after wide consultation throughout the Western Australian grain industry.

The GPC specified that contact insecticides would be phased out allowing sufficient time for grain handlers to review their grain storage, protection and management strategies. Initially the focus will be on the export and domestic market (grain for human consumption), as indications suggest that the demand for insecticide residue-free grain will continue to increase. The eventual aim is de-registration of all contact insecticides used on-farm, and in the stock feed and manufacturing industries.

In addition to the precious market advantages already won, there are numerous sound reasons for phasing out contact insecticides.

- There is public antipathy towards the use of pesticides generally and a greater awareness of residues in food. An initiative to further reduce insecticide use in the grain industry would receive wide community support.
- Analytical techniques have developed so quickly that residues measured in parts per billion (ppb) can now be readily detected. The delivery of grain into the central storage system containing barely detectable insecticide residues could jeopardise valuable markets.
- Most of Western Australia's grain crop is delivered to the bulk handling authority direct from the paddock to the central storage system (via the 'clean pipeline') where there is no reliance on insecticides. CBH advise that no insecticide protectants have been used since 1989–90 (R.D.Grant, pers. comm., 1993). In addition, CBH is now using a sorptive dust (Dryacide®) for surface treatments to further reduce possible contamination from insecticides (N. Ireland, pers. comm., 1993).

Western Australian growers are already accustomed to insecticide-free grain storage and have been able to operate in an environment of protectant restriction for some time. The decision to withdraw insecticides will have minimal impact on growers who will lose the use of maldison only, a product which is rarely used because of widespread farm resistance (Rimes and Moulden 1978).

The decision to withdraw contact insecticides is consistent with the original strategies conceived in the 1970s when it was decided by the GWLC that insecticides were not the long-term answer to grain protection (Dean 1993).

Conclusion

The successful integrated approach to stored grain management described in this paper is a result of sound initial planning and formulation of effective strategies developed by the Western Australian grain industry. The future challenge, which will require the full co-operation of the industry, is to at least maintain the present position while shaping future management strategies beneficial to the industry.

Containment of phosphine resistance on farms will require more attention. Grower fumigation practices need to be reviewed, as does the need to maintain sealed silos at prescribed standards. Alternative methods for controlling insects on-farm are needed, particularly the development of an alternative fumigant to phosphine. A technique for in situ treatment of infested grain in unsealed farm storages would be invaluable.

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References

Dean, K.R. 1993. Withdrawal of contact insecticides. Australian Grain, 3, (6), iv.

Moulden, J.H. 1981. The impact of a farm regulatory grain insect control program on insect infestation and insecticide resistance.

Proceedings of the First Australian Stored Grain Pest Control Conference, Melbourne 1981: 8–9.

Moulden, J.H. 1987. Grain insect infestation and insecticide resistance in Western Australia: an analysis 1973 to 1984. Western Australian Department of Agriculture, Research Report 1/87.

Newman, C.R. 1987. Sealed grain stores in Western Australia — a review. Agriculture Protection Board of Western Australia.

Rimes, G.D. and Moulden, J.H. 1978. Notes on the distribution of malathion resistance in Western Australia. Proceedings of a Symposium on the Protection of Grain against Insect Attack during Storage, Moscow 1978.

Sexton, M.T., Dean, K.R., Emery, R.N., Newman, C.R. Rogers, K. and Uren, B. 1990. Stored grain insects — a species management plan. Agriculture Protection Board of Western Australia.

Uren, B. 1987. Grain storage and insect control on WA farms. In: Harvest ahead. Mt Lawley, Western Australia, Kondinin Group, 80–83.

Young, A. 1994. Stored grain insects in Western Australia: a benefit/cost analysis. Unpublished research report. Agriculture Protection Board of Western Australia.