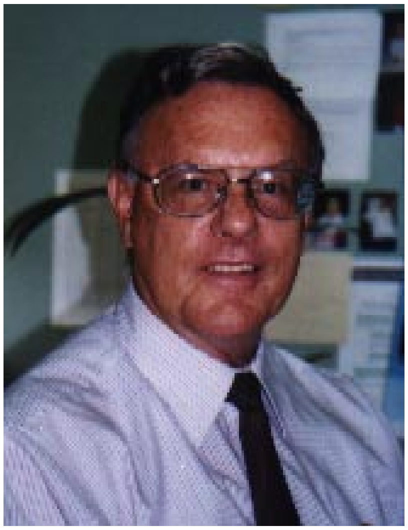
GUEST EDITORIAL



Robert Taylor, born 1938. Principal Scientist with Natural Resources Institute (NRI, now part of the U. of Greenwich), at Chatham, UK. B.Sc. U. of Sheffield (1961). 1966–68, with the Pest Infestation Laboratory, Slough, UK (research on fumigation technology). 1968, Tropical Stored Products Centre, Slough (worked overseas on British Government-funded aid projects on stored-products protection in Kenya [1968–70], Uganda [1971–72], and The Gambia [1975–77]. 1977–82, Slough-based research on stored-products protection in tropical countries. 1982, 2-year secondment to FAO, working in Nepal, to advise the Food Corporation on improvements in storage management technology. 1984–90, further research at Slough, mostly in connection with insect resistance to fumigants and contact insecticides. 1990–92, NRI, Chatham. 1992–, a member of the Methyl Bromide Technical Options Committee (under the United Nations Environment Programme). 1998–, consultant for several United Nations organizations that operate projects in developing countries (including Syria, Indonesia and Vietnam) to demonstrate alternative technologies to methyl bromide fumigation. *Major interests:* Replacement technologies for methyl bromide fumigation, and detection and measurement of resistance in stored-product insects.

Facing the Future without Methyl Bromide – Are Alternatives Available to This Versatile Fumigant?

Measures to protect agricultural crops from damage by pests are necessary, *inter alia*, prior to planting and also in the postharvest period of storage and distribution. One of the measures for achieving this is fumigation, a very old concept, although the types of chemicals now used were introduced only in the 1940s and 1950s. The special properties required of fumigants, especially those used to treat food commodities, have resulted in relatively few compounds being suitable. One of the more important of these is methyl bromide (MB), which has a broad spectrum of activity against insects and mites damaging seeds and harvested crops, and against soilborne pests including nematodes, fungi and bacteria. In 1992 MB was listed as an ozone-depleting substance under the Montreal Protocol Agreement and the present stepped reduction program for phasing out use of the chemical was agreed upon in 1997 (7). The current position is that, except for certain special and emergency uses, manufacture and distribution of MB will cease on 1 January 2005 and 1 January 2015 for developed and developing countries, respectively. The important question now apparent is, how easy will it be after these phase-out dates to manage pest control programs that have relied for many years upon the use of MB as a fumigant? The very broad range of uses for MB can be expected to require an equally diverse range of alternatives.

Considering the agreed upon phase-out schedule, there is an obvious and urgent need to introduce alternative technologies to MB fumigation as quickly as possible both for soil fumigation – the major global use (*ca* 76%) on a volume basis (2), and for postharvest applications. Since 1992, there has been an ongoing and intensive research program into alternatives, much of it being conducted in the USA, a major producer and user of MB (43% of global usage in 1996)[1] particularly for soil treatment. The decision in the USA, in 1994, to phase out MB use totally within 7 years under the Clean Air Act, provided further inducement for research into alternatives. Some progress in reducing MB use has been achieved, much of this through the stepped reductions required in developed countries under the Montreal Protocol Agreement. It has been stated frequently that there is no single replacement for many of the uses of MB and this appears to be particularly true for soil fumigation, the field in which the greatest amount of research into alternatives has been conducted. A wide variety of alternatives have been proposed for soil treatment, many based upon combination techniques within Integrated Pest Management programs that may include chemicals. Among the many possible components of such programs are crop rotation, soil-less cultures, organic amendments, biological control, resistant varieties, soil solarization, and steam treatment. Where a broad spectrum of pests needs to be controlled, individual components may have to be combined, possibly with chemicals such as metam-sodium or dazomet. In some situations the chemical chloropicrin can be used effectively on its own to treat soil, but in others it needs to be combined with another chemical, 1,3-dichloropropene. The MBTOC Report of 1998 states that no single crop was identified that could not be produced without MB fumigation, although the Report does not refer to the effect on crop yields. Research is continuing and the very latest developments indicate that the fumigants methyl iodide (1,6) and propargyl bromide (3,10) can, under certain conditions, control pathogens and weeds as effectively as MB. Neither chemical is yet registered anywhere as a pesticide.

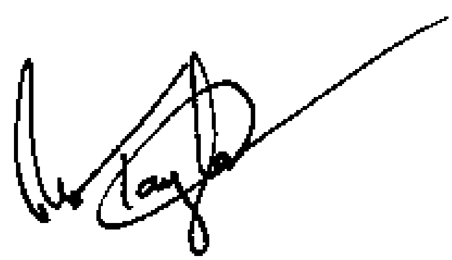
Although the postharvest uses of MB account for less than 25% of total world consumption, some of these uses are crucial to the maintenance of international trade. Fumigation is used to reduce the incidence of damage to commodities by pests, but also for quarantine purposes to prevent the entry into countries of particular pests that may harm local agriculture and export markets. The speed of action of MB is a major reason for its continued use for fumigating commodities moving in international trade. This property will be desirable for any alternative technologies introduced as replacements, because the use of slower disinfestation techniques could result in port congestion and product spoilage, especially of fruit, vegetables and cut flowers, for which treatments must last no longer than a few hours. The present exclusion from controls on MB when used for quarantine and pre-shipment purposes is recognition of the lack of suitable alternative treatment methods, particularly for perishable commodities. Although there are alternatives for treating both durable and perishable commodities, few have the advantage of rapidity of treatment associated with MB. Phosphine is a very effective fumigant for most durable commodities and is widely used, but its 5-day exposure period now regarded as a minimum requirement to avoid insect resistance renders it unsuitable where time is a constraint, such as in ships at port. Where suitable ships are available, in-transit fumigation with phosphine may offer an alternative to treatment with MB (8). The commercial development of cylinderized mixtures of phosphine (2%) in carbon dioxide may go some way towards widening the use

[1] Combined value for N. America, including Canada.

of the fumigant, and may allow shorter exposure periods than those traditionally associated with phosphine generated from solid metal phosphide formulations. Other gases are being evaluated as potential commodity fumigants to replace MB. Sulfuryl fluoride, used in the USA for many years to control wood-destroying insects, is currently being examined for possible use in quarantine treatments as well as a more general fumigant for stored products (5,9). In Australia, research programs are in progress to evaluate the potential of carbonyl sulphide, cyanogen, and ethyl formate; these gases may have uses in specific situations (2).

Finding alternatives to MB that are both economically and environmentally acceptable in a relatively short time-period is proving to be no easy task. The evidence for this is perhaps most clearly demonstrated by action in the USA, in 1998, to extend the deadline for a complete ban on the chemical from 2001 to 2005. The change appears to be due to the awareness that insufficient alternatives are available for an earlier phase-out than that agreed upon under the Montreal Protocol (4). What is true for the USA is almost certainly true for other major users of MB and considerably more research and field-testing are necessary before this unique fumigant is finally phased out. For developing countries, where agriculture and trading in agricultural products are often of special significance, the major concern will be the increased cost of alternatives to MB fumigation, and assistance to enable compliance with phase-out programs will probably be necessary for a considerable length of time.

In summary, there are alternatives for many of the applications of MB but, because many are less convenient to use, they are not being actively substituted for MB while the latter continues to be available. However, as the dates for phase-out approach and the quantity of MB on the market drops, its cost can be expected to rise and users will finally be forced to switch to alternatives. Research into alternatives has been pursued assiduously but, unfortunately, registration authorities have not always shown the same diligence and this may prove a constraint to the introduction of some alternatives. A further constraint is the relatively small potential market for some of the alternatives developed, and which may be a disincentive to investment by manufacturers involved in the costly activities necessary for registering chemicals. Use of MB is likely to continue in some sectors such as quarantine protection for many years, but for the majority of uses the international agreements on phase-out can be expected to ensure that alternative technologies are introduced to help protect the ozone layer.



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