THE FUTURE OF INTEGRATED CROP MANAGEMENT (ICM)

Alastair Leake of CWS Farms Group outlines the rationale behind ICM, emphasising its future potential as a management system

The development of agricultural production has typically meant the concentration of a single species in a confined area. Rather than crop plants being treated as individuals the field is treated as a single population to suit activities such as sowing and harvesting.

Traditional agriculture

In traditional temperate agriculture, production was limited by a number of factors most significantly the genetic production potential of the species, nutrient availability and weed competition, although pests and frequently diseases could also exert an influence. To raise yield potential farmers began to select seed with higher yielding ability from the average sample, construct rotations which combined fertility-building phases with exploitive phases and manipulated sowing date and seed rate to suppress weeds. Multiple control mechanisms, therefore, were used and each mechanism provided a level of control that cumulatively allowed the crop to dominate. That said, control levels were highly variable because their success was dependent, for instance, on weather conditions, which could be unpredictable. Nutrient availability was also a severe limitation to gross output, especially on some soil types where the restorative period was often longer than the cropping period.

Several developments were key to breaking the limitations of these traditional methods. Plant breeding became more specialised and systematic, giving rise to greater yield potential, and inorganic fertilisers were developed which enabled soil fertility to be improved. This latter development consequently influenced crop rotations enabling more exploitive crops to be grown, but this relative intensification brought increased pressure from antagonists such as pest, diseases and weeds. In North European agriculture, weeds proved the most severe limitation to yield, although mechanical control and physical removal using hand labour were generally effective; in warmer climates pests proved more problematical.

The introduction of broad-spectrum, highly toxic, inorganic pesticides in the 19th century based on elements such as lead, arsenic, copper, mercury and tin provided the most effective single method of pest control. They proved particularly valuable as seed treatments and in monocultured environments such as fruit orchards and glasshouses. Being general poisons, however, meant that these compounds were also toxic to humans.

Intensification of agriculture

The most significant development in pest control occurred in the 1940s with the introduction of the organochlorine insecticides such as DDT. This group provided highly effective control with relatively low mammalian toxicity and at single stroke removed the problem of pests from many crops and where pests had provided the major limitation this enabled greater intensification and specialisation. Subsequent developments of both selective and non-selective herbicides and the ability to produce unlimited quantities of nitrogenous fertilisers from oil and gas resources removed weed control and nutrient supply as restrictions to yield. The result of these technologies has been a perpetual increase in world food supplies.

This intensification of production has not been without cost or problems. The effectiveness of the organochlorines in controlling pests meant that farmers were able to abandon the multiple control mechanisms formerly used in favour of one single mechanism. The widespread and indiscriminate use of chemical insecticides led to some pest species developing resistance and in the absence of any other control pressure these were able to multiply rapidly with devastating consequences. Resistance problems initially were managed by substitution where an active ingredient was replaced by another with a different mode of action. However, where resistance was widespread this simply meant over-use of the alternative compound with predictable results.

Future alternatives – organic, GM or ICM ?

It has become apparent in recent years that the management of crops requires the selective application of cultural, biological and chemical control. Furthermore, the demands made of agriculture have, in a food rich society, become more multifunctional and the maintenance and enhancement of biodiversity and the environment are now a high priority, particularly within the European Union.

A farming system has developed which requires the farmer to adopt a rational and structured approach to crop planning using a combination of traditional techniques and modern technology. Known as integrated crop management (ICM) this system is increasingly being adopted in response to consumer concerns and economic pressures.

Adverse environmental impact coupled with concerns about food quality, traceability and "healthiness" have created the conditions for the emergence of another farming system which rejects the use of synthetic inputs and

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advocates a return to more traditional approaches to crop rotation and nutrition. Known as organic agriculture, the increase in both demand and acreage farmed to organic principles has been spectacular in Western Europe. Simultaneously and equally spectacular, has been the development and growth of genetically modified (GM) crops which are now grown on millions of hectares throughout the world. In direct contrast to the organic approach, this technology effectively commits the farmer to utilise a single control mechanism, namely a chemical herbicide in herbicide-tolerant crops, even before seed touches soil.

A number of benefits are claimed for GM crops, both economic and environmental and yet there is strong opposition to the introduction of such crops in Europe until a more complete understanding of environmental interactions is obtained. This is justifiable given the lessons learnt from the use of organochlorine insecticides 50 years ago where the extent of food-chain effects were not initially identified. The study of the interactions between agricultural practice and the environment needs to be examined carefully to identify the individual techniques characteristic of all systems, be they organic, integrated or conventional, which are effective but most benign. These must also meet the multifunctional demands of society for high quality affordable food, reliably produced with minimal environmental impact, embracing traceability and generating sufficient profit for the farm to be economically viable. Both the organic and intensive GMO routes fail to achieve all of these objectives. The integrated system, which is neither locked into a philosophy or locked into a technology, shows the greatest potential for achieving these functions but is currently underdeveloped and under researched to achieve its full potential. At present the system is struggling to move beyond crop level. Within the UK a series of ICM protocols have been produced under the Assured Produce Scheme and these are now independently audited. Arable crops have a separate scheme known as The Assured Combinable Crops Scheme (ACCS) which is also verified but the principal aims of both schemes is to provide assurance as to production and storage methods with limited emphasis on environmental enhancement. Those farmers who wish to aspire to a higher level may choose to adopt the LEAF (Linking Environment and Farming) audit which provides a voluntary, self assessment tool, as well as setting out general guidelines for integrated farming. To meet the aspirations of today's society, the future of integrated crop management is dependent upon a number of key steps. First ICM needs to adopt clear standards and objectives at both crop and farm level. These standards need to be agreed between the whole food chain from producers to consumers, and made enforceable. The standards need to address both the production technique and environmental aspirations. However, this should not be a blue print to farm practice since the best practice on one farm may be inappropriate on another, but provide a menu of best options. Each farm wishing to obtain integrated status would need an initial inspection to define what is best practice for that particular business and be verified independently against that more precise definition. This would include a compulsory environmental enhancement plan. Clearly such an exercise is not without cost but given the willingness of the public to pay significantly higher prices for a farming system perceived to give pure food and environmental benefits a small premium for a system that really does should not be too unpalatable. Before any system can make such claims, however, environmental impact assessments need to be made of the various cultural, biological, mechanical and chemical options presented and some identification of what exactly is to be enhanced and to what level. This requires research to identify the way in which agricultural production interacts with the environment, which is complex because it inevitably means studying food chain effects. In a food-rich society, it is an opportunity to improve farmland habitat and increase biodiversity.

Further reading

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After graduating in Horticultural Science (specialising in biological crop protection) from Reading University, Alastair Leake spent 10 years in the UK glasshouse industry growing a range of salad crops employing integrated crop protection techniques and hydroponic crop nutrition systems. He became Project manager for the new Focus on Framing Practice establised by CWS Agriculture, Profarma and Hydro Agri (UK) Ltd. in 1993. The project is evaluating crop production techniques which can consistently deliver high yields of quality affordable food with minimum impact upon the environment. In 1995 he became responsible for the 270-acre organic farming experiment which has been ongoing since 1989, producing useful comparative data with other farming systems.