Journal of Environmental Sciences Vol. 11, No. 4, pp. 443—448, 1999

ISSN 1001—0742
CN11—2725/X

Article ID: 1001-0742(1999)04-0443-06

Transfer of Australian environmental research on the insecticide endosulfan to Anhui Province, China

Turlough F. Guerin

(1691 E Gree Briars Dr., Suite 3821, Schaumburg, Illinois 60173, U.S.A. E-mail: turloughg@hotmail.com)

Abstract: This paper reports on a case study that involved the transfer of (1) methods for the analysis and (2) information on the fate and proper use of the agricultural chemicals, endosulphan, from Australia to Anhui Province, China. A key outcome from the case study was that there was relatively little awareness of the potential environmental impacts from the use of endosulphan. Cross-cultural constraints in the interaction were identified and areas which will require further effort in technology transfer were discussed.
Key words: technology transfer; environmental management; insect resistance; innovation; endosulphan; China
CLC number: X592 **Document code**: A

Introduction

Technology transfer, or extension (at the local level), is the process of moving innovations from their origin to their point of operation. Innovations may include scientific and technical knowledge, ideas, services, inventions and products. Technology adoption is the implementation of this already transferred knowledge and is the end product of the technology transfer process (Guerin, 1994).

In China, "Peasant Technicians" working within the Agricultural Socialization Service, form one component of this country's extension process. As Cai (Cai, 1995) describes, much of their work is concerned with the introduction of new scientific and technological methods to the small farmer and the improvement of the farmers' technical skills. These technicians also have functions in providing contact between the farmer and the government, and in spreading government policy within the rural community. However, because of shortage of funds, such state-controlled services have been largely ineffective.

Other mechanisms of extension in China are the service organizations called Collective Units, which are financed by local communities (governments at village and township levels), and Individual-Joint Units of peasant households. Collective Units in the eastern region have higher net incomes, and as a result are claimed to be better able to make use of innovations than those located in the less economically advanced middle and western regions of China.

The Participatory Action Research (PAR) model of extension and the more recent Participatory Rapid Appraisal (PRA) model (Chambers, 1994), are increasing in importance as means of technology transfer in rural areas in the Asia-Pacific region. The members of these groups gather and compare experiences of technology transfer and extension. There is little information in the literature on the actual extent and effectiveness of the PAR and RPA approaches in China, but it is likely that they will play an increasingly important role in rural development in the future.

Based on the information in the literature, it was evident that waste agricultural chemicals and poor management of these chemicals, has lead to widespread soil pollution in China. This paper attempts to address aspects of this issue using a case study of technology transfer from Australia to Anhui Province.

1 Rationale for the case study

There is a growing need for technology transfer of environmental and waste management technologies to China, particularly in lesser-developed provinces. It was central to this case study to encourage information and technology transfer between selected researchers and practitioners in Australia and endusers of the information and technology in Anhui. Those targeted in Anhui were conducting scientific research, education, and extension in environmental management,

particularly in relation to agriculture, as well as a group of vegetable growers (and other landusers) from the outskirts of Hefei City, Anhui. The specific aims of the case study were to (1) identify opportunities and constraints for future collaboration (between Australia and Anhui); (2) transfer information and technology for understanding the environmental fate of the widely used agricultural chemical, endosulphan, to stakeholders in Anhui.

2 Method

2.1 Case study methodology-information and technology transferred

2.1.1 Co-ordination and administration

This case study evolved from discussions with scientists at the university and the academy prior to the author's visit during December 1992. Delegates from the Foreign Affairs Office (FAO) coordinated the interaction, in conjunction with the Anhui Provincial Commission of Science and Technology and the university located in Hefei. The Research Institute for Asia and the Pacific (RIAP) provided partial funding for the case study at The University of Sydney, and the Ian Potter Foundation (Melbourne). The FAO (Anhui) provided accommodation, food, and local transport within Hefei.

2.1.2 Transfer methodology

A series of 5 lectures, each followed by workshop discussions (5 in total), was given at each of the institutions (1—1.5h duration for each lecture and approximately 1h for each workshop discussion). The methods for transferring the information and technology were based on the train-and-visit approach (Benor, 1984). During 2 of the lectures and associated workshop discussions, technology and information on the analytical aspects of endosulphan was presented and discussed directly with the end-users (researchers). This involved the use of informal/discussion and the issues discussed were: (1) the application of analytical techniques; (2) comparison of contaminant extraction efficiencies (between endosulphan and related compounds); and (3) procedures for optimizing contaminant extraction (from soil and water) and analysis, using locally available equipment (in Hefei). The information on the use of endosulphan (excluding the analytical aspects) was presented to potential local extension agents during 3 of the lectures and their accompanying workshop discussions, as well as to potential endusers of the information. It was recognized in this case study methodology that there were limited resources to transfer the information on endosulphan to all the end-users in the region.

3 Results and discussion

3.1 General findings

As a result of the case study, 4 key needs were identified as potential constraints for effective technology transfer from Australian researchers and information and technology providers, in the context of China. These were (1) the need to identify and prioritize environmental management research according to the needs of the province; (2) that there is limited funding, local expertise and other resources for research and application of environmental management technologies; (3) that there was a lack of evidence of prioritization of technology transfer and extension needs for insecticide management and the environmental fate of endosulphan, and (4) a need for an improved understanding of the inter-cultural aspects of the interaction between Australian technology providers and Chinese end-users.

3.2 Needs for identifying and prioritizing research, technology development and application

Both the institutions in Anhui considered that research into environmental management (particularly in agriculture) was important and necessary, but was not prominent because of the lack of direction in priorities, lack of expertise, and available resources. They recognized that identification and prioritization of both current and potential research and extension areas in environmental and waste management was needed (from both an agricultural and industrial perspective), and such prioritization would maximize the benefits from the research currently being conducted.

An example of where such prioritizing is required is the problem of domestic waste, particularly in and around Hefei. During the visit, it was observed that there were many (>10) relatively large volumes (>50000 m^3) of domestic waste landfills spread across Hefei and the surrounding rural areas. There is considerable scope for conducting research (relevant to Hefei) into enhanced biodegradation of domestic wastes, particularly in landfills, and recovering energy (i.e. biogas technology) from this potential resource.

3.3 There is limited funding, local expertise, and other resources

It was apparent that there was limited technical support for scientists, lecturers and research students (at both institutes) with regard to the operation and maintenance of laboratory equipment. This was particularly the case with GC equipment for determining insecticides. At the time of the case study, the 2-year-old GC (at the university) was not being used (nor apparently had been since purchase). This was because there was no one (known by or within, the Department of Plant Protection at the University) that could set up, maintain and operate the equipment (on a day-to-day basis). Furthermore, it was noted that there were electricity failures commonly occurring at each of the institutions visited, which had reportedly led to failures of numerous laboratory trials.

During the workshop discussions the importance of understanding how to use and maintain such equipment for obtaining reliable results were discussed, based on work conducted with similar equipment in Australia (Guerin, 1993). Further direct instruction is likely to be necessary to ensure the specific technical information is transferred and implemented. This example of analytical instrumentation illustrates how lack of resources, financial and otherwise, can make commercial technology transfer prohibitive since transferring organizations need to have specialist staff located on-site.

3.4 Local technology transfer needs were identified

There are potential hazards from the use of agricultural chemicals. It was evident from the workshop discussions that there was limited local knowledge of specific contamination problems caused by agricultural chemicals. This was reported by the university, the academy, and landusers, and particularly with regard to endosulphan. The majority of individuals were, however, aware of general developments in the international research field and had access to relevant international scientific and technical information. Information on envelopments on the fate of endosulphan in the environment (presented during the case study) was recognized as important for landusers in Anhui.

Although it was apparent that the type and extent of contamination problems in Australia and China are different, particularly with regard to domestic waste, both countries have relied on the use of agricultural chemicals to maintain and improve their primary production. As a result, both countries have environmental problems arising from their long term use. In Australia, and other developed countries, these problems have been well documented (Guerin, 1993). The rapid adoption of the use of agricultural chemicals in Australia has in some cases led to environmental impacts. However, the increased use of agricultural chemicals *per se* should not be blamed for the various environmental problems attributed to their use, but rather these problems have arisen from a lack of understanding of their potential environmental impacts and their subsequent mismanagement. In Australia, problems with organochlorine insecticides include the build up of specific chemicals in soil and bioaccumulation in livestock grazing on contaminated soil. Contamination of ground water supplies and the problem of resistance of insects to insecticides are further issues.

There is considerable potential for the reduction in the use of agricultural chemicals. Pimental *et al*. (Pimental, 1993) have thoroughly described both the environmental effects of reducing pesticide use in agriculture and have demonstrated that it is possible to reduce pesticide use by 50% without any decease in crop yields or change in "cosmetic standards". There are therefore considerable opportunities for developing nations such as China, particularly where application rates

and regimes can be further optimized. A Joint UNDP/UNIDO initiative, called the International Organization for Pest Resistance Management (IOPRM), provides a vehicle for this, particularly on the proper use of endosulphan and other insecticides (Forrester, 1993). Other Australian initiatives in the field of pesticides and their application to pest control in China and other LDCs of the Asia-Pacific, such as seminars and exchange programs, should be of assistance in this regard.

3.5 Endosulphan has a critical role in Chinese agriculture

Because of the problem of increasing resistance to insecticides in China, and particularly throughout the cotton growing regions of Northern China, the Chinese National EPA accelerated the registration of endosulphan. Up until 1991, this insecticide was not registered for use in China. The particular insects of concern were Heliothis moths and Aphids. Endosulphan should prove suitable in minimizing the resistance problems for similar reasons it has been successful in Australia and the United States. In these latter countries, it had been incorporated into insect resistance management (IRM) strategies and these have been widely (although not totally) adopted by farmers (Forrester, 1996). Endosulphan is now recommended for use in mixtures with the Bacillus thuringiensis (Bt) toxin and pyrethroids where populations of Helicoverpa armigera (a multiresistant species), has been identified, and where the use of this combination is economical (Forrester, 1996), such as in high value crops.

3.6 The effectiveness of endosulphan needs to be maintained

From the workshop discussions, many Anhui farmers reportedly use considerably lower concentrations of agricultural chemicals (from all the broad chemical groups) for insect control than those recommended by the manufacturers. In addition, they reportedly spray more regularly than recommended. In doing this, many populations of insects have reportedly become resistant to an array of insecticides. This has meant that higher concentrations of insecticides are being used to achieve insect control. The discussions on endosulphan, between the author and the participants, were important in raising awareness of this chemical and its potential for misuse.

When insect resistance continues unabated, then the chemicals currently used become ineffective and new chemicals need to be found. Considerable extension effort is required in China to disseminate information to the end users (predominantly farmers) to minimize the problem, that is, ensuring that it is used at the appropriate times of the growing season, nor applied too frequently, or at lower than recommended rates. Based on experience in Australia, IRM strategies have had to change, so ongoing technical exchange and extension will be necessary. The impact of using lower than recommended rates of agricultural chemicals in the environment has not been fully assessed in Anhui. Recent research by Chinese scientists has demonstrated that the use of endosulphan in mixtures containing insecticides from only 2 other different chemical groups, can reduce the incidence of insect resistance (Jiang, 1995; Forrester, 1996). Jiang and Liu (Jiang, 1995) also claim that landusers and other pest controllers in China are switching to the use of insecticide mixtures as the main method for controlling resistant populations of insects. This information needs to be widely and effectively communicated to, and adopted by, those involved in insect control in Anhui, as well as other cropping areas in China.

3.7 Non-point source soil contamination in rural Australia has been effectively managed

From discussions with the scientists from both institutions in Hefei, there is reportedly a problem of diffuse (non-point source) contamination over very large areas of land in Anhui (and other rural areas in China), where landusers have applied agricultural chemicals. There is, however, very little documented evidence on the extent of the specific problem in Anhui. In Anhui, non-point source soil contamination is unlikely to be addressed in the short term. A reason for this is that the main agricultural activities in the province are the growing of vegetables, rice and wheat, and production of livestock, mainly for local consumption. This is unlike much of Australia's agriculture, which involves grazing of livestock and subsequent sale of this meat for export. In this regard, Australian farmers had to act quickly to adopt practices which minimized contamination of livestock with agricultural chemicals when non-point source contamination with

chlorinated insecticides in pastures and pasture soils threatened Australia's beef export market in the last 1980s.

The problem of trace organochlorine insecticide contamination in grain crops and livestock is likely to become evident as China's agricultural exporting increase. Australia is in a position to alert China of the problems (past and present) in Australia, and how Australia has effectively managed these issues.

3.8 Inter-cultural aspects of collaboration are important in the technology transfer process

Observations were made regarding the inter-cultural interaction with the Chinese during the case study. Other aspects were the importance of being tolerant to the apparent ambiguity of general social interaction, being aware of particular gestures and body language, and checking that information was accurately being conveyed.

These observations should be of relevance and assistance to others aiming to transfer technology or exchange information with the Chinese. The observations from the case study are consistent with other sources that have discussed limitations to effective inter-cultural interaction between Westerners and peoples from the Asia-Pacific region, in particular the Chinese (Guerin, 1998). Selected observations during the case study were noted in the following paragraphs.

When presenting in front of the various groups, it was important to keep sentence length to a minimum. This was most important because, out of politeness, the Chinese generally do not ask for the speaker to repeat what has just been said. This problem, however, was kept to a minimum during the lectures and workshop discussions in the current case study because of simultaneous translation. Another notable aspect of the 1-on-1 interaction with the participants, was the vigor and energy of the participants and the enthusiasm with which the author was received during the case study. It is likely that this vigor demonstrated the participant's desire for new information but probably also reflects other inter-cultural issues.

It was noted that many of the questions that were asked by the Chinese participants attending the lectures and workshop discussions, were generally from those more senior (with respect to expertise), thus reflecting the importance of rank, age, and position in Chinese culture. The younger participants tended to ask questions informally, in the absence of their senior peers. Morrison *et al*. (Morrison, 1996) also highlight the importance of the highest ranking member of the western term leading any discussion and that subordinates in the western term can "shock" the Chinese delegation if they interrupt.

The current case study has identified some of the key constraints likely to be encountered, however, further empirical research needs to be conducted. Cross-cultural constraints need to be identified, understood and minimized for the effective transfer of technology and information to LDCs in the Asia-Pacific region.

4 Conclusions and recommendations

A linkage was established between Australian researchers and the major institutions in Hefei (Anhui) in the field of environmental management, particularly in relation to agriculture. Ongoing interaction, however, will be required to continue the transfer of appropriate technologies and information from Australia to Anhui, to help develop specific research programs, and assist in prioritizing research areas. It is evident that the areas of industry and agriculture that are having the greatest impact on the environment, in Anhui, need to be identified and prioritized for focused research and subsequent development and application of appropriate contamination minimization, mitigation and treatment technologies. It is apparent that there are a number of environmental issues of concern in China in relation to increased industrialization and expansion of agriculture and in particular the need to manage economic growth so as to ensure minimizaiton of environmental impacts, including air, soil and water contamination.

The findings from research conducted in Australia on endosulphan are relevant to Chinese agriculture because of its widespread and increasing use in China. Considerable local technology transfer (or extension) effort is required in Anhui Province to ensure land owners and other

agricultural chemical users understand the importance of using this chemical properly, and to change their behavior (where necessary). Legislators and regulators, scientists, agricultural technicians, extension workers and farmers in China, should consider the importance of adopting any new innovating to reduce residues of pesticides in the environment. The International Organization for Pest Resistance Management (IOPRM) provides a vehicle for this particularly on the proper use of endosulphan and other insecticides (Forrester, 1993). There is evidence that the efforts of the IOPRM have already been rewarded through subsequent technology exchanges between Australia and China.

It is apparent that overcoming the language barrier is only part of the overall problem of effective inter-cultural communication in the field of environmental management. Further effective transfer of technology, information, knowledge and skills between Australians and Chinese in the area of environmental and waste management, is likely to require a greater understanding of the constraints to effective inter-cultural communication.

Further empirical research could be conducted to determine the extent of technology transfer as a result of the case study, particularly information on the use of the insecticide endosulphan by landusers in Anhui Province. The further application of the PAR and PRA approaches to technology transfer are likely to prove useful for gathering this information and further assisting local technology transfer in Anhui Province. Further research is also required to determine which organizations are involved in technology transfer, particularly those in the private sector. Such research could include a systematic identification of the constraints to the transfer process, which when acted upon, should improve the effectiveness of current and future efforts in technology and information transfer. Assessing the importance (and contribution) of the private sector in this field is an area for further research, particularly in identifying the types of projects carried out and reviewing the effectiveness of these projects in delivering actual improvements in environmental performance in Anhui, particularly in agriculture.

References:

Benor D, Harrison J Q, Baxter M, 1984. Agriculture, Extension: The training and visit system [M]. Washington DC: World Bank.

Cai Y R, 1995. Research of Agricultural Modernization [J], 16(3): 211—212.

Chambers R, 1994. World Developments [J], 22(10):1437—1454.

Forrester N W, 1993. The management of resistant cotton pests in China [R]. Report prepared for China by the International Organization for Pest Resistance Management (IOPRM). Australia: IOPRM, 45.

Forrester N E, Bird L J, 1996. Molecular genetics and evolution of pesticide resistance [M] (Ed. by Brown T H). Washington DC: American Chemical Society, 160—168.

Guerin T F, 1993. The relative significance of biodegradation and physico-chemical dissipation of endosulfan from water and soil [D]. Department of Agricultural Chemistry and Soil Science. Sydney, New South Wales, Australia: University of Sydney. 240.

Guerin T F, 1998. Transferring environmental technologies to China: An Australian perspective [C]. Asia Pacific Economic Review. Volume 6, Issue 5.

Guerin L J, Guerin T F, 1994. Australian Journal of Experimental Agriculture [J], 34: 547—571.

Jiang Y G, Liu R X, 1995. Resistant Pest Management [J], 7(2):21—23.

Ji G L, Liu R X, 1996. Contaminants and the soil environment in the Asia-pacific region [M] (Eds. by Naidu R, Kookana R S, Oliver D P, Rogers S, McLaughlin M J). Dordresht: Kluwer Academic Publishers. 485—499.

Morrison T, Conway W A, Borden G A, 1996. Kiss, bow or shake hands [M]. Holbrook, Massachusetts: Adams Media Corporation. 55—62.

Pimental D, McLaughlin L, Zepp A *et al.*, 1993. Agriculture, Ecosystems and Environment [J], 46:273—288.

(Received for review October 5, 1998. Accepted December 21, 1998)