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## Report of the Working Group on Scientific Research, Technological Development and Training

1996-09-23

The working group was established in the beginning of 1993 under the joint chairmanship of Prof. Sun Honglie of the Chinese Academy of Sciences and Dr. Osayuki Yokoyama of the past four years, the work of this group has covered a wide range of important issues, starting with the general issue of environmental scientific research, technology development to achieve cleaner production and sustainable agriculture. With the support of the Japanese, Canadian and Chinese governments, the group has been able to organize more than 30 scientists of concerned disciplines from China and the rest of the world, and to provide seven reports to the Council and the Chinese Government. In 1996, the last year of the first cycle of CCICED, this group provided the following two annual reports.

### Sixth Report

Sustainable Water Resource Management as a Component of Cleaner Production in China

#### Executive summary

Water resources are critical to China's economic and industrial growth and may be a more limiting factor than energy. But water resources management has been given less attention than energy within national planning for the industrial sector. In particular, water demand management has not been sufficiently promoted as an alternative to major and costly water development and transfer schemes. The geographical distribution of water in China compared to the areas of water demand creates water scarcities for industry and urban areas. China also suffers from major water pollution problems from municipal waste, 80% of which is untreated as it enters water bodies; agricultural runoff carrying fertiliser and pesticide residues; and industrial waste water. The many small township and village enterprises in rural areas pose a particular challenge for water control because of their large numbers, wide geographic dispersal and highly polluting technology and production processes.

The CCIED Working Group 3 has reviewed industrial water consumption in China, with particular attention to case studies of high water consumption industries such as iron and steel, coal power generation, and the chemical fertiliser industry, and has compared Chinese performance with experiences in other countries. A similar comparison, based on case studies of dye stuff industries, pesticide manufacture, and pulp and paper mills, as examples of highly polluting industries, was conducted with respect to water pollution control performance. For both water consumption and waste water quality, industrial performance in China fell considerably below best practice in other countries such as Japan, the Netherlands and North America.

The Working Group concludes that there is great potential for water savings and for improving water quality in China, and that demand management for industry would reduce both water requirements and the amount of waste water discharged. The key to demand management is to encourage water recycling by industry, by making the best technology available and using legislative and economic measures to make recycling the most cost-effective option for industry.

Integrated water management, based on river basins as the spatial unit, and with specially legislated water management authorities, is seen as essential to comprehensive national planning for water as a critical national resource and as an input to industrial production. Research and training in China also suffers from not having a holistic approach to water, including both the natural and social sciences and engineering sciences. There is also a lack of interdisciplinary institutes with a focus on water.

International cooperation is an important component of a national innovation strategy for cleaner production, combining Chinese innovations in science and technology with assessment and adaptation of key technologies from abroad, as well as experimentation and adoption of legislative and economic measures that have been successful in other countries.

## Recommendations

### 1. Comprehensive planning and management for water

· Water supply is as critical to China's industrial success as is energy. There should be long term national planning for water development and conservation, which establishes the legal framework for national, provincial and local planning for industrial development and factory location.

· Industrial planning should locate water intensive industries where water is most available. For example, more use could be made of sea water for cooling purposes, if water intensive industries were located along the coast.

· Water authorities should be established with clear legislative authority at the local level to implement comprehensive planning and integrated management of water resources.

· Comprehensive management is best based on the spatial unit of river basins.

### 2. Water recycling

· China faces water scarcity and has developed major projects for water transfers to its urbanised and industrial areas in the north and east. Savings in water consumption of up to 75% for certain industries can be achieved by water recycling at much lower costs than major water infrastructure projects. Therefore water demand management, including technological, legislative and economic measures to achieve recycling, should be a major component of China's national water management strategy. This recommendation supports the findings of the CCICED Working Group on Resource Accounting and Pricing Policies.

### 3. Water control technology in cleaner production

· Technology for water recycling and waste treatment should be developed in parallel. Research and development (R&D) in China should focus on appropriate technologies for small, medium and large enterprises.

· A national innovation strategy to develop water control technology is recommended to include both the strengthening of Chinese capacity for technology assessment of foreign technologies and support to Chinese R&D institutions to develop Chinese technologies. The current situation of enterprises and local authorities buying many different technologies is expensive in initial capital costs, leads to higher maintenance costs, and does not necessarily provide the best outcomes to meet water quantity and quality objectives.

· Technological solutions are not enough. Cleaner production within industry must also involve innovation in production processes and management systems, which should include specific attention to water demand and water treatment.

### 4. Township and village industrial enterprises

· The successful development of rural industrialisation in China has led to the creation of millions of small point sources of water pollution which in combination are a major pollution problem for China. Since environmental clean-up costs are too high for small, generally under-capitalised enterprises, the Working Group recommends that further research is needed on land use zoning, water demand management and pollution control as key preventative measures within cleaner production innovation for township and village industrial enterprises.

### 5. Water pricing and other economic measures

· Water prices for industry should be increased, so that together with effluent charges, they become an incentive for industry to adopt water conservation, recycling and treatment measures.

· Regulatory measures should generally combine both economic incentives such as subsidies to install water recycling and treatment technologies, and disincentive such as water quotas, effluent charges and fines for noncompliance. The implementation of existing regulations

should make water control measures attractive to industry and should be reinforced by effective monitoring and prompt government action.

#### 6. Research and training

- More support should be given to interdisciplinary research on water through special research funding initiatives and through new institutional arrangements ,such as research networks.

- Existing research institutions for water should encompass a more holistic scientific approach to water and to water management, and some institutions ,such as the China Water-Pollution and Waste-Water Resource Research Center in Beijing should expand their training activities.

- Engineering institutions and universities have particular responsibility to ensure that water economy and waste treatment is a component of the curriculum not only for water specialists but also in industrial process design courses.

- Expanded and upgraded training programs for water managers in government and industry at all levels should be a priority, for both urban and rural areas.

#### 7.International Cooperation

- It is recommended that a special program in international cooperation on water, particularly within the Asian region, be established to include scientific information exchange and innovations in water technologies and management. This would enable Chinese industry to take advantage of the experience in other countries and could increase the rate of innovation within China to offset the current unsatisfactory technology import situation.

#### 8. Establishment of a new CCICED working group on cleaner production

##### Proposal for a Working Group on Cleaner Production

In"China's Agenda 21", the Chinese government proposes sustainable agriculture and cleaner industrial production as its priority programmes to ensure China's sustainable development, With support of concerned UN agencies and developed countries, the Chinese government has make great efforts in promoting sustainable agriculture and cleaner production in major industrial sectors since the Earth Summit in 1992.Considerable progress has been made. Since 1993,the CCICED Working Group on Scientific Research, Technological Development and Training has undertaken investigations and research on environmental R & D, cleaner production, water resource management and sustainable agriculture. Many suggestions and recommendations have been put forward with respect to policy, legislation, management, R&D, education and training.

It is therefore proposed to split the Working Group on Scientific Research, Technological Development and Training into two new groups in the next cycle of CCICED: one group to study cleaner production and the other to focus on sustainable agriculture.

The Cleaner Production Group is to develop a work plan focusing on three key aspects of cleaner production. The following three components resulting from earlier investigations will compliment the work being undertaken by other CCICED working groups such as the Trade and Environment Group, and the Resource Accounting and Pricing Group. As a result, the work of CCICED will be strengthened through closer working group collaboration.

- 1.Township and village enterprises have developed rapidly, and rapid development has resulted in severe environmental pollution. Recommendations on policies and regulations, guidance for cleaner technologies, production model and structure of products will be given by the working group.

2. Climate change is an important issue in the world and also in China. Special measures in the areas of policy, management and cleaner technology should be taken to reduce the emission of GHG. Analyzing the barriers and problems, and searching for a practicable solution, will be a major task for the working group.

3. ISO 14000 will be adopted throughout the world, challenging Chinese enterprises in which the traditional model, with poor management and out of date processes, is still in vogue. If more attention is not paid by central and local and authorities and enterprise managers, then sustainable economic development will not be possible in China. It is therefore very important for the government authorities and enterprise managers to know ISO 14000.Suggestions on adopting the economic and environmental coordination development model for cleaner production

should also be given to these authorities and managers. Additionally, the experience from developed countries should be combined with the situation in China to ensure an optimal solution.

In addition to the Co-Chairs, contributors to the reports from this group include seven international and nine national experts and their assistants as follows:

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Seventh Report

The Role of Sustainable Agriculture in China's

Environmentally Sound Development

Executive Summary

China is rapidly becoming a major industrial power, yet agricultural growth will continue to be vital to both economic and social welfare and environmentally sound development. There is a danger, however, that agriculture may be unable to make this contribution in the future, unless certain challenges are met.

China's agriculture faces three interrelated challenges. First, expanding future production fast enough to remain broadly self-sufficient in food, and particularly in grains. Second, ensuring that future agricultural growth is sustainable and reversing its current negative impacts on the environment. Third, raising farmers' incomes so their material well-being improves and they have both the incentive and the capital to invest in better soil conservation, more efficient irrigation and upgraded technologies. The three challenges are linked by the issue of China's environmentally sound development and the need to strengthen and redirect science, technology and training to provide the foundation for sustainable agriculture.

Some western observers doubt whether China's agriculture can grow fast enough to meet the rising demand for food. They predict that China cannot remain self-sufficient in basic foods like cereals, and will rapidly become a major net food importer, possibly importing 369 million tonnes of grain by the year 2030. They believe that overseas suppliers will have difficulty in producing such large amounts for China.

CCICED Working Group 3 believes that this view can be questioned, China has the potential to remain broadly food self sufficient and to protect the local and global environment, provided that there is prompt action to:

- a. reduce the amount of prime cropland lost to urban and industrial development;
- b. prevent land degradation and other environmental damage;
- c. improve the supply of water for irrigation, and raise water use efficiency in both rain-fed and irrigated farming areas;
- d. increase crop yields and labour productivity through the application of sustainable and eco-agricultural concepts(see note 1)and appropriate mechanization;
- e. raise livestock production by increasing investment in improved grassland productivity and fodder production to reduce China's growing dependence on imported feedgrains; and.
- f. increase research and development (R & D)efforts to provide the scientific and technological basis for the required innovations.

(Note 1:Eco-agriculture is defined as a new approach to agricultural production and development which combines the ecologically sound features of traditional farming practices with the higher productivity possible with some modern agro-technologies, It seeks to maximize eco-system stability and agricultural sustainability through the recycling and renewal of plant nutrients and the strengthening of natural pest and disease control mechanisms.)

The loss of prime cropland to urban and industrial development is very serious, being about 0.2%per year nationally, and as much as 6%annually in some coastal are as, These losses are not sustainable, If they are allowed to continue China could lose 10%of its cropland over the next 50years.Thus there is a need for comprehensive legislation to protect prime farmland, and strict enforcement mechanisms to ensure that the law is fully implemented at the local level, More investment is also needed for new land development and the restoration of degraded land, If these opportunities are grasped, net land losses could be quite small.

Soil erosion, salinization, and other forms of land degradation are lowering crop yields on the remaining land, Techniques are available to limit this degradation but greater awareness of the opportunities and the dangers of inaction are needed at all levels, Additionally, there should be stricter enforcement of land use regulations at the local level, and better incentives for farmers to abide by the regulations.

The poor management of modern agricultural technologies, such as the use of certain pesticides, is harming the health of agricultural workers and food consumers, lowering crop yields and undermining the sustainability of farming systems, as well as endangering drinking water supplies. These problems need action at many levels, but particularly in the area of R&D and at legal/regulatory levels. Research is needed to raise the understanding of the sustainable plant nutrient and pest control mechanisms embodied in existing Chinese eco-agricultural systems, so that they can form the basis of new technological developments. Legal and regulatory action is needed to prevent or restrict the use of dangerous pesticides, and to provide better incentives for the development of effective and integrated crop nutrition and pest management systems.

Agricultural performance, of which seventy percent if grain production, is heavily dependent of irrigation; but this contribution could fall because of growing water shortages, Rapid urban and industrial development are causing increasing competition for the limited supply of water, Therefore much needs to de done to develop new sources of water, and to raise the efficiency of water usage if agriculture. Better irrigation and water harvesting techniques could do much to achieve a greater availability of water and higher agricultural efficiency.

Finally, the adoption of the existing opportunities to counter land degradation and to improve the use of existing technologies, together with the development of new technologies with lower input levels that exploit eco-agricultural concepts, could make another major contribution. Adopting these opportunities would help to achieve

sustainable increases in crop and livestock yields, as well as the higher land and; labour productivity that are required to raise farm incomes and provide the incentive for greater investment if sustainable agriculture.

The Working Group concludes that it will not be easy to overcome the challenges of broad food self sufficiency, to achieve sustainable and environmentally benign agriculture, and to improve farm incomes, However, there are either existing options for doing so, of good prospects for

developing appropriate ones, the options require a wide range of changes. The following options are of particular note:

1. The formulation of a long-term development strategy for agriculture, because the required shifts in technology will take longer than the usual 5-10 year planning framework;
2. Strong investment in agricultural R&D, Independent projections suggest that a slowdown in agricultural R&D could cause a fourfold increase in the amount of cereal imports required by China by the year 2020. This would have major implications in the area of foreign exchange expenditure;
3. The redirection of agricultural research to focus more on the development of economically and environmentally sound technologies;
4. The creation of greater awareness at all levels of the need to accelerate the shift to more sustainable agriculture, and to change the training and incentives given to extension workers to promote sustainable agriculture;
5. Extend efforts to widen international cooperation for the development of sustainable agricultural technologies.

#### Recommendations

##### Legal and Regulatory measures

1. A strong state law should be adopted to protect prime cropland, together with new enforcement mechanisms at the provincial and local level to ensure compliance.
2. Legal and institutional mechanisms should be strengthened to ensure compliance with the International Code of Conduct on the Distribution and Sale of Pesticides so that highly toxic and persistent pesticides are banned or highly restricted.

##### Agricultural development strategies and research

3. New strategies for agricultural research should replace the present fragmented uni-disciplinary approaches. The strategies should be restructured to follow a more integrated multi-disciplinary approach based on eco-system concepts, and the enhancement of agriculture's environmental conservation functions. They should focus on increasing the efficiency of the existing eco-agricultural systems, on maximizing natural crop growth enhancement processes and nutrient cycling, and minimizing off-farm input needs and land degradation.
4. More emphasis should be given to the development of less expensive slow release mineral fertilizers that increase resource use efficiency, raise farmers' incomes, reduce contamination of surface and ground water, and minimize the release of nitrous oxide into the atmosphere.
5. Research and development work and demonstration trials on integrated pest management (PM) should be expanded with emphasis on biological control, the use of biopesticides, reduction in the number and rate of pesticide applications, and the maximization of natural mechanisms. It should be supported by the development of low toxicity, coated and of the less polluting pesticides.
6. R&D on mechanizing weed control and other labour intensive practices should be increased.
7. A national program should be established to raise water use efficiency in (a) irrigated areas through changes in water pricing, water management practices, improvements in application techniques and on-farm water recycling, and (b) rain-fed areas through the wider adoption of water harvesting, mulching and other practices.
8. Grass fed livestock production should receive much greater emphasis in China's agricultural development strategy and investment. It should aim at increasing the utilization of China's vast grassland resources which are not suitable for crop production, and reducing the need for imported feed grains. RGD needs to be expanded on pasture improvement and fodder crops for the better quality grasslands.
9. China's aqua-culture potential is important and needs to be protected in a number of ways. A license system should be implemented that aims to achieve maximum sustainable yields, such as by preventing over-fishing through restrictions on the area and timing of fishing. Investment in aqua-culture production (especially in North China) and in processing should be raised. R&D on aqua-cultural diseases should receive greater priority.

##### Training and awareness

10. An awareness raising program should be launched for national leaders, senior administrators, scientists and farmers to highlight the need for and benefits of a more sustainable agricultural growth path and eco-agriculture approaches.

11. Training and awareness programs should be strengthened for those involved in the clearance, sale and use of pesticides in order to improve compliance with pesticide safety regulations and good practice.

12. The working conditions of extension workers should be improved to improve access to this knowledge.

#### International cooperation

13. A number of countries have developed integrated pest Management (PM), soil and water conservation, and irrigation techniques that could be very beneficial to China. Special cooperative programs should be established to improve access to this knowledge.

#### Establishment of a new CCICED working group on sustainable agriculture

14. Proposal for a Working Group on Sustainable Agriculture;

a. In "China's Agenda 21", the Chinese government proposes sustainable agriculture and cleaner industrial production as its priority programs to ensure China's sustainable development. With support of concerned UN agencies and developed countries, the Chinese government has made great efforts in promoting sustainable agriculture and cleaner production in major Industrial sectors since the Earth Summit in 1992. Considerable and consistent progress has been made ever since. From 1996, the CCICED Working Group on Scientific Research, Technological Development and Training has undertaken investigations and research on environmental R&D, cleaner production methodologies, water resource management and sustainable agriculture. Many suggestions and recommendations have been put forward with respect to policy, legislation, management, R&D, education and training.

b. It is therefore proposed to split the Working Group on Scientific Research, Technological Development and Training into two new groups in the next cycle of CCICED: one group responsible for cleaner production and the other group responsible for cleaner production, and the other group responsible for sustainable agriculture.

c. The primary tasks of the new working group on sustainable agriculture should be to:

(I) promote sustainable food production and natural resource conservation;

(II) consider in more detail the actions required to advance the principles and practice of eco-agriculture, in particular, to bring together traditional farming skills with frontier science;

(III) examine R&D and the other required changes in a much longer time frame than most current analyses and encourage scientist-farmer participatory research;

(IV) set out the multi-sectional nature of the policy and infrastructure changes needed to ensure that China's agriculture shifts onto a more sustainable growth path and plays its full role in China's environmentally sound development.

Under the leadership of the Co-Chairs, the following seven international and nine national experts and their assistants from this group contributed to the report:

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