



# *Science, Technology and Development*

*by*

*H.R.H. Princess Maha Chakri Sirindhorn*

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**Her Royal Highness**

**Princess Maha Chakri Sirindhorn**

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# *Science, Technology and Development*

I am neither a scientist nor a technologist. My interest is in development, and I consider myself a development worker. Professor Dr. Ginkel, President of the United Nations University, may also have thought so when he invited me to participate in this international conference on “Globalization: Challenges and Opportunities for Science and Technology” during August 23-24, 2006, and to give a lecture on science, technology and development. The preparation for this lecture was quite a serious matter. The organizer of the conference asked me to submit my vitae of not more than 150 words and an abstract of 400 words by June. The full paper was due in July.

After the talk I was advised that I should translate my lecture into Thai. They thought it would be useful for the Thai people too. So I did that, but instead of translating the full lecture I rewrote a short paper summarizing it, because I felt that most Thai people have already known well about it, especially the examples from His Majesty the King Initiated Projects. The paper in Thai was first published in the Journal of the Military Academy of Thailand. Afterwards the National Science and Technology Development Agency (NSTDA) published it as a booklet.

NSTDA would also like to publish the full lecture in English, which could be useful for non-Thai readers. This book is for that purpose. It begins with the abstract and the full paper submitted in July, 2006, with a few more things that I added during my lecture. My points were elaborated and illustrated by a presentation of a number of slides. The second part of this book describes those slides.

# *Abstract*

*Development is a process leading to progress or change for the better. Sustainable development is the goal of those who work toward improving livelihood of the people without destroying the environment. In implementing a development project, both high and appropriate technologies are very important tools to achieve successful results and outcomes. This applies even at the grass root level at which provision of the four basic necessities for life, namely, food (including water), habitation, clothing and medicine, is the fundamental aim.*

*Over the past century, we have witnessed the key role of S&T in development leading to alleviation of poverty, better health and better education. The remarkable advancement in information technology, biotechnology, material science, nanotechnology, space technology, etc., has greatly enhanced our capacity of utilizing, reconstructing, managing and conserving the nature. From the author's experience, education, work, health, and security are the key aspects of development, and S&T plays an important role in all. This presentation will highlight some lessons learned in the development projects in Thailand, in relation to the application of S&T in development. Some selected issues on agriculture, health, nutrition, education, water, energy and environment in various projects will be exemplified.*

*The 21<sup>st</sup> Century brings many challenges and opportunities to science and technology. Through research and development, S&T has expanded knowledge and options for mankind for centuries, and it will continue to do so at an even more rapid rate in this Century. However, as the costs of research*

*and research products are rising, “knowledge divide” can become an important global issue in the near future. We may be faced with new kinds of poverty, illiteracy, ethical problems and social unrest, caused by that divide.*

*UNESCO and UN University can take the leading role in promoting S&T cooperation and tackling such dilemmas to bridge the gaps among the faster- and the slower-growing “knowledge societies”.*

# *Introduction*



Science and technology have enhanced the capacities of human beings in utilizing and transforming environments to meet their needs. In the past few decades, scientific and technological advances have caused very rapid changes in human societies. We can say that science and technology speed up development, and in turn development catalyzes science and technology advancement. They have evolved together and are indicators of one another.

## *My View of Development*

Development is a process leading to progress or change for the better. The goal of development workers is sustainable development to improve livelihood of the people without destroying the environment. One must recognize that development varies with culture, geography, religious belief, ethnicity and socioeconomic background. Even though there is no “one-size-fits-all” formula of development, success stories usually involve development workers who are caring, responsible and respectful for other human beings. In other words, development involves a lot of humanity and spiritual element.

Obviously, in order to achieve the goal we need to improve a lot of things, and we have to specify our goal clearly. In my experience, sometimes

we want to help disadvantaged people, we start with improving the place and their livelihood. For example, we improved their schools. Formerly, it had been a bad school. When we improved its quality until it became a good school, rich or influential people put their own relatives in this nice school. Of course, the place has turned into a gorgeous place, but the people we would like to develop have been chased away somewhere. We end up developing the place, instead of the disadvantaged people. This is the dilemma of development.

In charity we have to give without other thoughts. In development, however, we are more outcome-oriented and need to do a lot of experiments. Sometimes people criticize us that we experiment too much. We always experiment, because if we introduce new things without experimenting, we might have something which works in some place, say in Japan, but not in Thailand. So we have to experiment first to see whether it is really good for Thailand. This takes a lot of time, and after that we have to do a lot of assessment and evaluation to decide whether to continue the development process or not. Anyhow, we need to have love, diligence, knowledge, skills, faith, and conviction, just like we do in charity. This is not just that we are benevolent and help other human beings. Human beings are social animals, and we have to live together. If others are unhappy, we cannot be happy alone. This is how we work.

## *Science and Technology*

**Science** is a study to gain understanding about nature, from something as small as quantum to the limitless universe. The knowledge of science is useful in our daily lives and careers. The study of basic science also plows the seed of scientific thinking, methodology and research essential for problem

solving. Therefore scientific knowledge and scientific process are valuable assets of mankind, and they should belong to all.

**Technology** is human invention or innovation to facilitate human beings to have comfortable living and to accomplish difficult tasks. Suitable technologies are important tools to achieve successful results and outcomes of development. In any development, science and technology education are necessary, even at the grass root level. We cannot achieve sustainable development if the education component is not incorporated into the plan. What, when, how and how much scientific and technology should be used depend on each circumstance. There are no set rules like appropriate technology for rural development, high technology for urban development. There is also no clear cut border between basic and applied sciences. They are all related.

## *My Experience in Development Work*

Human needs may vary, but everyone needs at least the four basic necessities for life, namely, food including water, habitation, clothing and medicine. These four have had their priorities in all of my development projects.

I have had the privilege of accompanying Their Majesties the King and Queen, my parents, to visit many remote areas in almost every corner of Thailand since I was very young. In the 1970s I had some responsibilities in development work. I met many different kinds of people and had opportunities to observe and analyze their ways of living and needs in their surroundings. Many lived in severe environments without access to any public services, namely, education, health care, etc. In many cases they lacked the basic necessities mentioned above.

At present I am responsible for many development projects, especially the ones related to the Chaipattana Foundation ([www.chaipat.or.th](http://www.chaipat.or.th)) registered officially in 1988.

The objectives of the Foundation are as follows :

- To support the implementation of Royally-Initiated and other development projects
- To promote the development of social and economic welfare activities to improve the quality of life of the people and to enable them to become self-reliant
- To carry out plans or projects that are beneficial to the people and the country as a whole
- To cooperate with the government sectors and other charity organizations for public benefit or to take action that reinforces support of public welfare
- To carry out activities without political involvement.

The activities of the Foundation can be read from the Foundation's journals ([www.chaipat.or.th/chaipat/journal/journale.html](http://www.chaipat.or.th/chaipat/journal/journale.html)).

## *Community Development*

I would like to mention a few key aspects of development.

**Education** is the most important factor to sustain a country's development. Science and technology education should be implemented at all levels, from kindergarten up to secondary and tertiary education. Students should learn both skills and also the power to think in a scientific but imaginative way which

will certainly lead to creativity and innovation. To be able to fulfill the educational goals, science and technology are needed, for example, scientific equipments and laboratories, books, journals and other printing materials, computers and computer-related gadgets, etc. For people with disabilities, science and technology play an important role in their achievements.

In rural and remote communities, sometimes we have to start from scratch. We build schools or learning centers in villages. Infrastructures like water supply, transportation, clean drinking water, nutritious food, basic medication, have to be provided. Science and technology play an important role in provision of the needed resources. The schools also face the problems of shortage of educational resources, especially teachers in science and technology and teaching staff in general. This problem can be partly solved by providing good library, using information and computer sciences, e-learning, and distance learning. Both teachers and students along with villagers can benefit from such programs.

We hope that our efforts in development will lead to an equal opportunity in education and success in life for all.

**Work or employment** is another key aspect of development. An adult person should work, be self-reliant and be able to contribute to others as a good member of the community. In most part of Thailand, agriculture and agronomy remain the major sector. Knowledge and know-how of science and technology can help the people produce enough and have excess products to earn their living. With more knowledge of science and technology, some can get more technical jobs in the industrial and service sectors. Good and secure work gives a person a sense of self-esteem and security.

**Agriculture and agronomy** are the main targets of most development projects in rural Thailand. They have had great influence on our culture and way of life since the old days. It is every government's major policy to develop

this sector. It feeds the people and provides the basic necessities for the people. In 1997 when the big economic crisis hit Thailand, this sector acted as a buffer to alleviate the damage. Agriculture and agronomy provide good foundation for “sufficiency economy”, the term and the concept coined by His Majesty the King, my father, after long years of practice and study. Science and technology can help build the agricultural and agronomic capacities, aiming at an increase of production without going beyond the limits of the environments and the availability of natural resources. The important science and technology used in agricultural development are irrigation and flood control, seed technology, pedology (soil science), post-harvest technology, animal husbandry especially dairy farming which initially is not easy for tropical and subtropical areas, etc.

**Fishery** has been a main career and food source of Thai people. In the tsunami in December 2004, not only did we lose thousands of lives, including my nephew, but we also lost innumerable fishing equipments. So we need to provide the survivors with many boats. Imagine how many trees would have to be cut down to meet their demands. Luckily, we were able to make fiberglass boats, designed specifically to suit their different fishing skills, thanks to the advancement of material science. The fiberglass boats saved many trees and also a lot of money both for the construction and the maintenance. The advancement of material science improves the quality of those boats. Technologies are also important in the design of the boats and the appropriate machineries.

Fishery is always hit by the soaring oil price. Research in acquiring bio-diesel from plants has been continuously carried on. We have an experimental project using methyl ester from a pilot plant. In the future, the communities will be able to produce some energy to meet their needs.

Sustainable aquaculture is very important for Thai economy. It should be done in a way that it does not put too much stress on environment.

**Agro-Industry** involves industrial processing of agricultural products. It starts from simple home industry up to sophisticated factory. Knowledge in science and technology is undoubtedly crucial.

**Health** is one of the most important aspects of development in which the advancement of medical science and technology can help a great deal. However, some treatments and special care are still costly, and we often face ethical dilemmas when it comes to making decision in those cases.

**Nutrition** is a good preventive measure of health care. Nevertheless introducing nutritious food into a community in which they have their own eating culture may not be so simple. We should understand their culture and emphasize as much local production and local nutritious products as possible.

For about 25 years, I have had the opportunity to work with the schools in the remote areas to solve their problems in nutrition. Cases in severe protein and energy malnutrition are rare now in Thailand. However, there are still some micronutrient malnutrition or vitamin and mineral deficiency, for example, iodine deficiency disorder, iron deficiency, vitamin A deficiency, etc. I try to focus first on the local production of food before using fortification and supplementation. Therefore in health and nutrition, agricultural and nutritional technologies are much needed.

Apart from school children, we also work with day care centers, mother and child care, pregnant women, and provide health education for these target groups.

We assess the progress of the project roughly by monitoring weight and height of the target groups, testing blood samples and calculating agricultural production and food intake in the area. There are many cases that nutrition projects have less favorable consequences. We have found out that the target groups have suffered from parasites. Some have severe diseases such as malaria and dengue fever.

# *Role of Science and Technology in Development*

Over the past century we have witnessed the key role of science and technology in development leading to more production of food, better housing, better health and higher quality of life in most countries. Strong positive correlation between science and technology development and economic development has been confirmed in the World Competitiveness Yearbook published annually, the results of a long-term comparative study of about 60 countries by the International Institute for Management Development (IMD). We can plot a graph of any science and technology capacity indicator, like R&D expenditure per capita, R&D personnels, IT users, patents, or publications against the GDP per capita, and find a consistent positive correlation between them.

There has been remarkable advancement of platform technologies like information technology, biotechnology, material science, nanotechnology and space technology. Once a high-capacity technology is discovered, there is always a need for commercial mass production to facilitate every household and every individual to have even more convenient living and working. In our lifetime, we have already witnessed an astonishing change of lifestyle and social interaction. Something that was considered very high-tech and very expensive at one time can later on be very cheap and affordable by all. Science and technology can also make that happen.

In the area of **information technology**, it was not so long ago when we had to punch a big bunch of cards to put our data into huge mainframe computers at the computing centers. Today we have the privilege of having much higher-capacity and many times smaller computers right in our own homes, or even in our palms, the ones that can connect us with sources of information and people all over the world. It is possible for us to see another revolution of information technology in the near future in the field of quantum

information science. We can expect even faster communication, more speedy processing of complex interactions, and unlimited access to countless sources of information.

Computers are used in every aspect of development work, for instance, building a database of each activity, controlling the machineries, book-keeping and accounting, etc.

Let me give one example about the use of ICT in development work. There is a lot of work to do all over the country. I cannot be present everywhere in the country at the same time. I use e-mails or SMS successfully in communicating with my teams of development workers and in receiving their reports.

Robotics is also a result of the advancement in computer and electronics. We can design robots to replace human in risky tasks. We can also have robots to help out in many other situations.

In **biotechnology**, information technology speeds up research which is mostly multidisciplinary. For example, high speed sequencing of genes, genetic engineering, protein engineering and the convergence of science and engineering disciplines have opened up many new research possibilities, like stem cell research, tissue engineering, bio-imaging, cognitive science, molecular diagnostics, recombinant vaccines, differential drug delivery, and bioremediation, etc., leading to the discoveries of new products and processes that are useful in medical, agricultural and other industries.

As natural resources become scarce and there is increasing concern about environmental deterioration, **material science** has played its important role in developing environmentally friendly materials and low cost artificial materials for different uses, including construction materials. New ceramic materials such as piezoelectric ceramics, bio-ceramics and electronic/electro-

optic ceramics provide technologically important alternatives to traditional ceramics. Special polymers can be used as artificial muscles and light-emitting devices. Equipments using solid-state ionic materials form the basis for new types of batteries, fuel cells and sensors.

In recent years, there seems to be a lot of natural calamities that give new challenge to development workers. We have to do planning to build completely new villages. New building materials are needed for houses, and infrastructures, for example, electricity, water supply, waste and waste water management, road systems, etc. All should be environmentally friendly.

**Nanotechnology** has become promising when nanoscientists learn and know more about how to manipulate things at the atomic level.

Nanotechnology Center is a new center in Thailand, and we cooperate with companies. The center cooperates with the R&D departments of some companies. For example, we produce microchips for a European company that makes medical equipments, and the company helps us develop the products. Some of these products are used as sophisticated tools for development

**Space science and remote sensing** are also very advanced, and with the combination of information technology, we can now view the pictures of our roof and lawn or any place on earth in real time, right on a monitor in our own home or palm.

To be able to manage development, we need to know the terrain well enough before starting any project. That is the reason why survey engineering and cartography are very important. Apart from topographic maps, we used aerial photographs, airborne sensors and satellite images. Remotely sensed data has many applications. I myself used to do the classification of land use and land cover and used some information for some development projects. In the early '80s, the resolutions of the sensors were not as high as what we have nowadays. We benefited just from the electromagnetic spectrum and electronic

signals. It depended more on ground truthing. Digital images can be integrated with other information in GIS, and it is a good tool for decision making in development.

## *Some Development Projects in Thailand*

This year the Thais celebrate His Majesty the King's 60th anniversary of the accession to the throne. There have been more than 3,000 development projects during those 60 years. Some are called the Royal Projects specifically to help the northern hilltribe people, originally to replace their opium plantation with other crops. Some are the King's Private Projects, to test his hypotheses or ideas before big-scale implementations. Most projects, in the order of thousands, are called the King-Initiated Projects, which may be under many governmental organizations and coordinated by the office of special commission to coordinate all of the King-Initiated Projects. I have been helping in some projects, and I would like to share some of them with you.

### **Water Resource Development**

His Majesty considered water resource development the main aim from the beginning, because water is the most important factor of agriculture.

#### **1. Irrigation**

Thai people are familiar with the pictures of His Majesty carrying the maps with him everywhere, in order to update maps of the project areas and then plan the irrigation projects to suit the needs of the people. Even with small scale topographic maps (1:50,000) he can tell the good sites to build dams, the amount of water in the reservoir, the size of the watershed, the nature of the ground (which kind of rock formation and soil) and even the cost of construction.

I would like to show an example of a newly constructed underground dam in Chiang Mai. It was built in a cave. The advantages of building such a reservoir are that we have less water loss due to evaporation, and the water does not flood local farmland. The difficulties of the construction are due to the nature of karst formation (limestone area) that needs grouting. Careful geophysical survey should be done.

## **2. Chaipattana Aerator**

Seven models of Chaipattana aerator have been developed. The manufacturing and material costs vary between US\$ 1,000-2,500 and the operating cost is around 1.5 unit of electricity/hour (at \$0.05/unit). A Chaipattana aerator can deliver up to 2 kg. of oxygen per horsepower per hour into the water. It is now widely used to treat the water both in Bangkok and rural areas.

The “Chaipattana Aerator” has been considered and received a patent in His Majesty the King’s name on February 2, 1993. The aerator is the world’s ninth mechanical aeration device to be patented and the first patent to be issued to a Monarch, and so His Majesty the King became “the first Monarch in Thai and World history to receive a patent”. In terms of the international awards of honour, the Belgian Chamber of Inventor, which is Europe’s oldest organization of invention, organized the Brussels Eureka 2000 : the 49th Anniversary of the World Exhibition of Innovation, Research and New Technology between November 14-20, 2000 in Brussels, Belgium. The International Committee and the National Committee presented cup prizes, medals, and certificates to His Majesty for his sagacious invention of the “Chaipattana Aerator” as follows :

- Minister J. Chabert Cup, which is the award for an outstanding invention presented by Minister of Economy of Brussels Capital Region

- Grand Prix International Cup, which is the award for the ingenuity in invention presented by International Council of the World Organization of Periodical Press
- Prix OMPI Femme Inventeur Brussels Eureka 2000 Medal together with certificate, which is the award for the world outstanding invention presented by World Organization of Intellectual Property
- Yugoslavia Cup, which is the award commending His Majesty's ingenuity presented by the Group of Yugoslavia countries
- Gold Medal with Mention and certificate, which is the award for the ingenuity of His Majesty in efficient application of the technology presented by Brussels Eureka 2000.

### **3. Cloud seeding**

Cloud seeding, or Royal Rain Project, is the making of artificial rain. It was initiated more than 50 years ago. The process is divided into three stages. Each involves flying on an aeroplane to spray different well-known and nature friendly chemical substances such as calcium chloride, ammonium nitrate, sodium chloride or kitchen salt, dry ice, silver iodide, etc. at the selected altitude and location where clouds are seeded. It turns into mass which becomes unbalanced and formed beads of water falling down as rain drops eventually. A high degree of expertise and experience is required in selecting the type and amount of chemicals to be used, while taking into consideration weather conditions, topographical conditions, wind direction and velocity, as well as the location or delimitation of the area for chemical seeding. Royal Rain Making is a true friend of farmers in time of droughts.

It can also be useful as a tool for environmental protection, because it can put out forest fire in some regions.

## Soil

The studies of soil quality, protection of soil erosion and soil conservation are important development issues in an agricultural country like Thailand. His Majesty initiated many ideas to correct different kinds of problematic soil, for example, saline soil, acid sulfate soil, nutrient-deficient soil, sandy soil with hard pan, etc. The cause of each problem has to be carefully studied, and the problem is corrected accordingly. For example, for the acid sulfate soil, the cause is the sulfuric acid which is formed from sulfate-containing sediments through a natural process. So to correct it, we can either wash the acid off by flooding the area with water then draining it, or mix the soil with alkaline marl to neutralize the acid. A more drastic change can be done by speeding up the reaction of sulfuric acid formation, so that all sulfate is gone. Then the acid soil is treated once and for all. This is the so-called "the Land Aggravation Project", and all steps require scientific knowledge and scientific methods.

Vetiver grass is an amazing plant that, at first sight, looks like another kind of weed. Vetiver grass is very common in Thailand. It is fast growing and has a very deep and thick root system that spreads vertically rather than horizontally. When grown densely, the roots act like an underground wall or curtain to trap the soil from eroding and the moisture in the soil. It can endure harsh condition. His Majesty was first interested in this plant more than 10 years ago and started experimenting. Now it is proven that vetiver grass is the best plant to prevent soil erosion and to conserve water in the soil. It also has many other uses, for example, the leaves can be woven into nice handicrafts, and the roots of some species can be extracted to make perfume.

## Energy

There are many projects on energy. At Chitralada Palace there is production of rice husk charcoal and gasohol. There are many ongoing research projects on alternative energy, for example, hydro-electricity, bioenergy, solar energy and wind energy.

I am now responsible for a bioenergy research project, as we all know that diesel oil can be extracted from coconut, palm fruits, jatropha seeds and even used cooking oil. It remains for an innovative economic model to be found. The market demand for edible oil produced from palm fruits and coconut is more competitive than energy oil. In this sense, it is believed that a community production for community use, instead of a large-scale production for nationwide use, is the most promising economic model at the current stage. A few pilot projects in different parts of Thailand are going on. It is expected that villagers in a small community can learn how to find the right balance between crops for food and crops for energy.

## **Science and Technology for People with Disabilities**

Science and technology, especially the IT, are very useful for the independent living and the education of the people with disabilities. We have to take care of them case-by-case, because their defects and needs are mostly different.

Since 1975, I have been responsible for the welfare of the disabled war veterans, so I have become interested in the production of artificial prosthesis with the use of new material and IT, and robotic techniques. These science and technology help boost their quality of life, and so it is a part of human resource development.

There are some cases of congenital disability, for example, children without limbs. So computer with special parts like trackball and softwares for voice command are used. Computer-controlled wheelchairs are useful.

I have just started a new project to help the blind to study science. In Thailand there are about 600,000 blind people. Statistically, only some hundreds of them received university degrees, and all in social sciences and humanities. The general attitude of most people including the teachers is that the blind

cannot study science, because it is too dangerous for them to do scientific experiments. We now have some bright blind kids in our pilot project, who are studying science courses just like other students in the science track, with the help of computer that works through mathematical models enabling them to do the calculation. So they can work just like sighted people. It is a great challenge for us to try, and with the help of many scientists and technologists I believe that Thai blind children will have good future like the blind in many other countries.

### **ICT, Distance Learning and E-Learning**

In the Golden Jubilee Year of 1995 when we celebrated the 50th anniversary of His Majesty the King's accession to the throne, the Distance Learning Foundation (DLF) was inaugurated, and a distance education center was established at Klai Kangwon School, Hua Hin District of Prachuap Khiri Khan Province. It uses both satellite and television, and later on the Internet, to reach out to all in remote schools. Nowadays the DLF has extended its services beyond its original objectives to also cover more than 3,000 ordinary schools, vocational and general education, public and private.

I use distance learning and e-learning to train teachers in the remote areas. In the future, hopefully, ICT will be able to create equal opportunity for all.

The IT training courses are also offered to prison inmates in order to give them opportunities to acquire knowledge and skills in the use of IT. Some also learn how to repair computers. Some can earn money from their IT skills while serving their terms. Our survey has shown that a number of them even got jobs in IT firms after they got out. The training program is now extended to cover prisons in provincial areas. The first IT-related degree program on Business Informations Systems has now been offered to prison inmates. more than fifteen prisoners has registered for the program.

## Database

ICT enables us to have extensive databases of anything. It also helps linking the databases together. I have succeeded in establishing the database of plant genetic resources in Thailand, by bringing the dispersed databases under the same system and linking all of them up. This is not an easy task, but once it is done, it is very useful for researchers and students. I know that there are many worldwide scientific databases that scientists and technologists can share and contribute from all over the world. This is how science and technology advance.

## *Globalization : Opportunities and Challenges for Science and Technology*

It is now the age of globalization. The goal of our development work should be sustainable, integrated, holistic and balanced development. We live in a borderless world which offers us both opportunities and challenges.

### Opportunities

1. The world is shrinking while the information world is expanding. News from one corner of the world can be heard everywhere simultaneously. Science and technology have bridged the geographical gaps by bringing people closer together through faster communication and transportation. Linking databases and sharing them enable more self-learning of knowledge and information. Anyone can increase his or her knowledge with less dependence on experts. We become more self-reliant on updating ourselves to the advancement of knowledge and information.
2. Science and technology are no exception. They can reach more target groups nowadays, and open up more choices and opportunities to all. The trend will go on at an even more rapid rate.

3. Some products that were available only among the rich, or some equipments that were only for scientists, become cheaper and available for wider users.
4. There is more possibility for patients with serious illnesses to survive or to have less pain due to progress in medical science.
5. More useful materials, like lighter and more durable materials, are now available.

## Challenges

Even though many opportunities are opened up for us, many new problems and dilemmas also arise. Those will be the challenges of this century.

1. The first challenge is how to have more people learn and keep up with rapidly advanced science and technology. Many more trainings are needed for more people to master new advanced technologies fast and well enough to make maximum uses of them.
2. The second challenge is how we can build up the capacity of our educational process to increase the abilities of our next generations to analyze, synthesize and evaluate, so that they are able to make good decisions to make better use of the enormous information and knowledge available to them.
3. The most important challenge is the ethical and social aspects of the science and technology application. How can legal and social institutions keep up quickly enough with the dynamism of science and technology, to understand their impacts on humans and societies and to protect them from unethical uses?

4. Information comes too much. Before we did not have enough information, but now we have too much. We become indigested, and so we have to learn how to be more selective. There are also new ethical aspects that have to be considered. For example, if some new thing is possible, but it is still expensive. Whether we should give it to other people who are not our relatives or who are not our nationals, etc., is very difficult to decide.
5. Although this leads to more self reliance, there are also many challenges for us. When I start to be familiar with one of the gadgets, it becomes out of date and I have to buy a new one and to learn new things again. So I have never managed to master all those new technologies. How to manage technology wastes is of course another problem, besides the waste of money to buy new equipments because the old ones become outdated. Chemical wastes are more difficult to manage.
6. The existing science and technology may result in an increase of the world population, so new challenges arise. The Earth is facing many crises, like energy and freshwater shortage and global climate change. Rises in the cost of crude oil have pushed government and private laboratories to develop cheaper sources of energy. The Worldwatch Institute predicted that gas, solar energy, wind and geothermal energy would take a large share of the world energy market while the use of coal and oil would fall sharply in the near future. There is also concern about cleaner energy as well as clean freshwater. Although we are enjoying more convenient living and working brought about by science and technology, in this century we also have to take care of many global problems, like energy shortage, freshwater scarceness, “greenhouse” gases and natural disasters. These too have to rely on science and technology.
7. In the past, we can talk among us about what technology should be done. Now if some people overhear our conversation and use our idea to create something and get the patent, then we cannot use it without charge

anymore. For the development workers, perhaps it may not matter, but for the poor people, they will not have access to the solution of the problem. This is very difficult. Also, there are new laws and regulations that we have to learn, such as those about intellectual property and other standards. This is very important because now the world is shrinking, and we have to live up to international standards. It is not something that we can just imagine or dream about.

There is no end when it comes to human capacity to discover new science and create higher-capacity technologies to meet our demands. Science and technology are definitely useful tools of development. Like any tool, however, it is double-edged, and so it can be harmful when misused. The question is how we can keep ourselves from becoming the victims of our own success.

In September 2002 the United Nations has adopted the Millennium Development Goals (MDGs), as a blueprint for building a better world in the 21st Century. The declaration of MDGs has marked a global commitment and concerns of less developed countries. The MDGs aims are to ensure that every child gets primary education, child and maternal mortality reduced, HIV/AIDS, malaria and other diseases under control, and the number of people living in extreme poverty and hunger to be halved, all by 2015. This is a big challenge for us all.

As the costs of technology and that of research are rising, “knowledge divide” in the growing “knowledge society” and “knowledge economy” can become a big global issue in the near future. We may be faced with more poverty, illiteracy, ethical problems and social unrest due to that “divide”.

I believe that bringing young brains and great minds from all over the world to discuss these issues can help bridge the divide and steer the use of science and technology towards the MDGs.

# Slide Presentation

## The Four Necessities

In Thailand, we talk about the four necessities, and I will start to explain how we have applied science and technology in the provision of those necessities.

In earlier days, we talked about only four necessities, but now many people add transportation and communication as the fifth necessity.

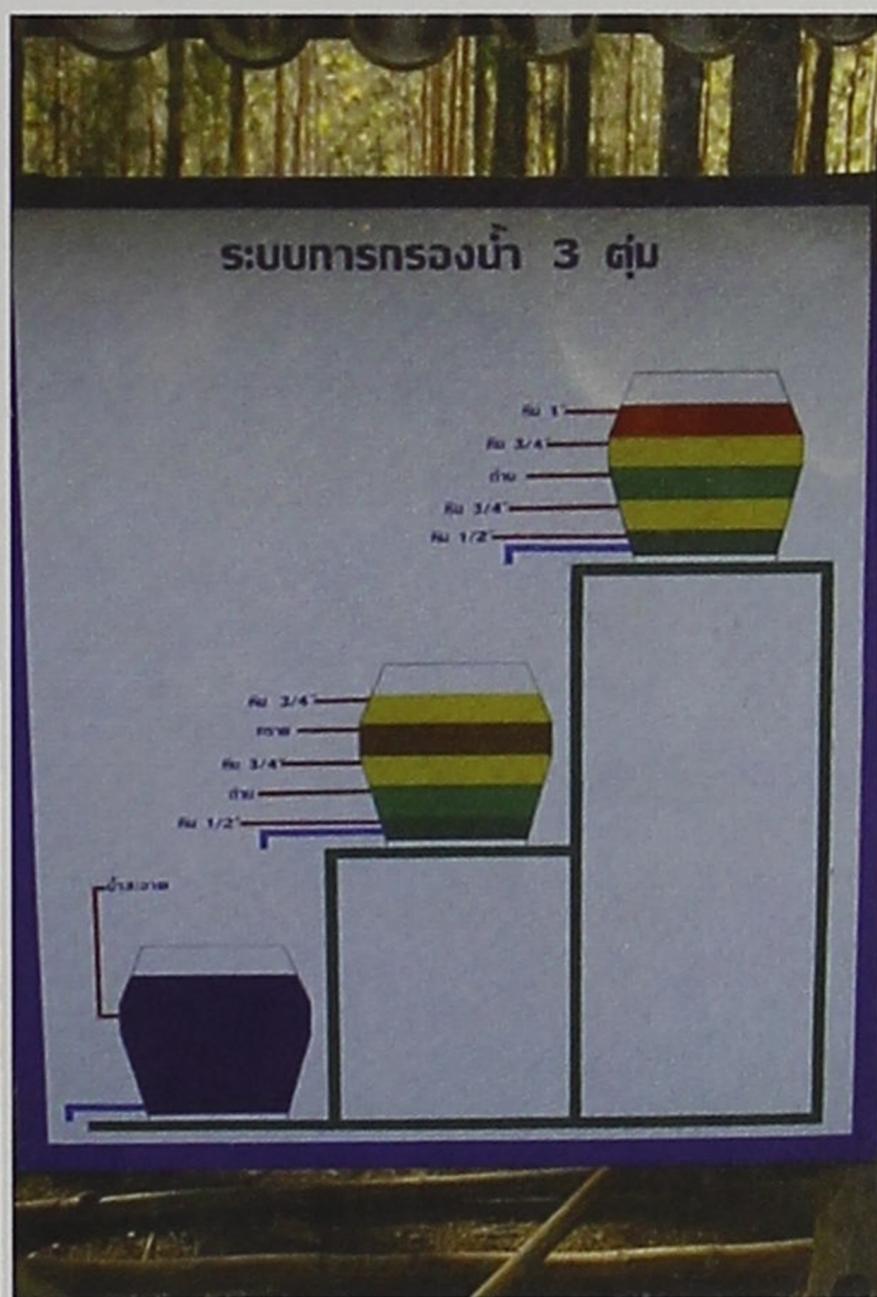
### Food and Water

When we talk about food, it is not only food. We have to add drinking water as well. Everybody has to eat, but food provision may be very difficult. When we work, I have to make sure that everyone of us tastes the food at the place where we work to see what “delicious food” means to the people in that area. Then we can make that food hygienic and nutritious. The principle should be based on their liking and try to add nutritious ingredients.



*Varieties of Thai food*

Water is also very important. Water in some places is not clean and hygienic, and it has bad taste. The way we used to purify water is called the “three jars of water” . This has been used for about thirty years. We try to start with folk knowledge and put some sand, gravels, and charcoal in each jar through which unclean water flows. At the end we get fairly clean water. A very rough system for cleaning water is shown in this picture. We may have many other techniques, but they may need a lot more money and a lot of science and technology, like membrane technology and so on.



*Traditional three-jars method*



*More advanced technology for clean water*



*Mobile unit of water purification*

The tsunami incidence has affected a lot of drinking water in artisan wells. People who live around there did not have good drinking water for a while. This picture shows a mobile unit of water purification that we used during that time. Just for the tsunami victims alone there are a lot of things to do.

## Habitation

We now move on to the second necessity, that is, shelter or habitation. This is one example in which we have worked with many organizations to solve the problem. The Chaipattana Foundation where I work is a foundation helping to do development work. The Red Cross has also helped. To build a house, it was not just construction of a house, but we had to look for new building materials. Sometimes material like wood is not available for mass construction, and even if it is, we do not want to destroy the environment by building too many wooden houses. We also had to clear the road to get to their houses. When you build a road, people also need electricity to go with it.



*House construction after the tsunami*



*Electricity, water supply, etc.*

The most important thing was how to manage wastes. People mostly forgot about wastes. When we talked about toilets, many people laughed. In fact it was a crucial thing. How to build toilets which really work and how to manage wastes and waste water is not a simple affair.

Next is another place in which we worked. We got the people from other projects to work on the problem of wastes. We did experiments on waste management with the help of the mangrove dwellers in a natural way. This is what we have been doing for some time, and the people who worked in this project turn to be experts in sanitation and waste management. They can now train people in other projects. Now they work all over the country in various locations and situations. We take in the garbage and then use some organic ways to treat the wastes. To prevent the wastes from getting into clean water ways and mangrove forests help a great deal in cleaning and purifying the environment.



*Solid waste and waste water treatment area by the Laem Phak Bia Project*



*Encourage villagers to separate different kinds of waste*



*Garbage Disposal by Laem Phak Bia Environment Research and Development Project*



*Waste management*



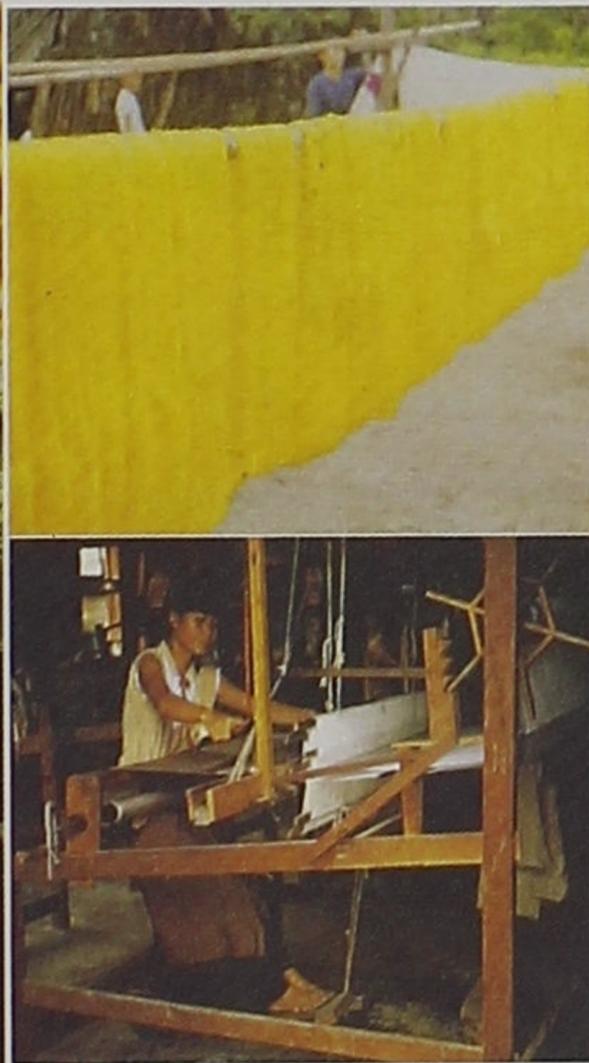
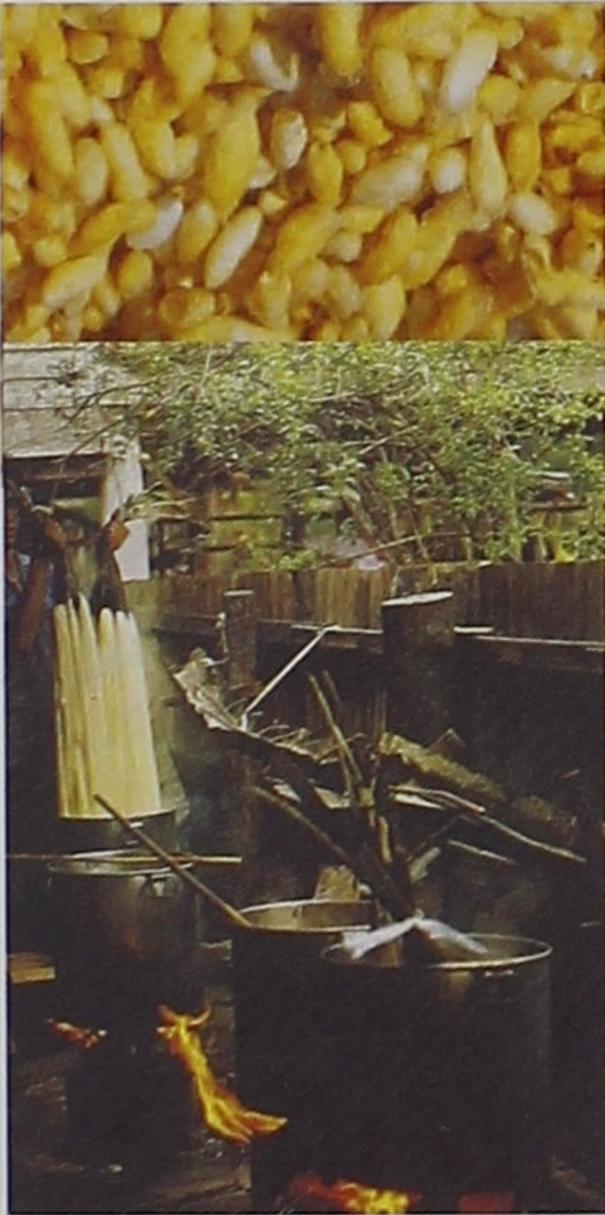
*Waste management research*

## Clothing

Originally, cloth came from natural resources. Silk weaving is very important for Thailand, also for Japan and many other countries. People have used this little worm, shown in the next picture, to help make beautiful clothes. We also have cotton and some other plants that can be used to produce textile. At the beginning, we used those for our own consumption, but later, silk and cotton become commodities that can generate money. We have tried to use scientific method to improve silk worms' food, silk worm varieties and natural dyes. Now everybody has in mind how to be sustainable and how to work in an environmentally friendly nature, not to get rich alone, leaving our children or our grandchildren poor.



*Silkworms and mulberry trees*



*Silk cocoons and silk weaving*

## Medicine or Health Care

The fourth necessity is medicine or health care. Here I do not have to explain much how science and technology help us live our healthier lives. Many people here would have already died without new medical technology. The picture shows His Majesty the King's mobile unit that offered health care and treatment in a rural area.



*Health care mobile unit*

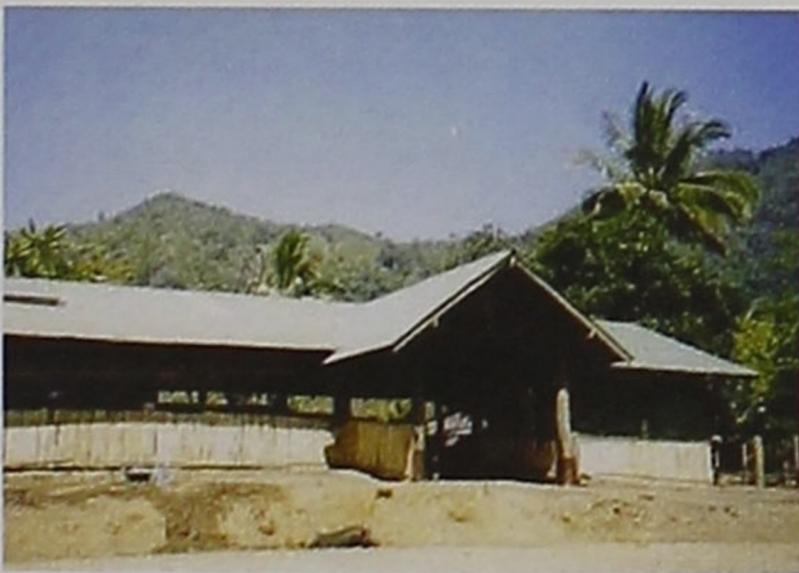
## Community Development

Now, I would like to point out various aspects of development. When we go to one place, we have to do many things at the same time. While we go out to meet the people, we talk to them to see what kinds of thing are needed in the area. Mostly, we have to tackle the problems of education and occupation for the people so that they can earn their living to help themselves with their health and nutrition. Most of the time, what they would like to have

is always electricity, health station, school, and road. So it is some kind of a packaged solution.

## Education

This picture shows villages and some schools in a rural area where we have worked. When we asked whether they wanted to have a school, they said yes and came to help us build the school. When we could not find enough teachers, distance learning has helped a lot. Even when there are teachers, to use teaching media the teachers need electricity, satellite antenna and power. This area is very far from the national grid, and so we have to get the power from alternative sources, for example, water or solar energy.



*Learning center*

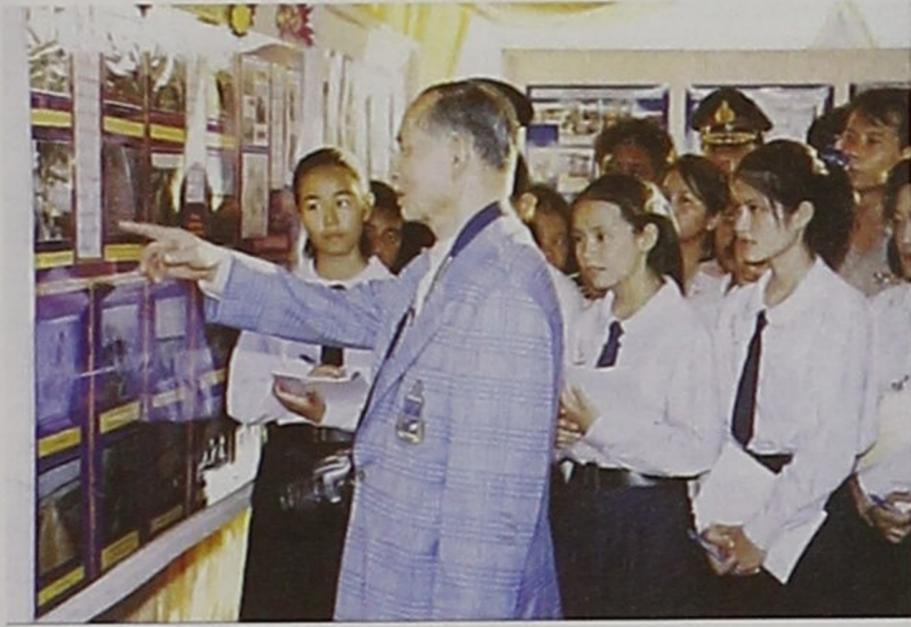
Sometimes communication to and from the schools and villages is quite difficult. A road may look something like what is shown in the next picture. It is not an all-season road. Some places are not on the mainland, and so we need to make a raft ferry to help them go somewhere.



*Schools in remote areas*

## Occupation

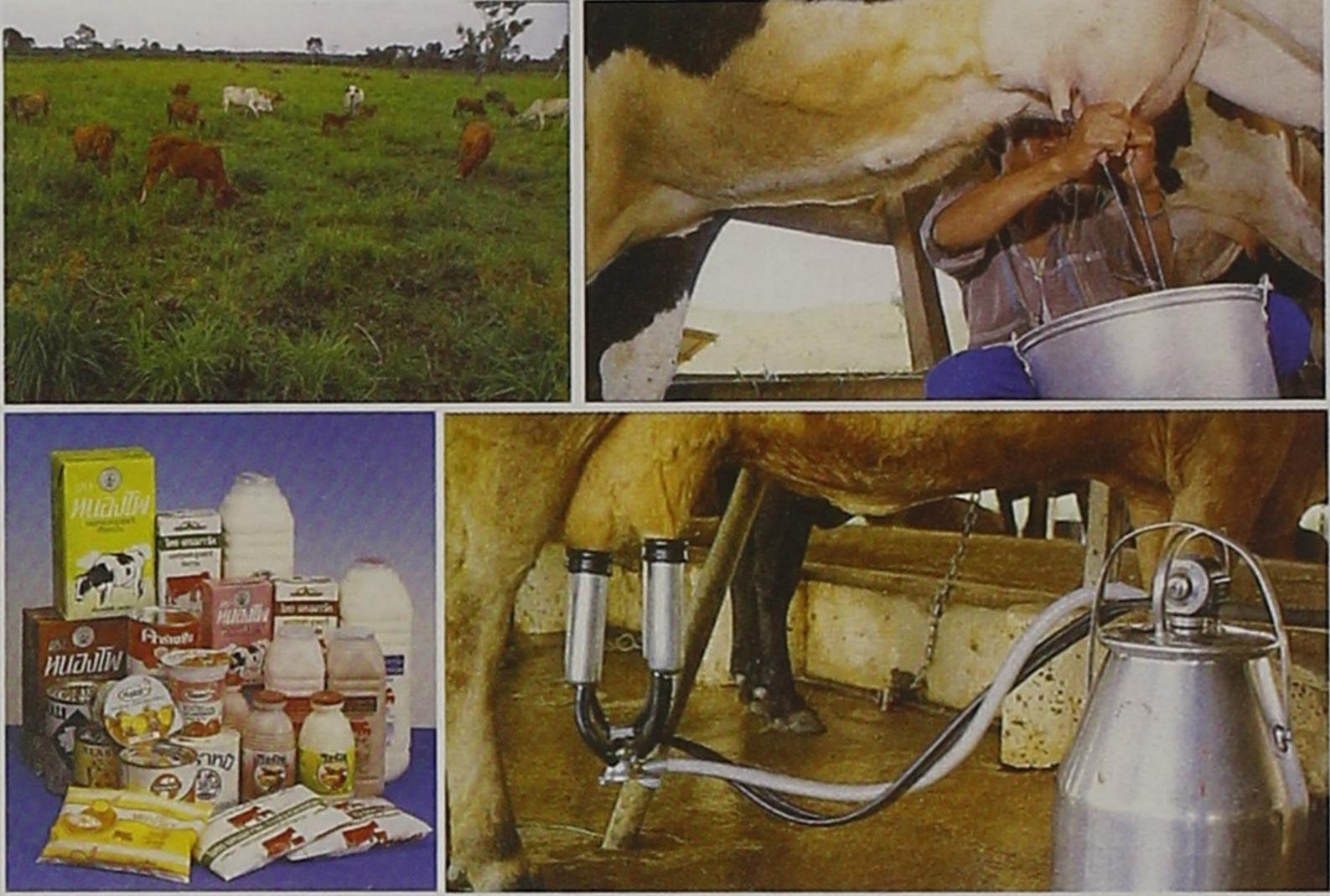
My father has a lot of experience in development. He has a lot of scientific knowledge. I think I am quite lucky to be a King's daughter, because I have had a chance to go to a lot of new places that nobody else has the opportunity to go. For one thing I have an opportunity to learn from my parents and also from the experts who have worked for my parents in various subjects. This can be called technology transfer. Now he does not talk to the grown-ups as much, but he talks about his knowledge in soil science, rain making, and so on, to the kids.



*His Majesty King Bhumibol Adulyadej taught students about soil, cloud seeding, etc.*

## Dairy Farming

We have introduced something like dairy farming. You may know that dairy farming in the tropical area, not somewhere in Europe or the temperate zone, is not at all easy. We need some kind of new technology to solve these problems. For example, in our region, there are more diseases than in the temperate zone. So, we need specific antibiotics to kill the germs, but the antibiotic residue can be harmful to animals and also to human beings who consume the meat or the milk of those animals. So we have to be very careful.



*Dairy farming and products*

## Herbal Medicine

Sometimes local people use herbal medicine, and our scientists are working on it now. This is how science and technology can help. When we want to keep the products longer, we also need science and technology in packaging the products.

## Fishery

Another job is fishery for local fishermen. During the tsunami, thousands of fishing boats were destroyed. Normally, fishing boats are made from timber. But if we cut down trees to make thousands of boats, all trees in Thailand would be cut. We might even go to cut the trees in our neighboring countries, and that is not nice. So we talked to the people who have knowledge in material science or material technology to come up with the solution. We ended up using a kind of fiberglass. At first, a lot of people were against the idea, because there is a belief that there are some gods or goddesses,

normally goddesses, one boat one goddess. But I think that a goddess may like a new house, just as we like to live in a house with new materials. So the goddess may enjoy living in her new home. If it is artificial material we can adjust the weight, the texture and everything. We can make it anyway we like, and we have proven that many people can stand on the boat without capsizing it. It can turn back to the normal position.

We have come up with another new idea. Normally a fishing boat uses machine and oil. At present there is pressure on the oil price which goes up all the time. So we have tried to help the fishermen by finding alternative oil, for example, used cooking oil. We have some oil-producing plants in Thailand, and we have tried palm oil and oil from the jatropha plant. Then we use different solvents to make methyl ester, which works very well.



*Fishing boat made with fiberglass*

I thought of my father who used to have a hobby of building sailing boat. Maybe we can try another method. Instead of using machine-operated boat, we can ask the fishermen to fish in the sail boat. We have asked someone from MTEC, the organization that works on material science, and also experts from the Navy, to see how we can find the sail boat that is appropriate for our climate and inexpensive. We should be able to produce it without much difficulty. We have not yet started this project.



*His Majesty the King and the sailing boat*

In some parts of Thailand, it is quite dangerous to work in the rubber plantation, because people have to work at night, and it is not as safe as before. So many rubber trappers are considering going back to the sea. The next picture is my mother's project, putting the artificial reefs into the sea. Fish come to live in their new home and breed a lot. So the fishermen think that they can

get more fish to sell and get more income. Again the problem is the oil, the fuel and the oil price. So now we combine a lot of projects; new boats, new fuels, and new fish.



### *Artificial reefs*

In this project, a lot of people help, for example, the Navy, the Fishery Department, the Ministry of Education (the Bureau of Vocational Education), and also the prisons. The prison authority or the Department of Corrections, has provided workers, and these workers were willing to go out from their normal places to work in our project. After getting out of jails, they can become good boat builders.

### **Handicrafts**

There are also some handicrafts that the people can earn income from. Sometimes we need a lot of experts. For example those in chemistry help in some places where the people do ceramics. We can have good material for

ceramics, but to improve the materials we need chemists or scientists to work in our project.



*A scene of rural lifestyle*

*Thai handicrafts*

## **Agriculture and Agronomy**

There is also some work in the agro-industry that adds more value to agricultural products. For example, the next picture shows a kind of mountain palm. The people around the Thai and Laotian border gather its fruits from the forest. At first, they thought we were crazy to tell them to replant the trees, because they were plenty in the forests. But now they are not so plenty any more, and we want the housewives to work more on this.



*Thai preserved food*



*Mountain palm*

Now some scientists go to the remote area to train these people. In the past, some companies exported these palm fruits, maybe to Japan, but I heard that Japan rejected those exported products because they did the color bleaching. They put in too much chemical, more than the amount allowed by the international standard. So we have to work on it all over again and to pay attention to this international safety standard.

## *Some Technologies for Development*

### **Biotechnology**

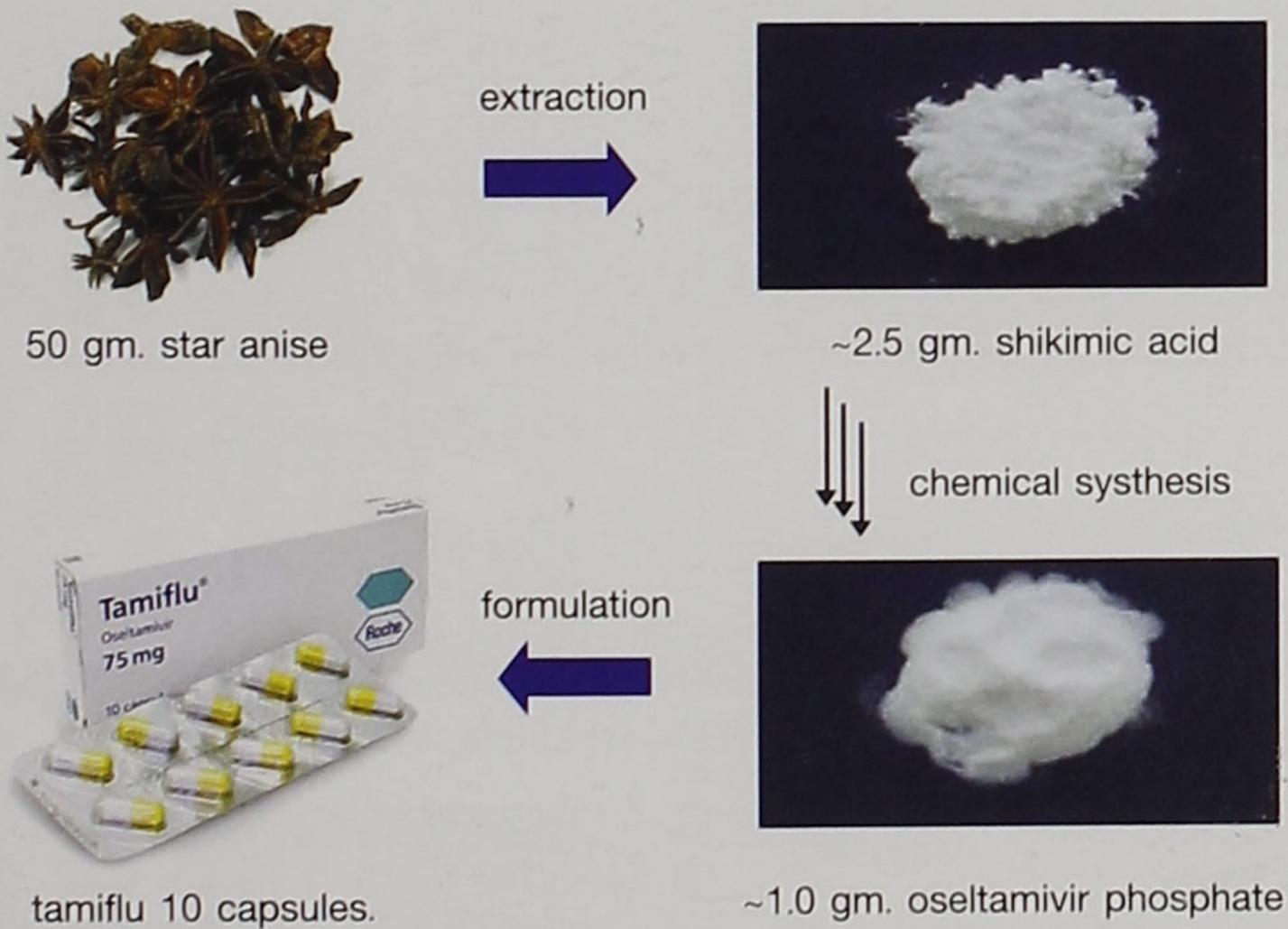
There are a lot of technologies available for used in development work. Some, for example tissue culture, was formerly done in high-tech laboratories, but we have introduced this technique to school children in both primary and secondary schools in the rural area. Now they have an opportunity to help their communities propagate the plants needed for the people's livelihood. In those labs, a lot of plants still die, and I asked the children to figure out why they died and how they could improve the method. We try to teach them scientific knowledge and scientific process, in addition to using those plants for food.





In the picture below, in Thai we called it “poi kak”, and in Chinese “pacheo”. Nowadays scientists say that it can be made into medicine that cures bird’s flu, and a lot of scientists are working on this area of research to improve the medicine

From star anis to tamiflu



Star anis (Source: National Science and Technology Development Agency - NSTDA)

## Communication Technology

In an emergency situation like tsunami, landslide or mudslide, for example the recent landslide in Thailand, starting from May this year (2006), we had a very bad mudslide that covered rice fields and fruit plantations and destroyed more than 70% of them. Normally, we use a lot of communication processes, starting from the walky talky and the old-styled radio like the single side band in those days. Now we come up with a new vehicle equipped with modern communication technology that can help find people who have survived the calamities and also help contact their relatives.

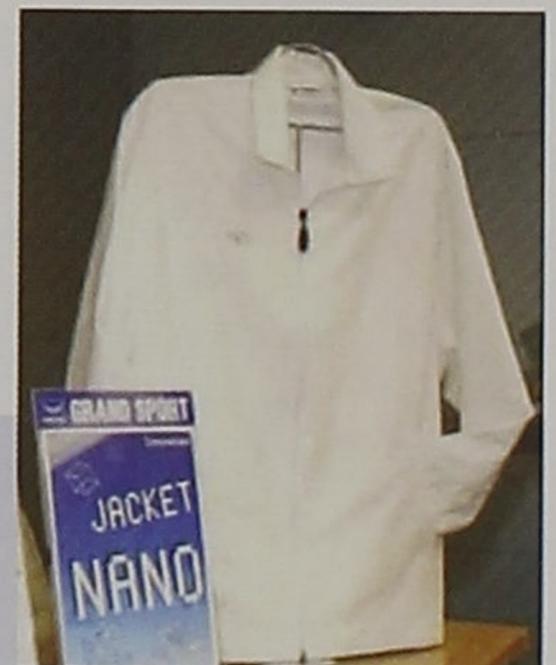


*Emergency & Educational Communication Vehicle : EECV*

## Nanotechnology

This picture shows some nano-products which have added more value to handicrafts, fabrics and other products.

Using ZnO for  
- fire retardation  
- water repellence  
- anti-bacterial action

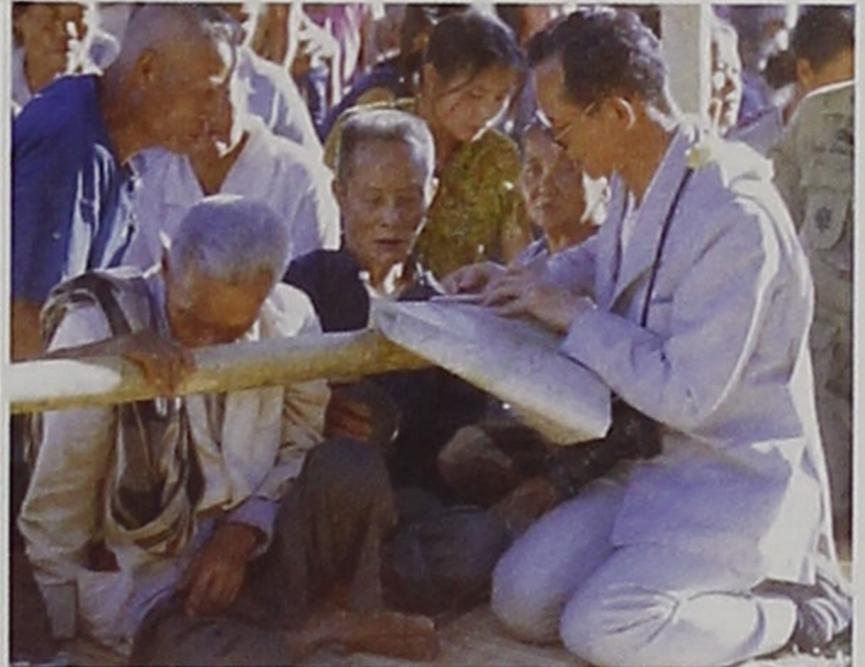
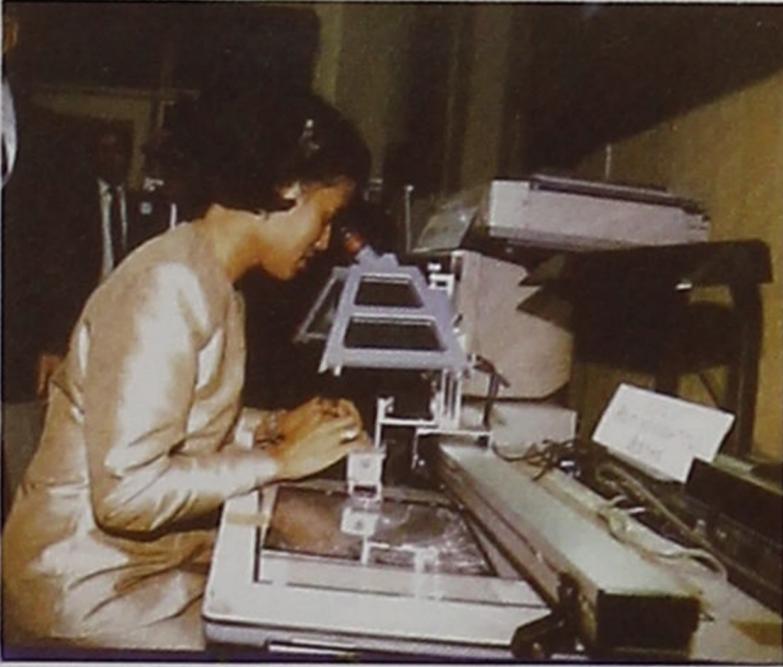




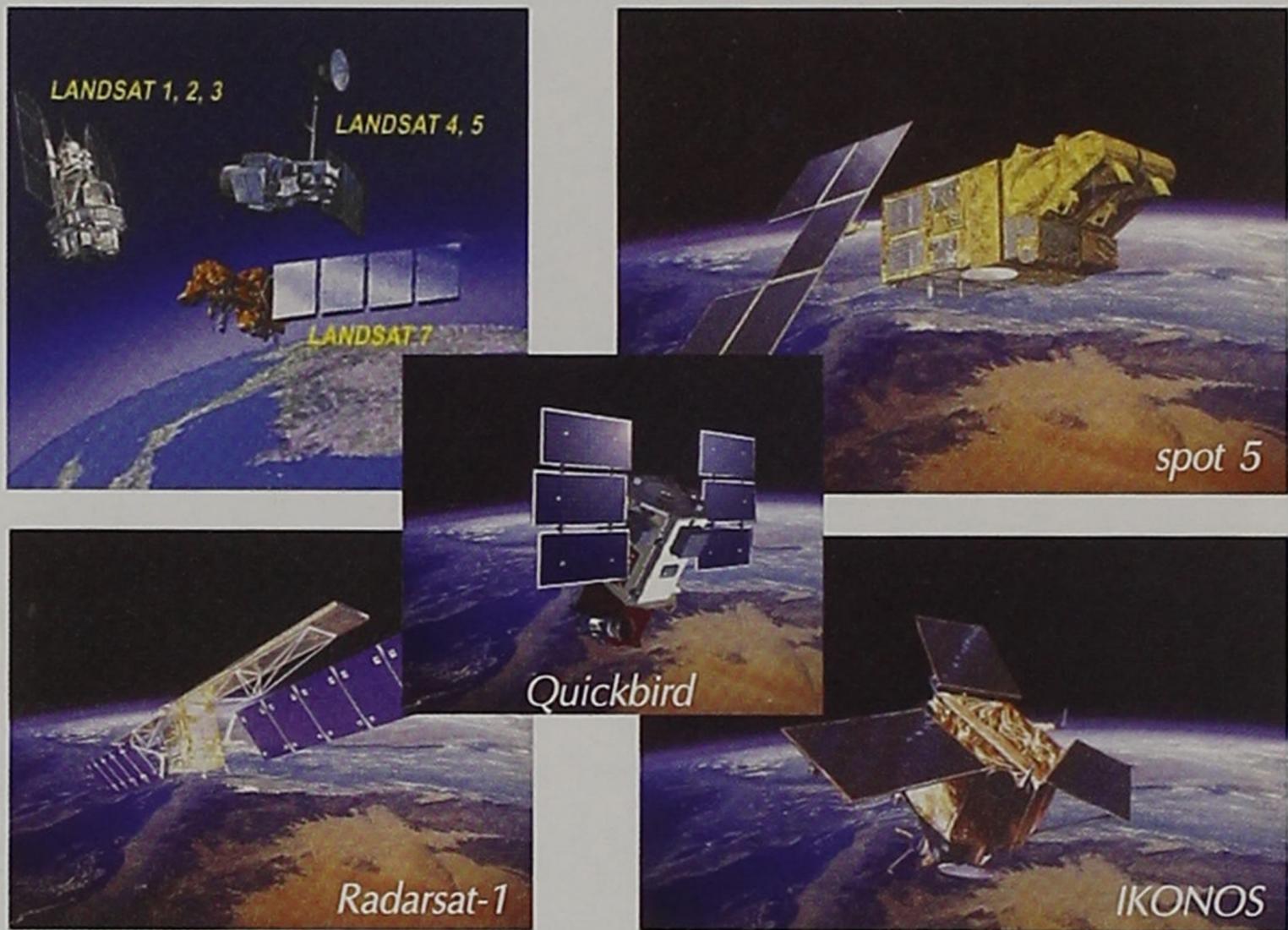
*Nanoshirts*

## Remote Sensing Technology

To decide exactly where we should develop, our usual procedure is to find the water supply, so that we would need the least pumping. Often we try to make use of the gravity. Otherwise, we have to use some oil for the pump. We should get information about the land from a map. To make a map, we do a conventional survey with area photography and by going out to the field asking for information from the local people. The latest technology is the satellite image, of which along with the airborne sensor, we can get both good resolution and spectrum signature as well.



*Map-making*



*Satellite technology*

## *Some Development Projects in Thailand*

### **Water Resource Development**

Talking about water resource, the UNESCO Director General has said that now water is the most important thing that we should preserve. To this end, we do the irrigation flood control. Sometimes we use small dams. There are big dams and small dams, or sometimes we group the small dams together in order to get the water. We should know about the height of each place and the contour line. For example, on the next page a swamp area in the southern part of Thailand is a big natural container of water. In the swamp with acid sulfate soil and peat swamp, the soil is very acidic. It is very sour, because it came from marine clay, and there is a lot of organic matter. But it is very dangerous if the water level is too low, because it can cause the acidity to go up. With the irrigation technology, we can now control the amount of water inside this dam.

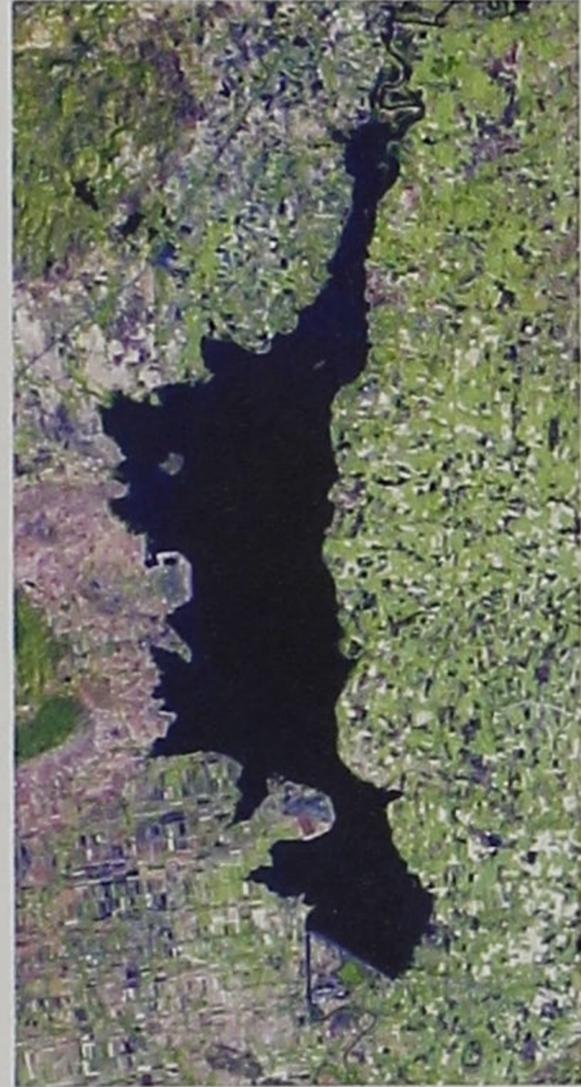
*Sirindhorn Dam, Ubon Ratchathani Province*



*Pa sak Jolasid Dam*



*in Amphoe Phatthana Nikhom, Lop Buri Province and Amphoe Wang Muang, Saraburi Province*



*Landsat 7 (band 5 4 3 - RGB) of Pa sak Jolasid Dam, January 24, 2002*

*Dams*

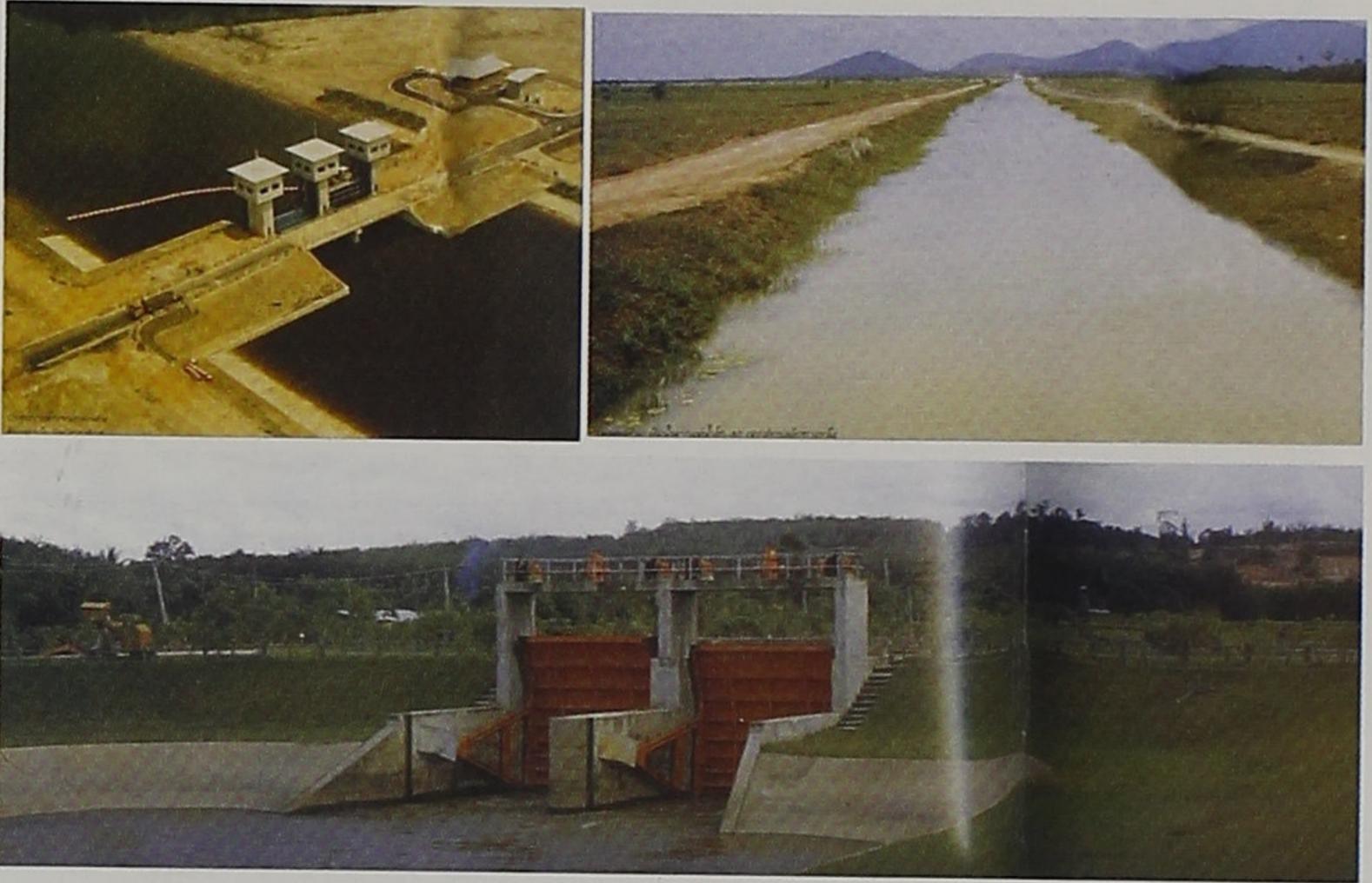


*Landsat 7 (Band 5 4 3 - RGB) of Pa sak Jolasid Dam, July 21, 2002*



*Phru Toh Daeng : Peat Swamp Forest Narathiwat Province*

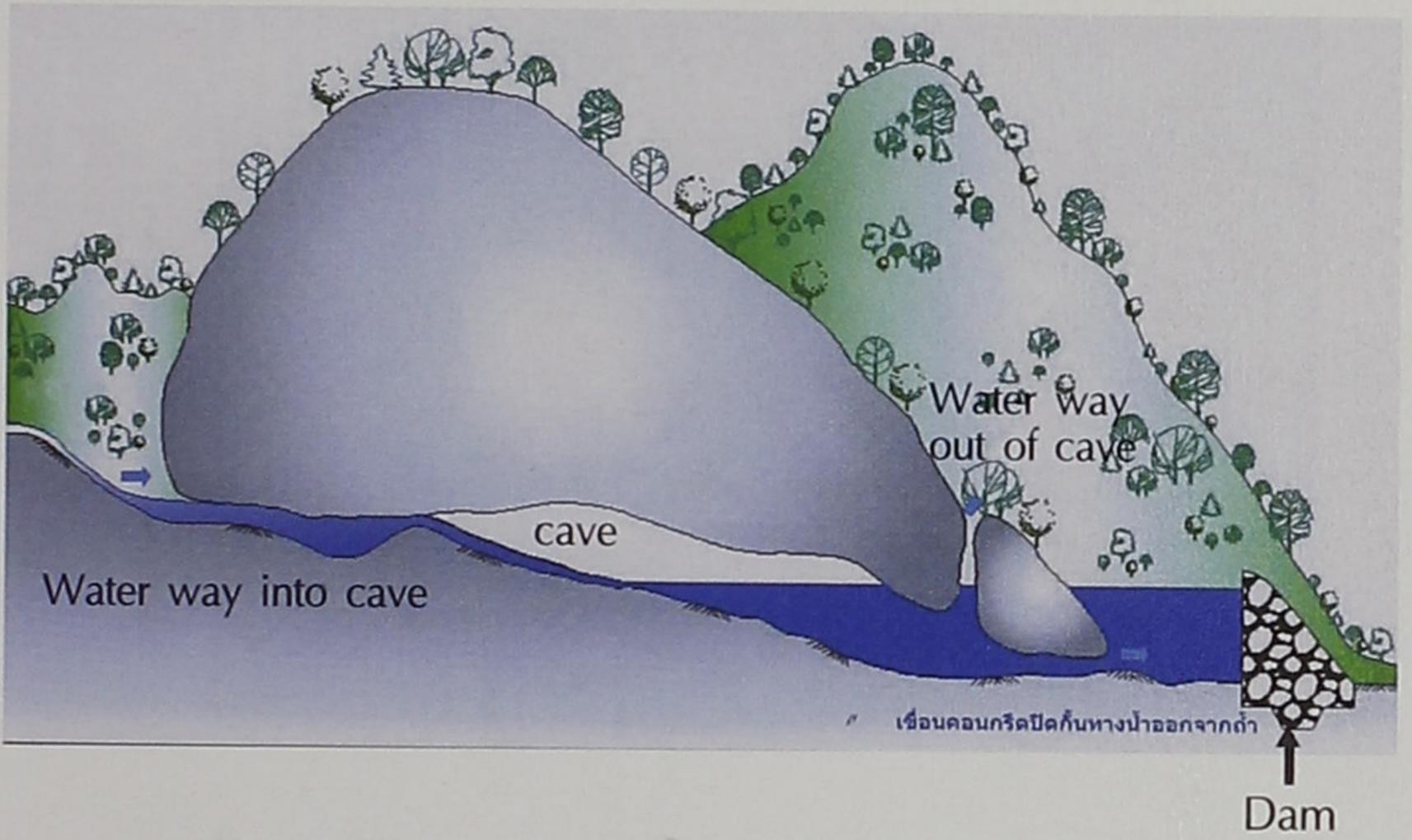
*Swamp*



*Water gates at Pruh Toh Daeng dam*

## Underground Dam

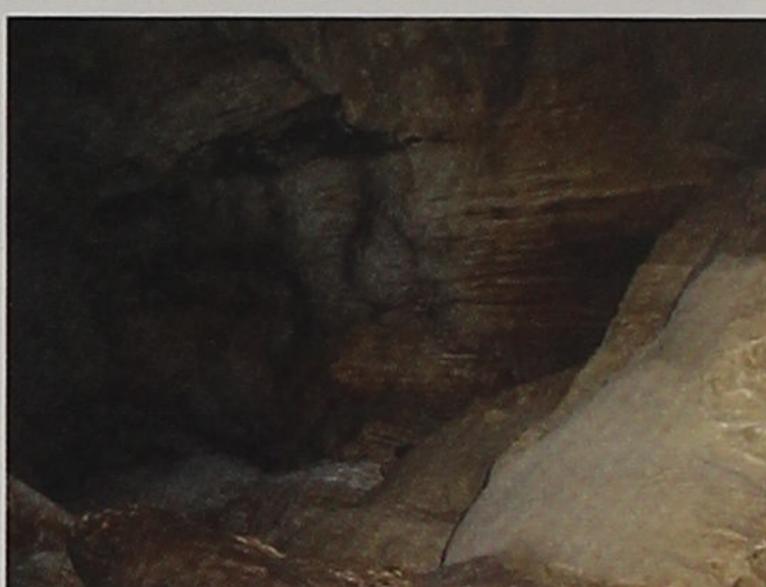
For the water reservoir in the cave shown in the next picture, my father will soon get a patent of this creation. It must be done in the cast or the limestone formation in a lot of caves and sink holes. What we have done is to build a dam, not exactly a big one, to keep the water inside the cave. There is a small check dam inside to let some water out. Next are the pictures during the construction and then what it looks like now. The benefit of having such a dam is that we can keep the water inside without losing it all out. Normally, when we build a dam, one bad thing is that the water would flood some people's fields and also some forests. But in this case it collects the water under the ground where there is less evaporation, and so we have more water.



*Underground dam*



*Model of underground dam*



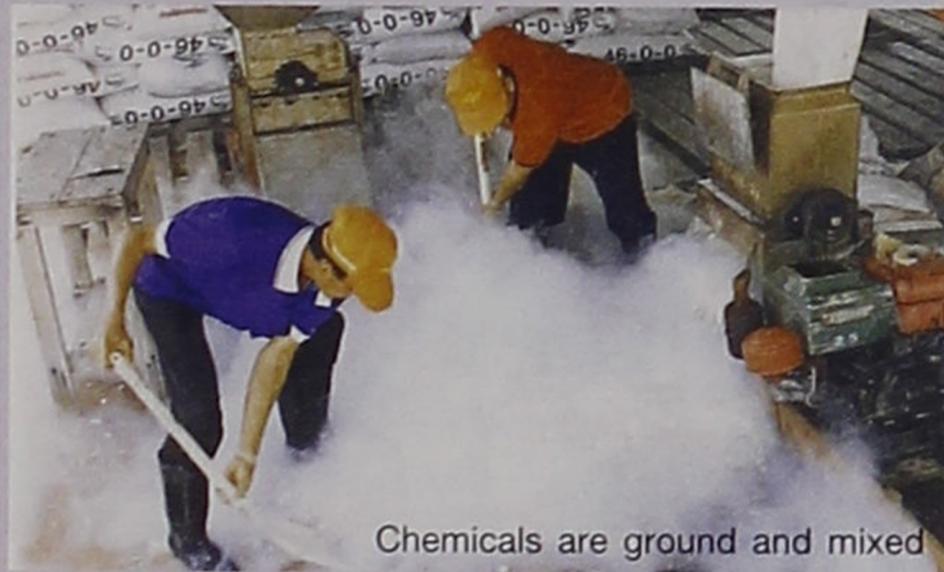
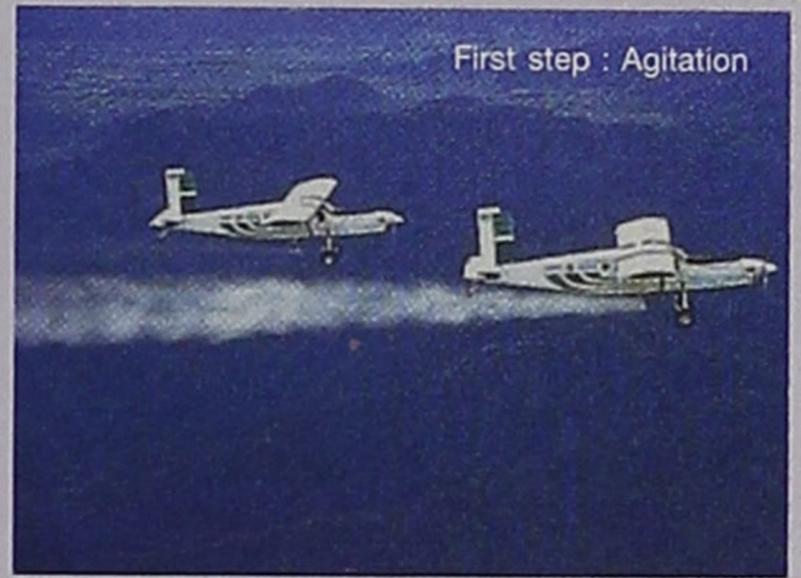
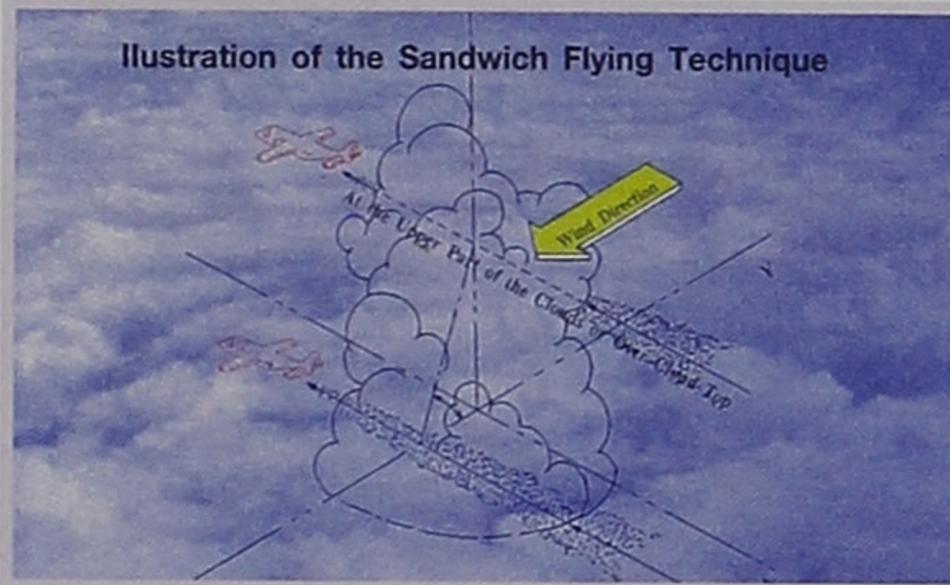
*Underground dam under construction*



*Finished underground dam*

# Cloud Seeding

The picture below is the cloud seeding technique. My father drew an easy diagram to teach the children. The way to do it is not just to make rains anywhere but it is done over certain reservoirs so that the water can be kept.



*Cloud seeding technique*

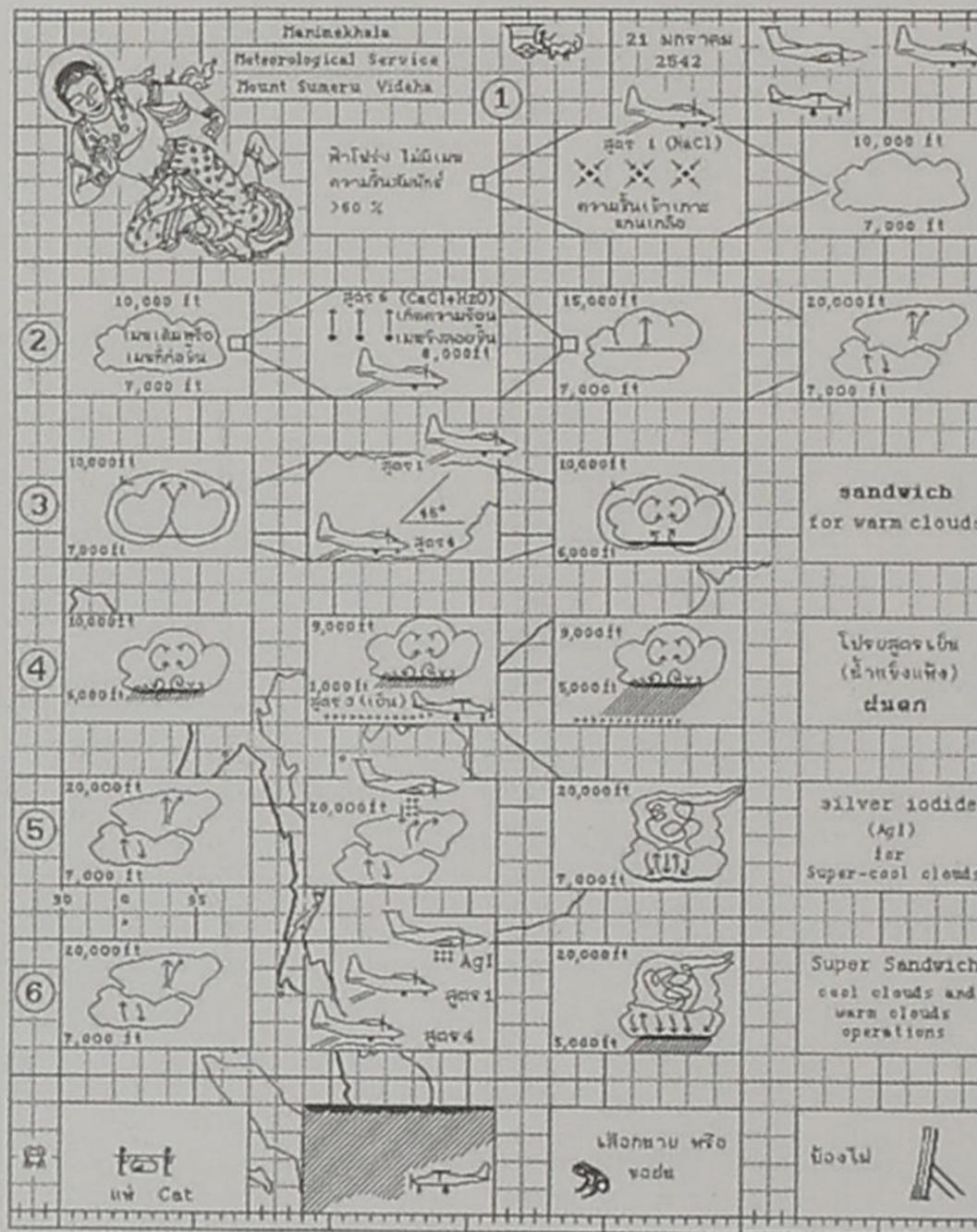


Diagram of cloud seeding process

## Forest fire extinction at Pruh Toh Daeng using cloud seeding

At one time there was a bad forest fire in the Toh Daeng peat swamp. Because organic matter is a good fuel, at first we tried to fight the fire by conventional method, but it did not work. So we used the cloud seeding to get the rain water into the reservoir and the canal that fed water into the swamp, and this put out the fire.





## Aerator

This picture shows another patented invention of my father. It is an aerator. When the aerator moves, the water gets more oxygen. It solves the problem of water stagnation. The next one shows an aerator that was a gift from us to the Mayor of Brussel.



*Chaipattana Aerator Model RX-2*



*Chaipattana Aerator Model RX-5C*



*Aerator*



*A gift from Thailand to Belgium*

## **Soil**

Soil is also a problem. Normally people do not use the land with problematic soil, but as the population grows, anywhere should be worked on. There are many problematic soil types: acid soil, saline soil, soil with hard pan inside, and nothing can grow in those soils.

### **Soil Aggravation**

The next picture shows the process of increasing acidity of the soil by bringing all acid-producing matter out, and then we treat the highly acidic soil at one time, after which the land can be used for cultivation. This is more effective than using lime dust which is costly, and now rice can grow.



Using lime dust is another quick way for improving the soil



Withered rice due to poisonous acid soil

The rice cultivation area at Ban Khok It and Ban Khok Nai in Narathiwat Province produced an increasing yield from 5-10 buckets (one bucket = 15 kg.) to 40-50 buckets.



“Klaeng Din” means to aggravate the acid soil in order to create high acidity by alternately leaving the soil wet and dry.



Cross section view of acid soil layer



Soil aggravation

## Soil Conservation

We do terrace farming on the mountains. The trick is that we have to remove the top soil. Then we cut the mountains into terraces and put the top soil back in its place. Now we can grow plants.



## Vetiver Grass

We have used a kind of grass called vetiver grass. In fact it came from the research work funded by the World Bank a long time ago. We can use it for soil conservation. This picture is the vetiver grass that we grew to stop soil erosion. We call it the living barrier.



**Vetiver grass :  
A living barrier**

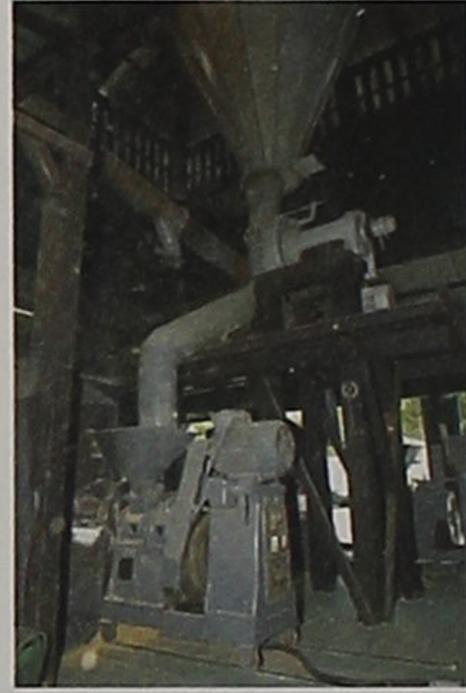


*Vetiver grass*

## Power

### Rice Husk

Another thing is the power or the fuel. In our palace, we have a rice farming project. We would like to find out what kind of rice mill is good for each place. In this project shown in the next picture, we get a lot of rice husk. We have made rice charcoal from it, and it works well. It was used twenty years ago in the refugee camps in Thailand, and a UN organization called UNBRO or UN Border Relief Organization was our good customer.



*Rice husk charcoal*

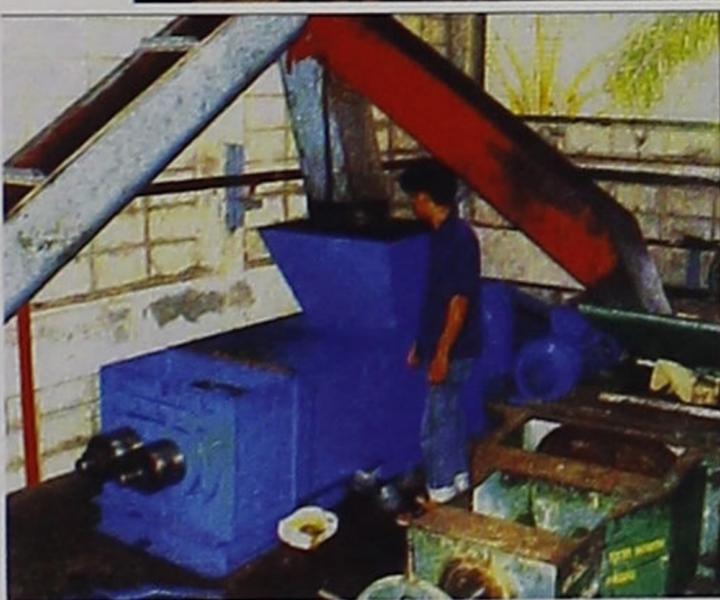
## **Gasohol and Biodiesel**

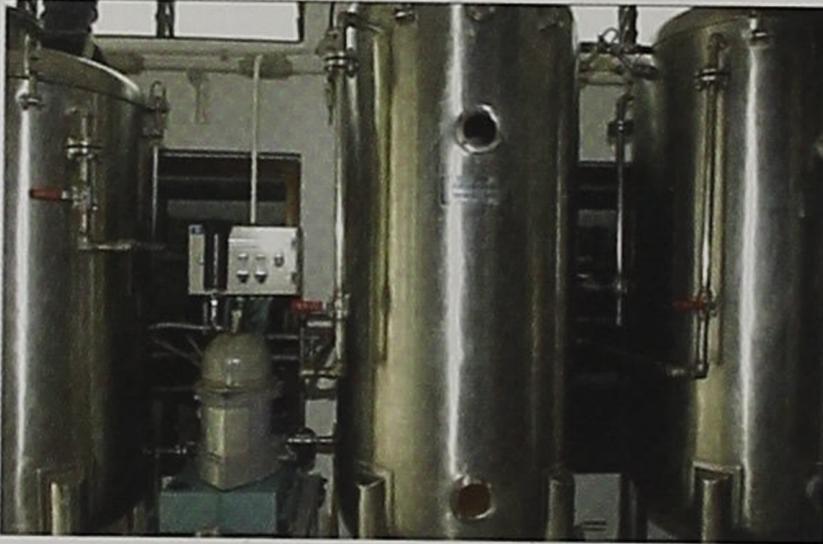
Some time ago we tried to make gasohol and biodiesel. Now the gasohol project is used along with the biodiesel to produce methyl ester that can be used for cars. I become a gas station girl from time to time. The oven in one picture is for cooking the palm oil. It is locally made with bricks and treated with sugar so that it would not break. We use the rice husk charcoal in the process of producing gasohol. The last picture shows the process of gasohol and biodiesel production.



*Gasohol project at Chitralada Palace*

From palm oil to biodiesel

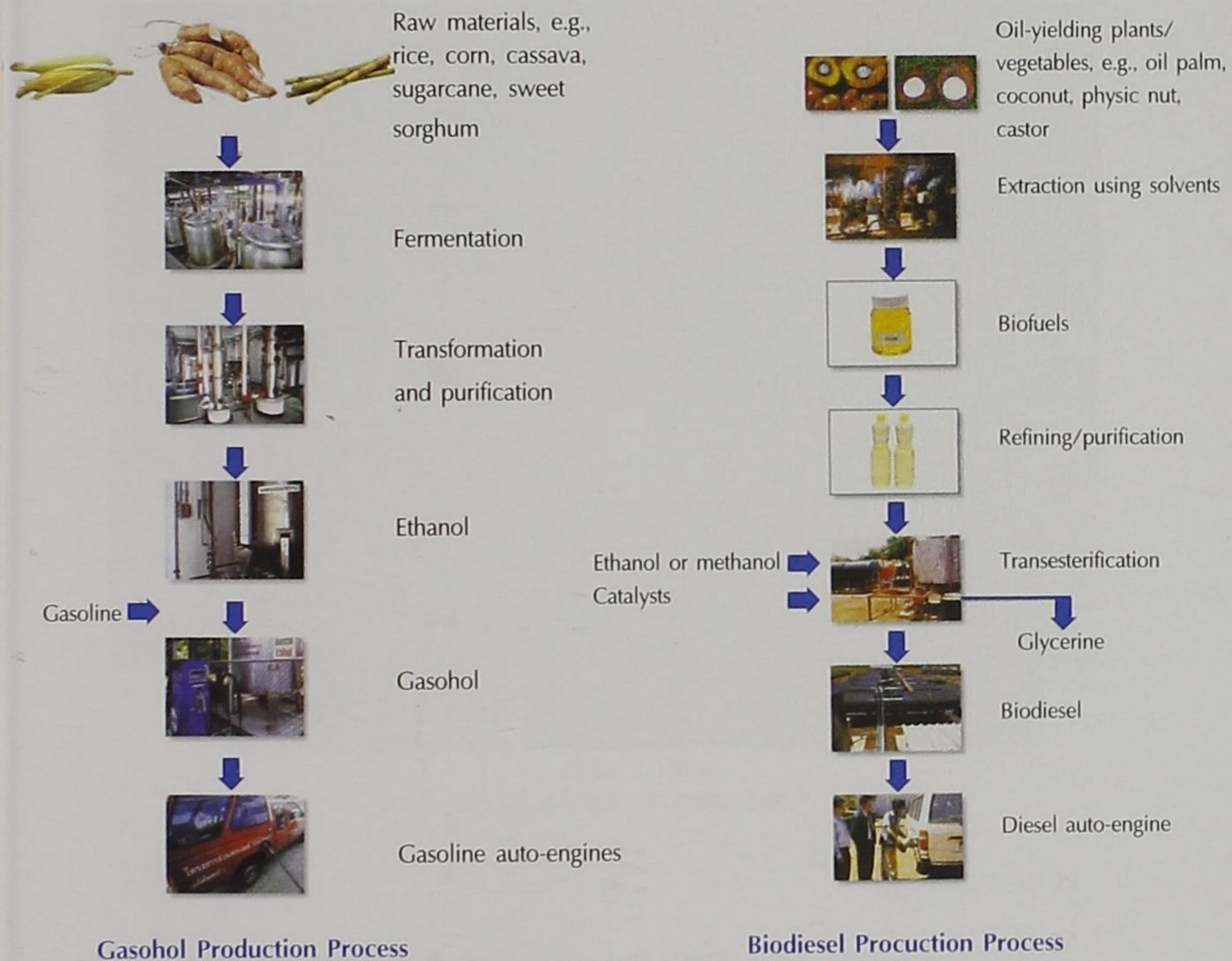




**Biodiesel Building, Royal Chitralada Projects, capacity of 2,000 liters/day**



**Biodiesel at Prachuap Khiri Khan Province**



*Process of gasohol and biodiesel production*

## Cooling System by Rice Husk

There is another new project that also uses the charcoal from rice husk. This rice husk is used to make a cold water system. It is applied to the mushroom cultivation. When we tried to introduce temperate zone mushrooms, they could not grow in our climate. But with this cold water production system, it is like an air-conditioned room.

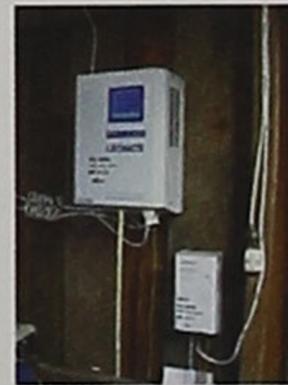


*Cold water production by rice husk*

## Solar Energy

The following pictures show the solar energy systems which are being used at the community learning centers far away from the national grid.

### Solar Energy at Community Learning Center Ban Pungtae, Amphoe Omkoi Chiang Mai Province





*Solar energy*

# ICT for Education Development

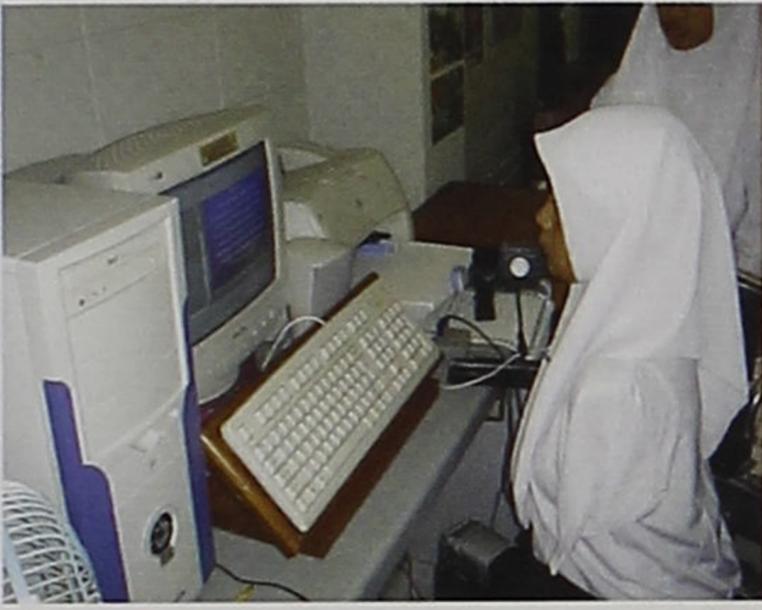
## ICT for the Disabled

In education development, we have used science and technology in helping people with some disabilities. For example, some computerized gadgets like a communication board, can teach the kids to talk.



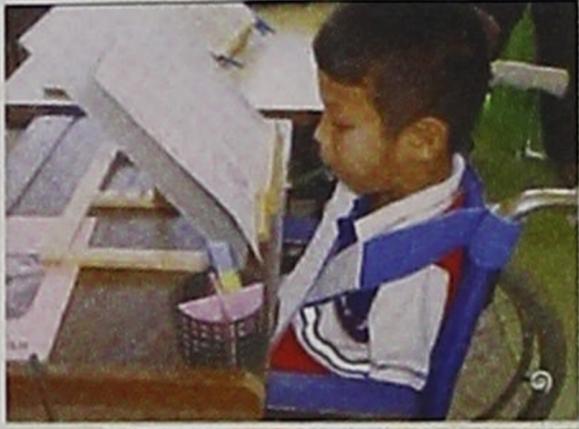
*Examples of ICT for the disabled*

The girl in the next picture has no limbs at all, no hands, no legs, and we have used a computer with a head gear to help her communicate and study. Now she is in a secondary school.



*ICT for a disabled girl*

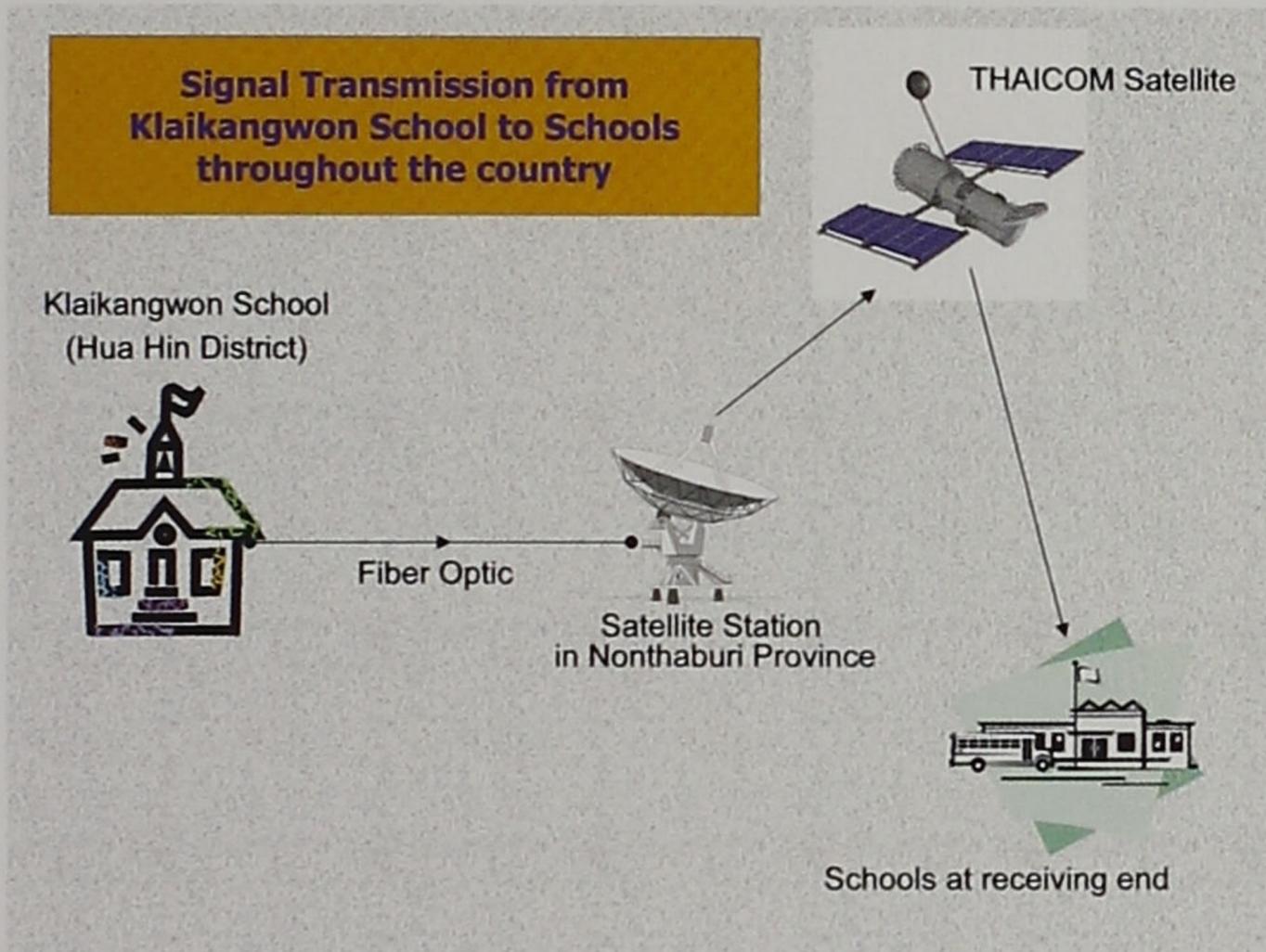
The boy in the next picture also has the same problem. We have tried to fix a prosthesis on him, but it did not work much because he enjoys sitting in a wheelchair and operates the wheelchair. The picture on the lower right also shows a gadget that I do not know who invented it, but we got the idea from abroad. In this way he can help himself in eating. Making a plastic gadget like the original model was quite expensive for us, and so we used different material. In this case it is ceramic, which is less expensive.



*ICT for a disabled boy*

## **ICT for Distance Education**

About the ICT, everybody already knows well its role in e-learning, database, etc., and so I can go quickly. We have had a project in one school, from which the instructions are sent to other schools. A teacher can be at one place and teaching goes through the satellite. We have many schools in rural areas that have the receiving stations.



*Distance Education*



*Distance Education*

## Conclusion

Through a number of years of my development work, I have learned a great deal about science and technology in development. I can say that development, facilitated by science and technology, can really build up the capacities of people, regardless of their cultural, socioeconomic and religious backgrounds. Development workers just have to realize that development often takes time and a lot of efforts, but changes do occur. No matter how little those changes are, they occur and accumulate. The instant reward that development workers can have is the joy of learning, gaining more experience and helping others, the reward they can keep for themselves for the rest of their lives.

Once in 1990 while resting on a desert floor on my way along the Silk Road in Northwest China, a sea of countless sand that extended beyond my sight made me think of a person in search of science and technology to quench his or her thirst of knowledge and to find the ways to solve problems that mankind faces.

*Though a hundred years more I acquired  
I would not have time enough  
To roam the world as desired  
I rush and run and rush and run  
Even to my last breath  
To see the world and the universe  
My heart, with delight, opens wide  
To savour all the truth  
To love with all my soul  
To learn and cherish my mind  
I'll verify my memories  
To last a hundred eternities!"*



# *H.R.H. Princess Maha Chakri Sirindhorn of Thailand*

*Her Royal Highness Princess Maha Chakri Sirindhorn, born in 1955, is the third child of Their Majesties King Bhumibol Adulyadej and Queen Sirikit of Thailand. She received her B.A. (1st Class Honors, the Gold Medal in History) in 1976, M.A. in Oriental Epigraphy in 1978, M.A. in Pali-Sanskrit in 1980 and Ed. D. in 1987, including special trainings in Cartography, Remote Sensing, GIS, and Nutrition.*

*Princess Sirindhorn is praised for her lifelong pursuit of knowledge and devotion to improving quality of life for all. The holistic nature of her development projects and literary works (over 100 publications) reflects her well-rounded knowledge in both Letters and Science.*

## **Work experiences:**

- *Executive Vice President of the Thai Red Cross (1977-)*
- *Faculty member and administrator of Chulachomklao Royal Military Academy (1980-)*
- *Some development projects:*
  - *School-based development (K-12 and higher education)*
  - *IT Funds for the Disadvantaged*
  - *Biodiversity and plant genetic resource*
  - *Water resource and alternative energy development.*

## **Special positions and awards:**

- *Trustee of Refugee Education Trust, 2000-*
- *WFP Goodwill Ambassador (School Feeding), 2005-*
- *UNESCO Goodwill Ambassador (Education of Ethnic Children), 2005-*
- *Ramon Magsaysay Award (Public Service), 1991*
- *Indira Gandhi Award (Peace, Disarmament and Development), 2004.*

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