From green to gene revolution:
How farmers lost control of the seeds from agricultural modernisation

Seeds are the foundation of agriculture. The seed diversity that existed, and that which continues to exist today, are products of constantly evolving efforts of farmers to conserve, adapt, improve, and utilise diverse range of seeds for equally diverse range of purposes. Throughout almost all the 10,000 year history of agriculture, the patient and careful work of millions of farmers produced an endless wealth of crops and varieties, with their myriad colours, flavours, needs, uses, adaptive characteristics, sub-products, growth habits, and so on. A very important part of this process has been the free exchange of seeds among farmers, which made the passing of knowledge, customs, traditions and culture possible from one farmer to another for countless generations.

Then modern farming came and changed everything. First was the formalisation of agricultural research followed by the re-orientation of agriculture itself. Armed with the new knowledge of plant breeding, scientists decided that farmers did not know a thing and claimed a monopoly over "crop development". Farmers were told that they were ignorant and their seeds worthless, while seeds bred by scientists (using the very same seeds of farmers) were presented as all that were worth planting. Farmers were also told of many other things. They have to be responsible in feeding the nation, not just themselves and their community, and thus have to be mindful of "productive harvests" – something measured in volume (of the same crop) and not diversity of outputs. They have to rely on agricultural technicians for technical guidelines in farming, as traditional knowledge are not based on science. And finally, they have to mechanise their operation in order to achieve "efficiency".

The result of this systematic undermining of farmers is well known. Thousands of varieties have disappeared. Agriculture has become deeply dependent on irrigation, machinery and agrochemicals. Farmers around the world disappear by the minute. Hunger continues to grow, and the food we eat has lost flavour and diversity. In the old days the quantity and diversity of supply in the market would vary across seasons and depend largely on the production choices of farmers, in a way shaping rich and varied food cultures throughout the world. These days, farmers grow a narrow range of crops throughout the year to guarantee its constant supply in the market. Not so much by choice as for the lack of it. If we look at our food system today, it has become essentially dependent on the industrial production of a few monocultural crops and a few species of poultry and livestock controlled by just a handful of big transnational companies. How did it all come about?

The industrial agenda

Who would have thought that the first steam engine in the late 18th century would have anything to do with the creation of modern seeds? But indeed it was the industrial revolution that caused major changes in manufacturing, transport, trade, agriculture and economy that would later have profound effect on the socio-economic and cultural conditions of the world. Spreading from Europe, North America, and eventually to the world, it would eventually give birth to the formal discipline of plant breeding, which would later influence the establishment a global food system.

The combination of these forces brought forth the economic and political agenda to industrialise agriculture. The idea being to develop a few varieties in a top-down manner that could be grown far and wide, that were designed to facilitate the use of new technologies (synthetic fertilisers, pesticides, mechanised tractors, etc) that were suited to the needs of big food companies wanting standardised varieties of a few crops like wheat, maize and rice. This happened first in North America, and the

model was then spread around the world, most dramatically toward the end of World War II, with what was called “Green Revolution”.

This process was heavily backed by governments who would spend the next decades launching national programmes – including public breeding – that would make farmers accept this new agricultural development model as “progress”. India, for instance, invested massively in the Green Revolution as a response to famine. The rest of Asia followed suit, including China with its own development of hybrid rice. Largely led by the public sector, the Green Revolution created global markets for agribusiness, both in terms of inputs and standardised commodities traded around the world.

The Green Revolution

Green Revolution was the name given to the agricultural modernisation programme that swept across Asia in the 1960s and 1970s, and launched an army of government-controlled, genetically-uniform high yielding varieties (HYVs) of cereal crops. Unlike other revolutions in history, it had one and simple goal: convert farms into industrial monocultures of rice, wheat and maize. Though successful in that respect, its lasting impact was not as much in the farms as it was in the mind. It instilled among farmers the habit of growing single crop for cash, as well as among scientists and agricultural research institutions an almost devotional adherence to the belief that population growth will outpace production and thus famine is inevitable.

The strategy to fight hunger in the world by bringing together international scientific research and the widespread dissemination of so called improved plant varieties in developing countries, also came at the heels of an important political juncture in history: the rise of the Soviet Union. In the 1950s, this model of agricultural development was put forward by the US-based Ford and Rockefeller Foundations as a way to thwart the menace of the "red revolution" or the expansion of communism in poor countries. There was a simplistic thinking that by increasing production and farm income, farmers would be less inclined to cultivate ideological growth, much less join political struggles. At the same time, the World War II purportedly left so much excess materials (for making bombs) that could be recycled into synthetic fertilisers, and one sure way to get farmers to use them would be to introduce chemical-responsive varieties of major staple crops. The proponents of Green Revolution themselves had their own business interest: Rockefeller built his fortune from oil refinery including its by-products while Ford built his empire from automobile and transport, and naturally had much to gain from the use of petrochemicals and the mechanisation of agriculture.

Starting in Mexico, the Philippines and India, the new varieties of wheat, rice and maize quickly spread through the tropics to replace farmers' varieties, through the establishment of four international agricultural research centers by the Ford and Rockefeller Foundations. Together, these four – the International Rice Research Institute or IRRI (1959), International Maize and Wheat Improvement Centre or CIMMYT (1963), the International Center for Tropical Agriculture or CIAT and International Institute of Tropical Agriculture or IITA (1967) – would later become the Consultative Group on International Agricultural Research (CGIAR) in the 1970s. The CGIAR, now composed of 15 centres, encouraged countries to shift to monoculture farming with the purported goal

of increasing yields and agricultural profitability. Its centres were responsible for producing high-yielding seeds that are responsive to irrigation, mechanisation, and plenty of chemical fertilisers and pesticides.

Impacts and trade-offs

The consequence of this effort has indeed been an increase in yields for specific crops and in specific countries – at least for their irrigated, fertile and flat land areas. For example, under the programme, India increased its wheat production ten-fold and its rice production three-fold. For the first time, the Philippines was able to export rice, albeit minimal amount, in 1979. Indonesia recorded an 85% yield increases in rice as well. But beyond the yield gains, there were many costs – economic, environmental, social, health, biodiversity, etc.

When the seeds were ripped out of farmers' hands and put in the hands of scientists, they were told that they would be given back "improved" varieties. But these varieties ended up causing more harm than good. By early 1980's farmers were already feeling the negative effects and speaking out against the Green Revolution. A major fault with this industrial model was that it designed plant varieties to perform optimally under the specific conditions of the laboratory. While in the old days farmers would develop seeds suited to their farms, this time they had to suit their farms to the seeds that scientists develop, by adding chemical inputs, use of irrigation systems, and a host of new farm implements and machineries. As a result, the use of large amounts of water, fertilisers and chemical pesticides impoverished soils, leaving them less fertile and highly polluted. Local biodiversity was drastically reduced, bringing farmers under the dependence of pesticide manufacturers and outside seed suppliers.

Loss in rice diversity alone was tremendous. Before the Green Revolution, Philippines had about 4,000 cultivars of rice throughout the country. But by mid-1980s, farmers were growing only 3-5 varieties, mostly developed by IRRI. Indonesia was the same case: from about 15,000 cultivars of rice prior to Green Revolution, the number was down to a handful of IRRI varieties in the 1980s. Bangladesh also reportedly lost about 7,000 rice cultivars during the Green Revolution. By mid-1980s, most of Asia's rice lands were practically a patchwork of IRRI's IR-8 and IR-24, the so-called Miracle rice varieties, replacing thousands of native and traditional cultivars considered "low-yielding" by modern agriculture standards. More importantly, the mono-variety mono-culture has led to disease epidemics and pest outbreaks.

The profound cultural and economic changes wrought by the Green Revolution produced a massive rural exodus, and, with it, a profound loss of traditional knowledge and skills. For most farmers, any early profits were soon converted into debts, with many farmers, unable to repay their debts, taking their own lives. A Thai rice farmer once remarked that before the Green Revolution, farmers were poor, after the Green Revolution, they are still poor, thus IRRI has no impact at all.

China's hybrid rice

While much of Asia was becoming deeply entrenched in Green Revolution, China was having its first success with developing hybrid rice, a variety with purported higher yielding capacity of 10-15 % over IRRI's inbred HYVs. Enthused by the apparent success of hybrid maize in North America, China's top scientists embarked on an arduous task of developing the first rice hybrids in 1971. They were supporters of the theory of heterosis, which states that crossing two distant genetic lines results in superior first generation offspring. In 1974, China had its first hybrid rice variety, developed by Yuan

Longping, considered “father” of hybrid rice.

The government and its scientists were anxious to get the new technology into farmers’ fields to catch up with the growing population. In their eyes, the best way to increase production was to get as many farmers as possible to introduce the rice hybrids into their paddy fields. The Chinese state used the ‘local work units’ to get farmers to abandon their traditional varieties and adopt hybrids, in much the same way they had disseminated the HYVs. The state also provided large-scale subsidies to help cover the initial investments on hybrid rice.

Over the years, with singular support on hybrids, much of native Chinese varieties disappeared in farmers' fields. Compared to the Green Revolution's HYVs, hybrids are F1 seeds, which are not designed to be saved and replanted thereby forcing farmers to buy fresh batch of seeds every cropping. This very nature of hybrids makes it a very profitable business for seed companies. This loss of control over seeds means that Chinese farmers are now dependent on outside seed providers. Today, more than half of China's rice land is planted to hybrid rice, supplied by both government and private seed companies.

In the beginning, it was all public agencies and state-owned seed companies that were involved, but it has changed dramatically in recent years, without many farmers knowing. Chinese government has a specific policy to develop a few large companies that can compete with the TNCs. An example of this is Yuan Longping Hi-tech Agriculture, owned by the father of hybrid rice himself, who developed it through public research but now commercialises several varieties of hybrid rice to his private company's own benefits. Yet, it is even difficult to see the difference between Chinese companies and foreign companies. Yuan Longping Hi-tech Agriculture is now partly owned by Vilmorin/Limagrain of France, when the latter bought a 46.5% controlling stake in the company.

Chinese companies are working hand-in-hand with the government to develop overseas markets. But hybrid rice has gone beyond Asia as it has become an important part of China's outward investments. Often fronted by the Chinese Academy of Agricultural Sciences (CAAS) and the Yuan Longping Hitech Agriculture Company, it's being brought to Africa, Latin America, Pacific, Caribbean and some parts of Europe, often under the pseudonym of “technical cooperation”. Especially in Africa where much of the projects involving hybrid rice are for export, it can have profound impacts on farmers' food and livelihood security. In Asia, the use of hybrid rice has resulted to higher incidence of indebtedness, rather than high yield, among farmers.

Hybrid rice consortium

Intrigued by the practical application of hybrid technologies in China, a few key agencies have formed a consortium to ensure that the rest of Asia tries to reap benefits from hybrid rice. An international project called “Development and Use of Hybrid Rice Outside of China” brought together IRRI, the Food and Agriculture Organization (FAO) of the United Nations, and the Asia Pacific Seeds Association (APSA), a group of all the major seed companies operating in Asia in the 1990s. The sole funder for the project was the Asian Development Bank (ADB). From 1998-2000 the ADB provided a total of US$1.5 million towards the project, targeting Bangladesh, India, Indonesia, the Philippines, Sri Lanka and Vietnam. Currently, IRRI coordinates a hybrid rice research and development consortium which alllows licensing of the varieties developed through public research for the commercialisation of private seed companies.

Corporate control

The “seed monopoly” that hybrids opened up was just the beginning of a much complex layers of control that would soon be realised through the ‘gene' revolution – more known as the era of “genetic engineering” – that started making headway in the 1990s. Its applications in agriculture put a whole new light on plant breeding as it offered almost limitless possibilities of “creation” and brought forth a multi-billion dollar industry that would have control not just on seeds or agriculture but of the entire life system. Employing primarily the techniques of recombinat-DNA, genetic engineering practically moves genes from one organism to another such that it is now possible to have pigs with genes from cows producing bovine growth hormone, bacteria with human genes to produce insulin, and plants with genes from bacteria producing natural pesticides, as in the case of Bacillus thuringinesis (Bt) rice that Chinese government recently approved for commerialisation.

But while much of the earlier “revolutions” was publicly-owned (i.e. government controlled) the gene revolution is largely a private affair. Through gene revolution it is also now possible for private companies to exert control and derive profits beyond the seed itself. Through intellectual property rights, companies can claim ownership through patent protection over pest-resistance expressed in the seeds (e.g. the Bt toxin in Bt crops), and a way to tie farmers to the use of specific pesticides (e.g. Round-up Ready in herbicide-resistant crops). For example US-based Monsanto, the world's largest seed and agrochemical company, owns the patent to the herbicide resistant gene (Round-up Ready) expressed in crops such as maize and soy. Any other seed company (like Pioneer) who plans to commercialise maize or soy seeds with that gene will first have to pay Monsanto, the “rightful” owner of that gene by virtue of its patent.

This added layer of ownership makes the whole seed production expensive, and companies like Monsanto can further extract profit from the use of their technology, by forcing farmers to pay royalty in the form of “technology fee”. This is why genetically engineered seeds are typically more expensive than any other seeds. This is also why agrochemical companies started buying up smaller seed companies at a rapid pace, and why much of the public breeding progammes were privatised if not to decay. Right now, a few big companies is in control of the global seed market, These are mainly agrochemical companies whose agenda is to stop farmers from saving seeds and develop seeds dependent on their chemicals and patented traits. In North America, which has had the longest experience with this, the input companies have basically captured all the extra revenue that farmers have created by increasing yields.

IPR on seeds

Intellectual Property Rights (IPR) are property rights created by law over creations of the mind giving the maker/the IPR applicant an official license from the government to enjoy economic rights over their invention for a fixed period of time to the exclusion of others. With IPR the IPR-holder can prevent others from making, selling, exporting, etc. of the product. This gives the patent holder a monopoly over the product for the term of the patent, which is a minimum of 20 years and extendable. The IPR-protected “invention” can only be used by the permission of the IPR holder and upon payment. Those who are for IPR say that since the person who got an idea gets legal protection from anyone else using it, it would encourage many others to innovate.

But what if the idea itself is stolen? As in the case of agribusiness companies using farmers' know-how of seeds to develop new varieties, getting IPR on them, claiming the new variety as company property and selling it back to those very people who thought of it first! IPR are of various kinds - patents, trademarks, trade secrets, plant variety protection and geographical indications. These are more and more being used in industrial farming to protect investors rather than the real inventors - small farmers, traditional healers, etc.

With more IPR pushed in via free trade agreements or FTAs, one can foresee more proprietary agricultural technologies being promoted, some more serious like genetically modified (GM) seeds, GM fish and other transgenic products. This may be good for biotech companies but not so for biodiversity.

Scientists critical of genetic engineering are saying that its application in agriculture is, by design, invasive and unstable. For example, the problem with genetic contamination (GE crops contaminating non-GE crops by, among other ways, cross-pollination) is a very real one and could cause a collapse of the entire seed system. The contamination of maize in Mexico has caused not only the loss of traditional varieties of maize, but put their food system in danger. And there were indications that the contamination was in fact deliberate to make Monsanto's Bt maize accepted by default. On the other hand, genetic contamination could also put an unsuspecting farmer in the middle of a legal claim. In Canada, there were cases of farmers being brought to court by Monsanto for supposedly “illegally using” Monsanto's patented gene in their canola farms, simply because their farms had been contaminated by pollens from a neighbouring farm growing Monsanto's GE canola.

Yet a whole range of food and industrial crops – cereals, beans, vegetables, fruits, beets, cotton - even trees and fishes, are being genetically engineered (and China is at the forefront of it all) to contain a special gene or two. Obviously these are not so much to help agricultural development of farmers but to further concentrate profits in the hands of a few companies. Despite all the hype of genetic engineering being the answer to feeding the world, only a handful of GE crops are actually being grown worldwide: maize, soya, cotton and canola, largely for industrial rather than food use. They contain either herbicide tolerance or insect resistance gene – nothing to do with nutrition. All of it is practically controlled by just four companies: Monsanto, Syngenta, Bayer, Du Pont, same companies who produce chemical pesticides.

Rebuilding agriculture from the ground

The march toward “progress” through different eras of agricultural modernisation has not only led to genetic erosion and monoculture. A wealth of traditional knowledge and diverse food and farming cultures, had been lost as well.

But there is a new wave of resistance that is also building across the globe. Local people are mobilising to counter monoculture as communities embark on broad range of initiatives to reverse the privatisation of genetic resources and traditional knowledge. Informal networks and alliances are being formed around seed saving, on-farm breeding, farmers' research, food sovereignty - all of them articulating the importance of constructive actions in reclaiming space for peoples' control of biodiversity. People are coming together to challenge old perspectives and infuse new ways of thinking and working. Others are looking for ways to bring agricultural research back into the hands of farmers and communities.

There is a dynamic rediscovery of local cultures that is leading to the redefinition of self-identities, a

re-cultivation of local economies that contributes to building of farmers' autonomy. This is happening now in a silent way. Seeds are being saved, passed and exchanged across many different communities. And these are not just seeds of crops, but seeds of hope being sown to rebuild the future of agriculture.

Some examples of farmers' seed alternatives in Asia

Women-led ecological agriculture in India

The Deccan Development Society (DDS), is a grassroots organisation working in about 75 villages with women's Sanghams (voluntary village level associations of the poor) in Medak District of Andhra Pradesh in India. The women members of the Society represent the poorest of the poor in their village communities. But since 1985, the sanghams have cultivated actively over ten thousand acres of degraded agricultural lands, and raised over three million kilos of grains every year. About 3000 women in 50 villages have enhanced the productivity of over 3500 acres of land, mostly fallow or highly marginal, to grow more than a million kilograms of extra sorghum in their communities every year. This activity has translated into production of nearly 1000 extra meals per each participating family per year, thereby demolishing the myth of the need for permanent government patronage for their food security.

By growing diverse crops, on their marginalised lands, over 1500 women farmers have established level community "gene banks" in 60 villages and have retrieved over 80 native varieties. This effort has not only retrieved a strong agro biodiversity on their farms but has also reestablished women's control and leadership over their community germplasm and knowledge. Since 1996, they have also designed and managed local production, storage and distribution systems to reverse the trend of increasing centralisation of food grains. The women's groups have shown that even the very poor farmers, once in control of their agriculture and natural resources, with a bit of help and access to financial resources, can feed themselves and the non-food producing members of their community. They have proved that even in some of the most degraded land areas of the world, people do not have to seek out genetically modified crops or transnational companies to feed them.

Community-managed seed wealth centres in Bangladesh

Nayakrishi Andolon or the "new agricultural movement" is an effort of Bangladeshi farmers to produce healthy, environmentally conscious foods in harmony with nature. It is a movement for new agricultural practices and a new relation with nature. The movement promotes traditional knowledge of farming such as crop rotation, green-manuring, pest control, etc. through its seed wealth centres that act as main hubs for training and seed exchange. It is also increasingly becoming a place for the women farmers to gather and share knowledge. Beside general discussions on agricultural practices, they share the knowledge on horticulture, seed preservation, food processing, medicinal plants, etc.

Through sharing of information, training and exchanges between farmers from different, areas Nayakrishi Andolon has spread to every region of the country and has encouraged a decentralised seed system. In every village there is a seed hut where seed preservation and seed storage takes place. Indivdual households also have their own collections. This effort came from the realisation that so much has been lost, and therefore there is so much to bring

back, and that there are so many ways to enhance biodiversity. The movement itself is the physical articulation of their fight against the transnational corporations that are destroying agriculture.

Farmer-led breeding in the Philippines

The Farmer-Scientist Partnership for Agricultural Development (MASIPAG) is a farmer-led network of people's organizations, non-government organizations and scientists working towards the sustainable use and management of biodiversity through farmers' control of genetic and biological resources, agricultural production and associated knowledge. It is widely known for its successful work on farmer-led research and crop improvement initiatives involving conservation and management of the country's rice biodiversity. For more than 20 years, MASIPAG has established itself as an "alternative to IRRI" but with a much broader vision of putting the seeds back in the hands farmers, by promoting farmer-led breeding (rice and corn) in the Philippines.

Its breeding programme is designed to breed varieties that are suitable for particular conditions and to maximize genetic diversity. Breeding is done in a participatory way involving farmer breeders with some help from scientists. This allows farmers to regain control of their seed and allows for a truly participatory structure and farmer empowerment. Over the years they have managed to retrieve thousands of native varieties, bred locally-adapted varieties that are high-yielding, good-tasting and more nutritious, and resistant to different pests and diseases.

But their effort is not confined to breeding farmer varieties. In fact, farmer developed varieties only serve as entry point for the development of sustainable agro-ecosystems, which they define as a sustained process of conversion both in the lowland and upland ecosystems. This means a conscious shift from conventional (chemical-based) to organic farming, from mono-cropping to diversified and integrated farming system, and from individual farm ecosystem to community-wide agro-ecosystems. For this, the conduct various forms of on-farm training, seminars, workshops and cross-visits to broaden awareness, impart technical knowledge and know-how and develop farmers' skills in managing biodiversity.

This downloadable pamphlet is developed by GRAIN and the Pesticides Eco-Alternatives Centre (PEAC) to raise Chinese farmers' awareness about the broad historical context of industrial agriculture, and how it paved the way for the introduction of modern varieties of crops and agricultural technologies. Available in Mandarin.
A shorter version (brochure) published by PEAC is also available.