Agrobiotechnology in South-East Asia: an overview

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Abstract
So far, 80% of the world population live in developing countries, and according to the estimated increase of population in the next 40 years a huge percentage of the population will move from subsistence to undernourishment or hunger. A significant part of developing countries' economies is based on agriculture and these countries will face the need to adapt their farming production to the increasing number of people to feed.
For the above mentioned reasons, many developing countries are investing in research and development in biotechnology applied to agriculture (both modern biotechnology as genetic engineering and conventional biotechnology).
This work represents a partial overview of the situation of agrobiotechnology in developing countries and issues related, with a specific focus on an emerging region, South-East Asia.

South-East Asia is a region located between China at its North, India at its East and Australia at its South. It consists of a peninsular part – Vietnam, Laos, Thailand, Cambodia, Myanmar and the peninsular part of Malaysia - and a maritime one, which consists of Indonesia, Brunei, East Malaysia, The Philippines and Singapore.
It represents a very interesting scenario for various reasons. All the countries I have mentioned, besides Singapore, are developing countries, with a strong percentage of their economy based on agriculture. Moreover, independent studies predict that this area will account for the highest demographic increase for the next 25-30 years.
Developing countries is a very used expression, whose definition is quite broad and not recognized internationally. It is normally used to define countries "with a low level of material being", but this expression is as faint as "developing countries". Moreover, many factors must be taken into account while referring to what "material being" is, like the level of income and subsequently of the poverty, the situation of unemployment, the education, the sanitary and health system, the infrastructure, the women and children situation - just to cite some examples. Indeed, the level of development can vary very deeply even between the defined *developing countries,* determining the need for further categorizations.
The World Bank subdivides countries in 4 categories, according to their income: high, upper middle, lower middle and low income. Both low and middle- income are considered as developing countries, even if it is clearly specified that a classification by income cannot reflect the situation of development. For the purpose of this article, I will refer to the World Bank classification, although it is, as I have already mentioned, quite constraining and does

not take into account many factors that are part of countries development.

So far, almost 80% of the world population live in developing countries (Arundel & Sawaya 2009). The Asia-Pacific region houses roughly 60% of the world's population, percentage destined to increase in the next few years (Gupta, Karihaloo & Khetarpal 2008). Many people, moreover, are attracted by the economic growth this area has been experimenting, mainly due to its investments in biotechnology (it's not new that Singapore is investing in industrial and medical biotechnology, causing a virtuous cycle in the economy that mitigated the effects of the economic world crisis). Given the increase in population, South-East Asia agricultural land per capita is decreasing causing the diffusion of uncontrolled burning to increase cultivable land; slow-down of agricultural yield, due to improper farming practices, has also been observed.

Agriculture and climate change in developing countries

Many developing countries base their economy on agriculture. In low-income countries, three out of four people depend, directly or indirectly, on agriculture – which includes livestock, fisheries and forestry – for their subsistence. Due to this reason, agriculture is essential in their economies, and has a big influence on their gross domestic product. Such a preponderant influence of agriculture on GDP is reflected on the work force, making such sector the basic source of work for most of population.

With the estimated increase of population – 9.1 billion of people in 2050 (UN Population Division/DESA 2009) – farmers will face the big challenge to find a way to adapt agriculture to the world population needs. But this is not the only issue agriculture would need to face.

Climate change, bioenergy, land degradation, loss of soil fertility, use of chemicals, put the agricultural system under a huge pressure, in order to produce food, feed, fiber but also income and employment possibilities. These factors, moreover, have a wide impact on food security.

"Food security exists when all people at all times have physical or economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life", World Food Summit 1996.

Food availability, accessibility, utilization and system stability are, according to the FAO's State of Food Insecurity (2002) report, the fourth elements of food security. Many developing countries, whose economy is based mainly on agriculture, have access only to their internal food production, fact that contribute significantly to a situation of insecurity: if any unforeseeable event, in fact, will affect their farming system, these populations will find themselves without any other possible option. Natural disasters like hurricanes, droughts or floods can easily bring these instable economies to their knees, and condemn millions of

people from poverty to hunger.

Moreover, developing countries have to face another "hot" issues: climate change. Agriculture and deforestation account for 14% and 17% of the global greenhouse gas (GHG) emissions and developing countries are responsible for roughly 74% of them. Agriculture itself releases in the atmosphere high levels of CO_2, produced mainly by microbial decay; CH_4, due to fermentative digestion by ruminant livestock or rice grown under flooded conditions and N_2O, due mainly to microbial transformation of nitrogen in soils (Smith & al. 2008). Deforestation, on the other hand, contributes in different ways: cutting trees means reducing the photosyntetic capabilities of the planet, and, at the same time, burning wood causes the release of CO_2 in the atmosphere (for examples, it is habits of some countries like Brazil and Indonesia to burn forests to get agricultural land).

A very interesting and useful initiative has been undertaken in 2005: it's called Coalition for Rainforest Nations (Stiglitz 2006). It is composed by 40 "*forested tropical countries* - four of them are South-East Asian countries, Indonesia, Malaysia, Thailand and Vietnam - *collaborating to reconcile forest stewardship with economic development"* (Coalition for Rainforest Nations). The countries can participate to some initiatives (Environment Sustainability; Reducing Carbon Emissions; Sustainable Forestry) implementing policies and working together to reach the common goal of "*manage tropical rainforest areas in support of climate stability, biodiversity conservation, sustainable development and poverty alleviation"*. This is an interesting way for developing countries to demonstrate support to responsible environment management and their commitment to reduce the GHG emissions: in exchange, they ask the possibility to sell carbon offsets to developed countries for avoided deforestation and not just for planting new forests.

Biotechnology applied to agriculture

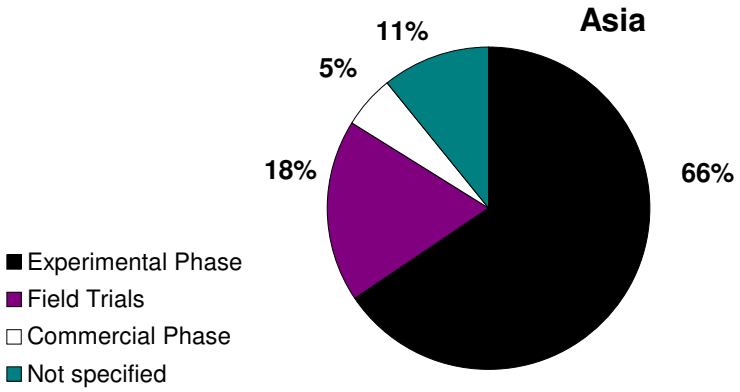
Agriculture is very important for developing economies, in terms of production but also for the employment opportunity it offers. Moreover, the arable and forests land in developing countries is larger than in the other parts of the world. For the mentioned reasons, it is not surprising the attention posed to implement agrobiotechnology in these areas.

According to FAO (2007), developing countries agricultural production increased in the last fifty years from roughly 45% (in the 1960s) to 70% (in 2005) of the global food supply, proving once again its pivotal role for the global food production (Arundel & Sawaya 2009). To make an analysis of the situation of agrobiotechnology (I am specifically referring to transgenic crops) in developing countries, I will follow the FAO categorization.

FAO divides developing countries into 5 areas: Asia, Africa, Latin America & the Carribean, European transition countries and Near East. All the above mentioned regions are quite active in terms of development of GM-crops projects: 1088 GM-crops projects are currently

reported in the FAO BioDeC database, subdivided in 592 at the experimental phase, 355 as field trials, 62 at the commercial phase and 79 with any specification regarding their status.
Among them, Asia presents the highest level of GM crops at the experimental phase and at the commercial phase (409 and 33 respectively for the experimental and commercial phases), while Latin America & the Carribean have the highest percentage of GM fiels trials (184 GM crops present as field trials).
Figure 1 shows the distribution of GM crops projects in Asia according to their stage, and it is evident that the highest amount of GM crops are currently in the experimental phase.

Figure 1: Distribution of GM-crops projects in Asia according to their stage.



Source: FAO-BioDeC database, rearranged

Focusing specifically on South-East Asia, it must be underlined that, with its 237 GM crops, it represents a small percentage of the all GM crops projects developed in the whole Asian region (603 GM crops, FAO BioDeC database). India and China, in fact, play in this field the biggest role: 218 and 71 GM crops projects respectively.
Among South-East Asian countries, the most active countries are Indonesia, The Philippines and Malaysia, with, respectively, 66, 51 and 45 GM-crops active projects, as shown in Table 1.

Table 1: Distribution of GM-crops projects in South-East Asian Countries according to their stage.

	Experimental Phase	Field trials	Commercial Phase	Not Specified	Total
Indonesia	54	9	1	2	**66**
Malaysia	41	1	0	4	**45**
Myanmar	1	0	0	0	**1**
Philippines	29	4	9	9	**51**
Singapore	0	0	2	3	**5**
Thailand	22	9	0	7	**38**
Vietnam	30	0	0	1	**31**

Source: FAO-BioDeC database. rearranged

In terms of cultivations, the Philippines have the highest percentage of GM fields: in 2008 The Philippines cultivated 0.4 million hectares, mainly GM corn (James 2008).
As I have just mentioned, developing countries are working hard to become competitive in the field of genetic engineering and to improve their economic situation, but genetically modified crops are not the only biotechnological application in agriculture taking place in these countries. Many projects, in fact, include crops modified by *conventional biotechnology*.
According to FAO BioDeC database, 2012 crops modified by conventional biotechnology are under development, and the most used conventional techniques in developing countries are: Micropropagation (28.90%), Random Amplification of Polymorphic DNA (RAPD, 10.07%), Anther culture and Microsatellite Markers (both 4.65%) (Arundel & Sawaya 2009).

The regulatory background in South-East Asia

As I have mentioned in the previous paragraph, South-East Asia is developing many projects in biotechnology applied to agriculture. This sector, indeed, could be boosted making use of a regulatory framework specifically thought to enhance the potential of this particular region of the world.
To sustain and take advantage of the peculiarities of this area and to face the issues mentioned above, Brunei, Cambodia, Laos, Indonesia, Malaysia, Myanmar, Singapore, Thailand, The Philippines and Vietnam grouped together in the Association of South-East Asian Nations, ASEAN, a geopolitical and economic association with the main aim of increase stability, peace and economic growth in the region.
Since 1977, ASEAN countries have been developing Cooperation in Food, Agriculture and Forestry. Its main aims are to develop and enhance the international competitiveness of

ASEAN's food, agricultural and forestry products through a well planned regional cooperation, and strengthen the food security, to reach the necessary high levels to be competitive in an international environment. To reach these goals, ASEAN promoted foreigner investments into the region, transfer and development of new technologies, cooperation at both regional and international level, increasing of the private sector (OECD 2008).

ASEAN perception in terms of biotechnology is well defined, and genetically modified organisms, GMOs, are seen as main biotechnology application in agriculture, essential for increasing crop productivity, improving food quality, promoting sustainable use of natural resources and enhancing economic benefits.

For these purposes, ASEAN countries developed legal frameworks to regulate the products obtained through genetic engineering and to address biosafety issues. The first legal framework appeared in 1980 (The Philippines), and in the past 10 years many regulations and guidelines have started to appear to comply with the international legislation. Specific attention has been posed to the development of National Biosafety Frameworks and the realization of the Biosafety Clearing-House, to meet their obligation to the Cartagena Protocol on Biodiversity. Specifically, all the countries are Parties of the Convention on Biological Diversity (CBD) and the only two countries not to be Parties of the Cartagena Protocol are Singapore and Brunei.

Two other important issues have become relevant for ASEAN countries: the food safety and the consumer protection. At international level there is no comprehensive legislation that covers all the above mentioned aspects, so the legal landmarks are binding laws (e.g. WTO Technical Barriers to Trade, CBD, Cartagena Protocol on Biodiversity…) or non-binding laws (e.g. Organization fro economic Co-operation and Development (OECD) Safety Consideration for Biotechnology, UN Guidelines on Consumer Protections…). For this reason, the legal frameworks put into force by the mentioned countries differ between them. In terms of consumer protection, some countries like Singapore and Indonesia developed guidelines for labelling GM-products, while others are focusing on ensuring fair trade practices and working on trade or intellectual properties agreements able to safeguard their rights.

Conclusions

As partial conclusion, it's possible to underline a growing tendency to introduce GM crops from developing countries (90% of biotech crop farmers were small and resource-poor farmers in developing countries in 2008) and Indonesia leads the pack in South-East Asia. Since the introduction of GM crops on the international market, the dominant traits have been the herbicide tolerance. A change in trend, both in the developed and developing countries, has been observed with the introduction of GM crops with stacked double and triple traits.

The main transgenic crops present in field trials in South-East Asia are *Bt* –corn, -cotton, -soybean, -sugarcane; RR soybean; Viral resistance papaya and tomato.

The great impulse given to transgenic crops is changing the economic landscape of South-East Asia, which is working hard to become more and more competitive on the international market, with investments in research and development and adapting the present legal frameworks and agricultural practices to the conditions posed by the main developed countries trading in GM crops.

Note

According to FAO BioDeC database, Asia includes the following countries: Afghanistan, Armenia, Azerbaijan, Bangladesh, China, Georgia, India, Indonesia, Iran, Korea Rep, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand and Vietnam. Besides Singapore, all of them are *developing countries*.

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