The Benefits of Crop Protection Products (CPPs) From a Seed Company Perspective

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INTRODUCTION

Debate on agricultural production and the way forward for the Thai agricultural (Ag) sector has become polarized on a variety of grounds, especially by those wishing to take *the moral high ground* on the role of science and technological developments within the Ag sector. A romantic picture often painted by opponents of scientific advance reflects on the so-called "glory days" for Thai agriculture 40-50 years ago. The story goes that this period was filled with farmers merrily working in sun-drenched fields, producing bountiful amounts of safe, clean food all year round. So much food in fact, that farmers' wives would happily share fruits and vegetables fresh from the farm (still with morning dew on them) around neighbouring villages, and exchange new seed varieties specially selected on-farm. Because farmers did not use improved seeds, crop protection products (CPPs) or other inputs, they would save money and not harm the environment. Best of all, so the story goes, farmers were producing food in a *sustainable manner*.

This glorification of what was then pure "subsistence agriculture" is a naïve dream and an affront to those who were sentenced to, what was in reality, a life of hard labour and abject poverty. Those purporting the "glory days of agriculture theory" should note that times were better characterized by back breaking toil, scarce arable land, seeds that never germinated, crops ravaged by floods and drought or perhaps pests and diseases, yields so low and variable that food security was not guaranteed & supply distinctly variable (seasonal), and healthy nutritious fruit and vegetables were a luxury. For those farmers' children able to live through the malnutrition, there was little chance for them to go to school because they were too busy helping their parents in the fields transplanting, ploughing, weeding, or harvesting.

Reality is, the period of widespread subsistence agriculture was not glorious for those who were imprisoned by it. Every day was a fight for life, a fight that still goes on in many corners of Asia. For most Thai people, the fight is over; progress has seen to that.

The progress that has freed many from the shackles of subsistence agriculture and propelled millions to move into commercial agriculture, whilst allowing new generations to enjoy formal education and the resulting human resource development, is multifaceted improvements in agricultural technology. Arguably the two most important elements of these improvements are the introduction of improved varieties bred for Thai conditions and the effective use of crop protection products (CPPs). These factors alone have brought considerable economic, social, & environmental benefits to Thailand over the last 40 years. Both private seed companies and public sector breeding programmes have thus been able to flourish as a result of improved agronomic and economic conditions, and have been able to add further value to the agricultural sector through the development of varieties suited to the tropical lowlands. Without the initial input of agrochemicals and fertilizers to non-improved varieties, the cascading effects of agricultural productivity improvements, driving national development towards an industrial-based economy, would not have been possible. Furthermore, breeding programmes in both the public and private sector would not have been able to deliver varieties to the Asian market without the input of CPPs, as the timely application of such is required both in actual breeding and seed production.

HISTORIC BREEDING & CPP DEVELOPMENTS

History is a valuable ally in accurately plotting the developments catalysed by modern farm inputs & agricultural technologies in Thailand. In the 1960s, Thailand's labour force was 75 % agricultural, with most involved in subsistence farming. Those skilful or lucky enough to grow more produce than they could consume could trade the surplus on the local market. Luck & favourable conditions were important factors in production at that time, farmers were at the mercy of pests, diseases, and needed appropriate rainfall, sunlight, & soil conditions to produce a good crop. There was no formal seed sector at the time in most areas. What seed was available was selected from imports from China & North Asia. Physical seed quality & suitability for tropical cultivation were constraints to high yields. Many would argue that this is still the case today in 2003.

Towards the end of the 60's, the seed market expanded in Thailand, better varieties were being imported & systematic selection trials were conducted. Farmers using the selected seeds witnessed clear improvements & were able to diversify their production to new crops. At the same time, CPPs & fertilizers became more widely available. Irrigation projects helped to make farming less dependant on rainfed conditions.

As the clear benefits of improved germplasm coupled with vastly more productive growing practices were being assimilated, breeding programmes in both the public and private sector became commercially viable and were beginning to yield promising results.

One landmark development, that would have repercussions for other agricultural sectors, was the development of hybrid maize varieties for tropical cultivation. In the 70s the cultivation of maize (corn) on a commercial scale was assisting in the impressive development of the animal feed industry, which was, as it is today, dominated by the Chareon Pokphand (CP) company. One of the major constraints at the time was that the open pollinated (OP) varieties of maize that were being widely cultivated in Thailand (Suwan series) though productive, were very susceptible to drought, and also to Downy Mildew infection. On average, yields were in the range of 180-200 kg/ rai. A number of private sector breeding programmes sought to address these problems through the introduction of improved traits via a hybrid maize variety. The resulting hybrid was nothing short of a spectacular improvement over OP maize. With drought tolerance, resistance to Downy Mildew and the benefits of heterosis, yields of 400 kg per rai were commonly produced (today yields average 550 kg/rai). Variability in production was reduced, and the resulting increases in yield had profound effects on maize growers and indeed the animal feed industry. CPPs played a vital role in controlling other pests and diseases, ensuring that the new hybrid could exploit its genetic superiority. Uptake by farmers of the new hybrid was impressive; once they had seen the new hybrid in the field they were not afraid to purchase new seeds for each planting.

Over in the public sector, the Ministry of Agriculture were busy with a rice breeding programme that was attempting to introduce the high yielding variety (HYV) traits in short stem rice germplasm from the International Rice Research Institute (IRRI) into local fragrant varieties of rice. The breeding programme was successful, the resulting varieties maintained their grain quality, aroma, and cooking quality of the fragrant Thai varieties but benefited from improved yield and resistance to rice hopper insects. Integration of the new variety with improved irrigation systems realized yields up to 6 tonnes per hectare (t/ha) in central regions during the dry season. In northern areas, where poor soil and weather often hamper rice production, yields of 4.5 t/ha were seen for the first time. CPPs played a key role in this improved productivity since the variety was not resistant to the stem borer, and application of pesticides was necessary to prevent widespread pest damage. Such pest intervention on the improved variety has allowed average production yields nationwide to rise to approx 3 t/ha and propel Thailand to the number one rice exporter in the World. Such economic impact cannot be dismissed or overstated.

In vegetatively propagated crops, the results of improved varieties and agronomic practices were also soon to make economic impact within the farming sector. Like most cropping systems at the time, rubber production was limited by non-improved cultivars and poor methods. In the late sixties the Ministry of Agriculture totally overhauled rubber production with the formation of the “ORRAF” state enterprise, which was funded by the World Bank. Through the Ministry of Agriculture & Co-operatives (MOAC) rubber farms were encouraged to cut down their old rubber trees and replace them with new varieties, which would entitle participating farms to privileges from the ORRAF enterprise. The scheme would extend seedlings of new improved varieties, herbicides and fertilizer, and a loan with a 7-year grace period. This initiative provided the impetus for long term productivity improvements in the rubber industry, one which through the input of improved cultivars, and reduction in weed populations and labour input through herbicides is now worth some US$ 1.5 billion per year to Thailand in exports alone.

The above three examples demonstrate the impact of private and private sector initiatives in both plant breeding and the introduction of CPPs. The economic impact of these improvements in maize, rice, and rubber are considerable. Without the technical interventions, three immensely important crops would not have underpinned the agricultural sector as they have over the last 40 years. In addition to the economic benefits, clear social benefits can be demonstrated (below).

NATIONAL DEVELOPMENT PLANS

Thailand has made a series of national economic and developmental plans in which agriculture has featured prominently. In the early 70s, it was clear to policy makers that the improving productivity in the agricultural sector, due to plant breeding and CPPs, was reducing the burden on farm labour. Plans were made to move the economy towards “light industrial development” utilizing labour resources no longer required on farm. During the years following the plan, the economic improvements in agriculture began to place a drain on village communities as rural migration to take newly created jobs in the textiles and service industries began to have deleterious effects. As agriculture became commercial, labour resources became more selective, and faced with such choices, more expensive. The rapid changes in productivity and beneficial changes to the socio-economic fabric of the village community were also to change working practices for the better and CPPs played a key role.

A clear demonstration of the changes can be seen in rice farming. Traditionally rice production labour inputs would be most intense during transplanting seedlings and during harvest. Transplanting was the preferred method of propagation as the germinated seedlings were more hardy, overcame seed quality issues and were able to compete more effectively with weeds, which prior to CPPs, could not be effectively controlled (apart from inefficient hand weeding or flood deoxygenating the field). With labour availability on the decrease, and labour cost being factored more prominently into production cost, direct seedling was revisited as a matter of necessity. Widespread uptake of herbicides by rice farmers allowed the direct seeding (broadcast) method to effectively serve as a low labour input method of rice propagation. The formation of harvesting service teams, equipped with mechanical harvest/threshing and packing equipment solved labour shortages during the harvesting phase. Today both transplanting and direct seeding are used, but hand weeding is largely a thing of the past. Studies in transplanted rice indicate that the benefit cost ratio of controlling weeds in transplanted rice is 16:1 for herbicides and 3:1 for hand weeding (Naylor, 1996).

A LAND WITH NO INPUTS

Critics of agricultural technologies often retort that the clear progress made in the agricultural sector could have been made minus the input of "expensive" seeds and CPPs. There are a number of studies that have estimated the economic consequences of a ban on pesticide use. These "what if?" studies deal with extreme-case possibilities, and most are from developed countries, but they serve as value indicators of CPP value. A study by Knutson *et al*., (1990) describes possible effects on U.S. society of a hypothetical ban of herbicides, insecticides and fungicides. Without pesticides, U.S. food production would drop and food prices would soar. With lower production and higher prices, U.S. farmers would be less competitive in global markets for major grains, cotton and peanuts. U.S. exports of corn, wheat and soybeans would drop 27 percent, with a loss of 132,000 jobs.

Closer to Thailand, one country that has effectively operated its agricultural sector without modern farm inputs over the last 40 years is Cambodia. Cambodia remains one of the poorest countries in the world. With a population of 14.1 million (UN, 2003) and a per capita GDP of just US$ 270 (World Bank, 2001), subsistence farming employs 75 % of the workforce. Over 90 % of arable land is used in rice production, the vast majority during the wet season. Rainfed production has its drawbacks, in 2000 one of the worst floods in living memory destroyed over 400,000 ha of wetland paddy.

Despite the best efforts of the International Rice Research Institute (IRRI), rice yields remain extremely low. According to FAOSTAT, Cambodian rice yields in 2000 were less than 2 tonnes per hectare, being barely above the peak yields of 1.7 t/ha obtained in 1970. The traditional farm saved varieties used by 98 % of farmers also show low germination rates (~ 50 %). More land has been planted to rice over the years to compensate for the low yields putting further drain on resources in a country where 35 % of arable land is unusable due to landmines. Since 1995 the country has achieved self sufficiency in rice production, and small surpluses have been available for export since. In 2002, 4.12 million tonnes of rice was produced in total (24 million tonnes in Thailand), with only 0.82 million tonnes being produced under irrigated conditions in the dry season. 0.4 million tonnes were unofficially exported to mills in Thailand and Vietnam, losing up to US$ 70 million in GDP contribution and government tax revenue as a result.

Farmers in Cambodia have little realistic chance of accessing good quality farm inputs and have produced rice much in the same way for the last 40 years giving them a yield of half that achieved by Thai farmers. Could the Thai economy even contemplate a 50 % reduction in rice production?

There were no private seed companies, no major CPP companies or fertilizer producers in Cambodia as of 2003. There are of course a whole plethora of donor agencies and NGOs in the Kingdom doing what they can to help, but without the impetus of the private sector to drive the industry forward, Cambodia's economy will remain in a quite desperate state.

CURRENT SITUATION

As the agricultural sector has flourished, so has the Thai economy. However, much of the growth and prosperity associated with the economy from the 60s to 80s was fuelled by increases in available agricultural land. During this time, Thailand was one of the few, if not the only country, to expand its Ag production base. The situation has of course changed since then.

Although the agriculture sector did feel the affects of the economic crises in 1997, it has since rebounded somewhat. However, in the last 10 years production of major crops has not increased significantly, whilst prices on world markets has declined. There are some significant indicators that revisions to agricultural systems, fundamental systems underpinning core production, are long overdue.

Thailand has approximately 21.2 million ha of arable land suitable for cultivation under which paddy-rice and maize, mungbean, and soybean were the major seed propagated crops. Paddy rice alone was cultivated in approximately 10.2 million hectares or 48 % of total farming land in 2000.

Table 1. Land utilisation in Thailand in 2000

Land classification	Area (million hectares)	%
Forest land	13.15	26
Arable land	21.20	41
Unclassified land (public land, swamp, highway, etc.)	16.96	33
Total	51.31	100

At the present time, the government is the sole producer of rice seed and major field-crops such as soybean, mungbean, peanut, and cotton while the private sector emphasises production of hybrid-maize and vegetable seed.

Table 2. Planting area, seed requirement, and average seed production 1995-1997

Crops	Planting area (million ha)	Seed requirement (tonnes)	Avg. production during 1995-1997		
			DOAE	Coop.	Companies
Rice	9.31	582,600	32,100	12,600	-
Soybean	0.35	33,000	8,940	440	
Mungbean	0.38	12,000	4,310	-	
Peanut	0.1	12,000	1,046	-	
Maize	1.38	25,800	-	-	22,000

Source: Seed Division, Department of Agricultural Extension, Thailand

As one can see, production by the relevant government agencies does not approach meeting demand for seed in rice, soybean, or peanut. This is a major constraint to future growth, with farmers retaining current varieties for replanting thus introducing variability into production and increasing the likelihood of seed borne disease. According to the study conducted by the Seed Association of Thailand (SAT), the Foundation Seed produced by the Department of Agriculture (DOA) was less than the amount of seeds needed by the Department of Agricultural Extension (DOAE) due to the budget, processing equipment, and personnel limitations.

Therefore it could be argued that there is a need for DOAE to produce certified seeds and supply to the private sector which could commercialise supply to farmers. In doing, so the DOAE will be able to supply more quality seed to the farmers. At the same time, the DOAE's Seed Division should increase the capacity of its processing plants by replacing its old processing equipment at its seed centres nation-wide. A seed production plan by the MOAC made in 1999 forecast that the public sector would produce about 25-50% of the total demand of rice, soybean and mungbean seeds by 2001. This plan has yet to come to fruition and needs to be revisited.

The seed production requirements of rice alone place additional pressure on production systems. The amount of land for rice production or rice seed production is not going to increase, quite the opposite with the reforestation plans of the government taking shape along with the demands of a growing population. It is therefore perfectly clear that more efficient production of rice and indeed rice seed is called for. Use of new HYV of rice, adoption of advances in irrigation and water management, and effective use of herbicides and fertilisers are possible solutions. It should be noted that Thailand's position of world's leading exporter of rice has been put under serious threat in the last decade. Vietnam is now the second largest exporter of rice mainly due to its adoption of hybrid rice technology. It has also allowed the private sector to participate in the supply of rice seed, most hybrids are supplied by private companies. It is not clear to the author what the strategy of the Thai government is with regard to hybrid rice (import of hybrids are not permitted), since Thailand has participated in the ABD hybrid rice regional project from its inception, and Vietnam's lightning progress could not have gone unnoticed.

ORGANIC STRATEGY

There has been a recent flirtation with the concept of organic production for Thailand. Calls have been made for the highlands in the North, together with Tungkularonghi in the Northeast to be made into, "An organic agro-industrial domain." Thailand's Department of Export Promotion along with the Food & Drug Administration established a five-year project in 1999 to set up a "World Class Standard for Organic and chemical-free food."

Organic agriculture has found favour with many in government who have been either seduced by the apparent opportunities for Thai exporters in countries like Germany where estimates of retail sales of organic produce topped 3 billion euros in 2001 (International Federation of Organic Agricultural Movements - IFOAM). Policy makers have also fed vociferously on pesticide scare stories that have deliberately played down the role of CPPs in benefiting agriculture and the Thai economy, whilst over emphasising the risks of CPP usage.

From a seed company (balanced) perspective, such scare stories do not stand up to close examination by those familiar with current agronomic practices or conditions of usage in Thailand. The seed industry, as represented by the International Seed Federation (ISF), does not have a defined position on the role of CPPs in agriculture and the reason for this is self-evident. Without the input of CPPs the seed industry, which has developed from a US$ 900 million industry in 1970 to one worth US$ 3.6 billion in 2002 (ISF), would not have been able to breed and economically produce the varieties that have fuelled its expansion. A position on the use of CPPs would therefore be mute, other than in the context of good agricultural practice (GAP), which the seed industry (as a member of the global plant science industry) clearly supports.

There is a need to accurately study the scale and extent of the problem of defined classes of pesticides poisoning (whether they be exposure, mild discomfort to hospital admission and fatality) at the community and admissions level across Thailand and in surrounding countries in order to develop the appropriate solutions. It is the author's opinion that the plant science industry indeed recognises the problems with pesticide use in developing countries but that the scale of the problems are not currently accurately recorded. Critically, the industry does recognise its role in solving such problems and working together with partners to look for sustainable solutions.

Whilst the driving forces behind a concerted move towards chemical-free agriculture may be open to debate, the organic sector presents an opportunity for the seed industry, and seedsmen across the globe are aware of this fact. The niche organic produce sector is growing, but the market is exactly that, a niche market. The organic market is currently centred in the USA, Japan and EU, with national markets such as Germany and the UK registering double digit annual growth in organic produce sales. Many of these countries are however developing policy to source organic produce domestically.

Despite the impressive sales figures (estimates) from IFOAM, organic produce totals less than 2 % of total food sales and most of the organic produce sold is meat and dairy products. Organic farmers mainly rely on the seed industry for seed. Seed companies were first asked to provide untreated seed, and later 'organic seed' produced under organic conditions. Even if the second requirement is technically less obvious, because most of the seeds produced under classical farming are strictly identical to 'organic seeds' in terms of composition, it is also quite understandable.

However, even within the cautious confines of the EU, all is not so rosy within the organic industry. A Danish study over five years has put the cost of introducing organic farming in the country in excess of US$ 725 million, twice the amount forecast by a government committee in 1998. Energy consumption and nitrogen emissions would rise if a ban on pesticides was to be enforced. On the back of this news came further disappointment when new EU regulations requiring that seeds used for production of organic vegetables should be produced organically due for introduction January 1st 2004 was withdrawn leaving many seed companies with expensive stocks of organically produced seeds. Organic grower groups claim that many supermarkets are demanding that organic vegetables must be produced with organic seeds, and reason that stocks of organic seed will not remain unsold. However, despite some successes of companies that have been dabbling in organic seeds for some time, supplying hobby and speciality growers, the regulations came too soon for the European seed industry and many EU states that could not satisfy EU commission demands for 5 % availability of organic seeds. A number of EU countries lobbied in Brussels that the issue of organic seeds was much more complicated that initially believed, and thus the Commission had to backtrack on its strict regulations.

Last year IFOAM set up a draft standard for the development of new organic varieties, strictly for organic farming. Several techniques would be banned from the development of 'organic varieties': with immediate effect, genetic engineering, cytoplasm male sterile hybrids without restorer genes, protoplast fusion, radiated mentor pollen and induced mutations; then possibly in the future, embryo culture, ovary culture and in-vitro pollination. 'Organic breeding' programmes would need to be certified, in order to guarantee that only allowed techniques have been used. In some interpretation the exchange of plant material between 'organic breeding' programmes and other breeding programmes would not be allowed.

It is clear that if such breeding regulations come into force in 2006 there will be a number of serious consequences for the seed industry:

- The necessary time for breeding an 'organic' variety will be prolonged and a lower efficiency will be reached.
- Because it is less efficient, breeding will be more expensive. This extra expense would need to be carried by the organic market.
- Restricting the exchange of material between traditional and organic breeding programs will strongly limit the possible access to genetic resources, essential for progress in plant breeding.
- Quick reactions to new biotic and abiotic stresses will be complicated and limited, because of the restricted use of efficient techniques and of the restricted exchange of breeding material.

The ISF views the regulations in the following light, "ISF recognizes that organic farmers and consumers of organic products have the freedom to decide which breeding techniques they consider consistent with organic farming. However, ISF wishes to clearly state that: a) it does not see the link between the proposed organic breeding methods and the very objectives of organic farming; b) the acceptance of these methods will negatively impact 'organic' breeding efficiency."

Others see implementation of the regulations as placing the organic industry at risk, particularly given that the genetic pool from which such organic varieties arise would be severely limited. The implications for the Thai government's organic strategy are profound, and neither the Thai seed industry nor Thai growers are in any position to meet the criteria as being touted for the major organic produce market, the EU. There are a number of reasons for this:

- The Thai seed industry is under extreme price pressure due to farmer risk perception and illegally multiplied varieties; increases in breeding costs and time to market would be unacceptable to seed companies.
- The extra cost of developing organic seeds would be difficult to pass to growers, who are currently buying on price rather than quality (farmer risk perception skewed).
- There is little incentive to develop for a niche market given the above risks, and given there is no enforceable intellectual property protection for plant varieties in Thailand.
- Pest and disease pressures in Thailand make organic approaches to cultivation extremely challenging and more expensive than conventional GAP.
- Thai grower co-operatives are for the most part inefficient, they are not well equipped to market organic produce either domestically and especially for export.
- Post harvest handling facilities and logistics are a major constraint to organic production, making Thai organic produce unlikely to meet major market requirements.
- Production in the open field would be seasonal and geographically isolated.

From the experience of Tropica Seeds and its affiliate company US Global Resources Asia, which builds greenhouses, there are a few highly professional growers who have invested significant amounts in protected cultivation systems that could benefit from the high value organic markets available in Europe. These professional companies use adbiatic cooling systems (evaporative cooling) and retractable shade to keep greenhouse growing conditions as close to 25 degrees during the day. Most have also invested significantly in insect screens that can keep insects as small as thrips out of the greenhouse. Movement of air across the plant canopy decreases the likelihood of fungal diseases. However, such installations can approach US$1 million and operating costs are high. They are far removed from the mainstream agricultural growers who must rely on conventional methods.

From the perspective of the author, government policy on organic farming and chemical-free food is a knee jerk populist reaction to misunderstandings about pesticide residues in food and the gross misinterpretation (often being deliberately diffused) that maximum residue limits in food are food safety limits. In addition, policy makers are short sighted in equating organic food with nutritious food, and also developing a national strategy aimed at a market which represents barely 2 % of food supply in Europe and currently in regulatory turmoil. As the FDA/Export Department's project comes to an end in 2003, it is clear that is has failed to have the impact that it sought regarding recognition of Thailand as a world class exporter of organic and chemical-free food. The lessons learned from the set-back should be assimilated.

Organic or chemical-free foods cannot be irradiated or treated with fungicides, and even with the best post harvest handling can retain plant fungi which sometimes produce lethal natural poisons. A move towards organic agriculture would increase fruit spoilage by 32 %, vegetables 21 %, peanuts 68 %, and corn 6 % according to a US Study on a ban on fungicides (GRC Economics, 1989). Without fungicides, per capita consumption of fruit and vegetables, vital to healthy diets, would decrease by 24 % (National Research Council, 1989). Evidence like this and other studies certainly bring into question the health benefits of consuming organic food, and the appropriateness of policy aimed at mainstream cultivation of such.

Rather than focus a strategy on a 2 % niche export market, surely it would be better to invest in building improved infrastructure to support Thailand's conventionally grown agricultural exports, which totalled *circa* US$ 7.5 billion in 2001. Of this considerable figure, US$1.5 billion was rice, US$1.5 billion of rubber, and US$ 600 of tapioca & sugar cane. By going back to the *fundamentals*, rather than targeting token projects for PR purposes, the Ag sector would be better served. By investing in seed production, improved plant breeding, education and farmer training for safe and effective use of CPPs, production of these important crops could continue to increase, rather than stagnate.

THE FUTURE

Despite the sustained opposition of fringe groups, NGOs, and certain corridors of government, improved varieties and new CPPs will continue to underpin the Thai agricultural sector. The way forward under the current political climate is clearly to consolidate the impressive economic gains made in agriculture, and make further moves to strengthen the foundations of this growth through sustained seed breeding & production, education and training on Integrated Pest Management (IPM), GAP, and introduction of further improved traits through biotechnology.

With over 200 private seed companies in Thailand, mainly concentrating on vegetable crops, the industry has made a massive impact on rural communities. The value of the internal seed market is tiny compared to the value of the sector overall, just US$ 12 million (compared to Bangladesh at US$ 60 million and China at US$ 3 billion - ISF). As lamented previously, the market is under considerable price pressure making the introduction of high value hybrids from overseas very difficult, despite 0 % tariffs on seed imports. With a growing tide of illegal seed piracy, and no workable Plant Variety Protection (PVP) law, the future for small to medium seed enterprises is far from secure. Efforts to introduce organic varieties would be completely untenable under current financial constraints.

Over the last 20 years, pioneering efforts by local companies have developed varieties specific to tropical Asia, these were simply not available before. In addition, Thailand has become a centre for contract seed multiplication for export, particularly for hand pollinated hybrids (cucumber, watermelon, hot pepper etc). This seed production contributed to seed exports in excess of US$ 60 million in 2001.

Though the figures are small compared to the overall Ag sector, the number of farmer families involved in contracted seed production is immense. Restrictions on CPP usage will not only compromise the seed multiplication business but further increase the costs of breeding for the tropics to a point where such activity is commercially unviable.

The seed industry fully supports the FAO definition of IPM, which permits CPPs to be used as part of an IPM programme. Much of the progress described in this paper has highlighted an integrated approach to crop and pest management. Improved seeds, CPPs, fertilizer, irrigation, and improved techniques have all been important factors. The crop protection industry enables and encourages the implementation of IPM by developing and selling appropriate products, techniques and services to protect against adverse effects caused by weeds, diseases and pests. IPM is an economically viable, environmentally sound and socially acceptable approach to crop protection. The revised *FAO International Code of Conduct on the Distribution and Use of Pesticides* contains an expanded definition of IPM and increased emphasis on activities associated with development and implementation of IPM techniques. Since the emergence of IPM as a concept in the 80s (though the concept of integrating several control methods goes back to the 30s), different groups have worked to adapt the definition of practice of IPM to fit their particular agendas. Careful consideration of all possible tools available to manage pests and produce abundant supplies of food and fibre in a sustainable manner are keys to making IPM work on the ground. IPM does not equate to chemical free agriculture under the FAO definition.

One valid IPM tool are varieties of crop developed through the use of biotechnology techniques (marked assisted or molecular breeding), or those varieties with biotech traits. The seed industry position on biotech enhanced varieties is very straightforward; seedsmen do not view such varieties to be any different to those produced by conventional plant breeding. As such, introduction of biotech traits in crops in Thailand would present an obvious step change in benefits to all concerned and should be encouraged as one component of a systematic IPM programme. Thailand should make its position on crop biotechnology clear, and implement it consistently.

SUMMARY

There are a number of factors that have contributed to the growth of Thailand's agricultural sector. The contribution of the Ag sector to Thailand's economy overall is well documented. The Thai Ag sector has unlimited potential, but one of the only variables that will not increase under a well co-ordinated Ag strategy is the amount of arable land available. The 21 million ha available to farmers can and will only be used more effectively as uptake of new plant varieties, CPPs, and plant nutrients continues. Only by assimilating new agricultural technologies and products will the value of Ag produce increase, and food quality quantity and safety be attained at the highest possible levels. As Thailand's strives to become an industrial based economy, it is essential to free human resources from the agricultural industries, lowering labour expenditures from the Ag sector and increasing per head productivity. *In order to do so historical developments have shown that new techniques and tools are essential*. Education and training are similarly important. Thai farmers need to invest in modern farm inputs, use them economically and safely, and market their produce far more aggressively and productively to free themselves from the burdens of debt and poverty.

Of all the benefits that CPPs have contributed to in the Ag sector, perhaps the social and environmental benefits are the most significant for a country like Thailand. Improvements in agriculture have realized a freedom of choice for families, and a chance for farmers' children to undertake an education and the opportunity for a career away from the farm. Environmentalists are some of the staunchest opponents of CPPs yet herbicide use has allowed minimal till agriculture to prevent soil erosion and curtail the growth of invasive weeds that could cause widespread environmental damage. One must also not forget the public health application of CPPs that go beyond agriculture, many tick- and insect-borne diseases – yellow fever, encephalitis, plague, typhoid fever, malaria – are held in check by insecticides. By controlling fleas, cockroaches and flies, insecticides improve the sanitation and comfort of our homes.

Clearly the agricultural workforce is ageing, and new generations of farmers are becoming more demanding in their requirements and expectations. The new chemistries and formulations from the research driven CPP companies are investing in the future of the new farming generation both directly and indirectly. Today's modern CPPs improve food quality, quantity, and variety. They improve human health by controlling natural food poisons, increasing production of fruits and vegetables and helping to control long-forgotten diseases. They protect our homes and property and allow Thai farmers to compete profitably in the increasingly global economy. Without CPPs, the standard of living that many of us take for granted today would not be possible and we would more than likely return to those "glory days" of 50 years ago.

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