RISE OF CARBON FARMING IN INDIA

— WORLD'S LARGEST AGRARIAN COUNTRY EXPECTED TO BECOME THE LEADING MARKET FOR CARBON FARMING CREDITS —

Yukiko Nozaki
Industrial Research Dept., Industrial Studies Div.
Mitsui & Co. Global Strategic Studies Institute

SUMMARY

- Carbon farming schemes provide financial incentives to farmers by allowing those who adopt such practices to sell their carbon credits. The programs began in the US and Europe, and are now spreading in India. The effectiveness of this incentivization is evidenced by the emergence of private projects, and the spread of carbon farming is being spurred on by government policies aimed at forming a market for trading carbon credits and reducing fertilizer subsidies.
- There are business opportunities for companies in the areas relating to the development of data measurement technologies and agricultural materials that contribute to carbon farming, and the avoidance of GHG emissions in rice and dairy farming should be relevant for companies from the viewpoint of managing Scope 3 emissions.
- India, with the world's largest area of cropland, but with significant room for environmental improvement, is likely to become the leading market for carbon farming credits.

A report by the author published by Mitsui & Co. Global Strategic Studies Institute in April 2021[1] identified the carbon sequestration and carbon credit programs being promoted on farmland in Europe and the US as models that could become new schemes for supporting farmers through private funding, replacing traditional subsidies. Since then, the focus has been on the possibility of applying those Western schemes in emerging countries where there are many low-income, smallholder farmers. Now, there is a discernible development to apply the schemes in the emerging country of India, and that is the subject of this report.

1. EFFORTS TOWARD SETTING UP CERTIFICATION FRAMEWORKS FOR CARBON FARMING CREDIT SCHEMES

Carbon farming[2], in which carbon is removed from the atmosphere and stored in the soil through appropriate farmland management, is attracting attention as a climate change mitigation strategy. Systems that give farmers financial incentives by allowing them to sell the carbon credits generated from such activities have been

[1] Yukiko Nozaki, "Agricultural Land is Attracting Attention as a Potential CO2 Sink－European and US Trends in Agricultural Carbon Storage and Carbon Credits－", Mitsui & Co. Global Strategic Studies Institute, April 2021

[2] Although "carbon farming" is narrowly defined as carbon removal and storage on farmland, in this report, the term is more broadly applied to refer to appropriate farmland management approaches, which include avoidance of carbon emissions, similarly to the term "regenerative agriculture" (which is mentioned later in this report).

developed mainly in Europe and the US. In the EU, a carbon farming certification system is expected to be legislated with a view to regulating trading of the carbon credits[3] under the EU ETS[4].

The private sector is also developing credit certification systems for carbon farming. The Verified Carbon Standard (VCS)[5], operated and managed by Verra, a third-party certification organization in the US, is a globally recognized carbon credit certification system. In October 2020, a comprehensive methodology for agriculture, including carbon farming, developed by Indigo Agriculture, Inc.[6] of the US was approved as VCS methodology "VM0042" (Methodology for Improved Agricultural Land Management)[7].

The methodology covers a wide range of farming methods, including reduction of chemical fertilizer use, improvement of water management and irrigation techniques, less tillage, agroforestry practices, rotation of crops, and the use of cover crops. In recent years, these approaches are also called "regenerative agriculture" and are increasingly adopted, especially in the EU and the US, as agricultural methods that holistically restore the soil health. At this time, the number of projects submitted for certification under VM0042 is low on a global basis as the methodology was only recently developed, and none of these projects have yet to generate carbon credits, but the number of projects and the generation of credits is likely to increase as carbon farming expands.

2. WILL THE MARKET FOR CARBON FARMING CREDITS GET UP AND RUNNING IN INDIA?

2-1. Companies beginning to submit applications for carbon credit certification

There are signs indicating that the market for carbon farming credits will spread into India as well. This is evidenced by the status of applications for VCS certification. India has the highest estimated emission reductions among countries with projects pending under VM0042, and the second highest number of projects in the world with 10, behind China (16) (Figure 1).

A look at the applicants shows that many are startups (Figure 2), including one that has only just been established (Figure 3, (5)). However, also among them are a subsidiary of a major Indian agrochemical company and a joint venture between an Indian seed giant and the methodology developer Indigo Agriculture (Figure 3, (2) and (4), respectively), indicating that large companies are also entering the market. There are also signs suggesting that the industry is beginning to attract the attention of companies overseas, such as Japanese companies (Figure 3, (1) and (3)). Moreover, it could be said that initiatives toward

Figure 1: Applications for VCS certification under methodology VM0042 by country

	Estimated annual emission reductions (metric ton of CO2 equivalent)	Number of projects
India	10,465,177	10
China	4,362,789	16
Switzerland	4,021,000	1
Argentina	1,100,000	1
United States	1,012,173	2
Paraguay	1,000,000	1
Mexico	950,000	1
South Africa	856,045	5
Denmark	750,000	1
Australia	232,924	1
Kenya	200,000	1
United Kingdom	107,209	1
Brazil	78,085	1
Italy	40,682	3
Lithuania	15,188	1
Germany	2,500	1
Israel	294	1
Global total	25,194,066	48

Source: Compiled by MGSSI based on Verra data (accessed on February 7, 2023)

[3] On November 30, 2022, the European Commission adopted a proposal for a framework for certification of carbon removals.

[4] European Union Emissions Trading System

[5] According to a September 2021 report on voluntary carbon markets by Forest Trends, a US environmental NGO, the share of private certified carbon offset trading volume attributable to VCS in 2021 (January-August) was a whopping 86%. Other major registries for carbon credits include the Clean Development Mechanism (CDM), Gold Standard, and Climate Action Reserve (CAR), and their respective trading volume shares were only 6%, 4%, and 3%.

[6] In 2021, the company announced a collaboration with Sumitomo Corp. to promote the business of agricultural carbon storage.

[7] Methodology for Improved Agricultural Land Management "VM0042"

avoiding greenhouse gas (GHG) emissions from rice cultivation and field burning (Figure 3, (4)) are specific to India.

Figure 2: Indian projects submitted for certification under VM0042

Project	Estimated annual emission reductions (metric ton of CO2 equivalent)	Area (hectare)
Varaha ClimateAg Private Limited	4,796,219	2,000,000
Grow Indigo Private Ltd	4,267,622	1,534,000
Boomitra Inc. (2 projects)	750,000	200,000
Suminter India Organics	275,748	52,031
Greneity Infocom Service Pvt Ltd	173,250	40,000
Mahanadi Compressed Biogas (CBG) Private Limited	64,457	-
Landmark Agri Exports Private Limited	58,722	8,085
Multiple Proponents	52,520	115,654
Biowin Agro Research	26,639	11,560
Total	10,465,177	3,961,330

Note: Companies indicated by the shading are also listed in Figure 3.
Source: Compiled by MGSSI based on Verra data (accessed on February 7, 2023)

Figure 3: Major companies undertaking carbon farming in India

	Company	Year established	Head office	Summary
(1)	Boomitra Inc	2016	US	In addition to India, the company is also involved in projects in Latin America and East Africa. In India, the company is collaborating with Kirishitan Kirishitan (formerly Carbon Farming India), which has been promoting carbon farming since 2018 and already has a customer base of farmers.
(2)	Grow Indigo Private Ltd	2018	Mumbai	The company is a joint venture between US-based methodology developer Indigo Agriculture and Indian seed giant Mahyco Grow. Mahyco Grow sells genetically modified cotton seeds through Mahyco Monsanto Biotech, a joint venture with Bayer (formerly Monsanto), the world's leading seed and pesticide company.
(3)	Sagri Bengaluru Private Limited	2019	Japan	The company is a subsidiary of the Japanese company Sagri. It has a track record in the data business in the Indian agricultural sector, and entered the carbon farming business as an extension of this experience. Its strength lies in its proprietary satellite data technology, including the capability to capture data on carbon, nitrogen, and other elements in soil with high accuracy in the non-visible light regions (infrared and microwave). The company plans to apply to the VCS as soon as it has gathered the necessary data for the application. In May 2022, the company's carbon farming initiative was adopted by Japan's Ministry of Economy, Trade, and Industry as a project to strengthen supply chains in the Indo-Pacific region.
(4)	Nurture Agtech Private Limited (nurture.farm)	2020	Mumbai	The company is a subsidiary of UPL, India's largest agrochemical company. It has submitted India's first project for crediting for the avoidance of methane emissions from rice cultivation, and the application is expected to be soon approved under the CDM-certified methodology "AMS-III.AU". The company is also considering applying under VM0042, as it is also working on the avoidance of methane and N2O emissions from field burning and farmland carbon storage by using a bio-formulation to break down the rice stubble that remains in the field after rice cultivation and plow it into the soil instead of clearing it away by field burning.
(5)	Varaha ClimateAg Private Limited	2022	New Delhi	The company has applied for certification of a project with the largest estimated emission reductions in India. It raised US$4 million in seed-stage funding in December 2022 from Omnivore, one of India's most prominent venture capital firms for agri-tech investments, and others.

Source: Compiled by MGSSI

2-2. Government push

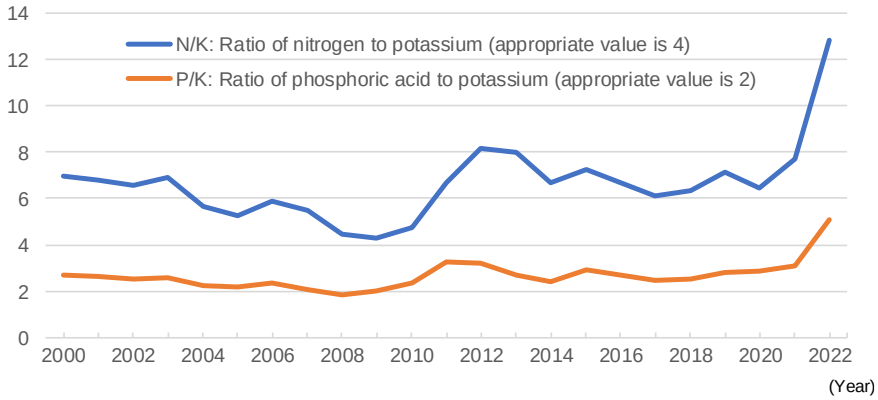
The number of carbon farming projects in India seeking to generate carbon credits is likely to increase further in the future, thanks to the government's policy support in this area.

Following the May 2022 announcement by the Indian state of Gujarat[8] concerning the creation of the country's first carbon credit trading market, in July of the same year, the central government adopted a bill to amend the Energy Conservation Act of 2001 to establish a nationwide voluntary carbon credit trading scheme, aiming to create the market within 2023. The central government encourages the formation of carbon offset projects toward this goal[9]. Among them, the government has high expectations for carbon farming projects, in particular. Prime Minister Modi made a symbolic statement in his Independence Day speech delivered in August 2022 that chemical-free farming, organic farming, and natural farming can give a boost to India's self-reliance.

The reason the government is promoting carbon farming in this way is because it leads to a reduction in fertilizer subsidies. Traditionally, the Indian government has kept the retail price of chemical fertilizers low with generous subsidies[10]. However, the subsidy amount has continued to swell year after year as the international price of chemical fertilizers has risen, and in FY2022 it exceeded the original budget due to additional price hikes caused by the war in Ukraine, putting further pressure on public finances. Against this backdrop, the government intends to reduce fertilizer subsidies in FY2023 in an effort to lighten the fiscal burden[11].

The existence of a subsidy policy thus far has allowed farmers to over-fertilize (Figure 4)[12], and deprived the industry of the opportunity to introduce carbon farming. However, the policy is now heading in the opposite direction, and it is expected that the cost burden for deeply chemical fertilizer-oriented farmers will increase in the future. If this happens, the adoption of carbon farming will spread rapidly among farmers who want to reduce fertilizer costs[13].

Figure 4: Chemical fertilizer use ratio in India by component



Source: Compiled by MGSSI based on data of the Food and Agriculture Organization of the United Nations (FAO) on chemical fertilizer use per area (accessed on January 19, 2023).
*Data for 2021 and 2022 were taken from the article "First urea, now DAP: High use of subsidised fertilisers raises crop yield fears" published by The Indian Express (December 12, 2022).

[8] According to a JETRO report (published in Japanese, May 31, 2022), Gujarat also launched a particulate matter emissions trading market in 2019 to help reduce air pollution.

[9] As India has assumed the G20 presidency for 2023, the country seems to be aiming to show the world that it is leading the way in decarbonization.

[10] Chemical fertilizers are cheaper in India than in other countries because of government subsidies. According to the Indian online newspaper The Print (April 4, 2022), urea in India costs Rs. 267 per 50 kg bag, compared to Rs. 791 in Pakistan, Rs. 593 in Indonesia, and Rs. 719 in Bangladesh. For phosphorus fertilizer (diammonium phosphate (DAP)), the price per 50 kg bag is Rs. 1,350 in India, while it is approximately eight times higher in Indonesia at Rs. 9,700, more than three times higher in Pakistan and Brazil, and almost two times higher in China.

[11] Reference: The Economic Times (December 23, 2022)

[12] Although international comparisons are difficult because fertilizer requirements vary depending on crop and soil conditions, according to the Food and Agriculture Organization of the United Nations (FAO), the total amount of nitrogen (N), phosphate (P), and phosphoric acid (K) per unit area in India was 193 kg per hectare in 2020, which is less than in other Asian countries with robust rice production industries (469 kg in Taiwan, 337 kg in China, 313 kg in South Korea, 224 kg in Japan). Therefore, while it is difficult to say that India uses an excess of fertilizers in general, it is undeniable that some fertilizer components are overapplied. Farmers tend to overapply urea, in particular, because the government subsidizes more than 90% of the cost and the maximum retail price (MRP) is fixed at a low price. Therefore, the use of N, P, and K deviates from the prescribed ratio of 4:2:1 that is considered appropriate in India. According to The Indian Express (December 12, 2022), the extreme 13:5:1 ratio of NPK use, combined with the fact that DAP also came under regulation again in 2022 as a result of the Ukraine crisis, is making the situation worse. The circumstances are such that a shift to an even more undesirable balance of soil components could lead to reduced agricultural production and food security issues.

[13] When transitioning to carbon farming, yields generally tend to decline during the first few years, so government support is necessary to compensate farmers for their losses during this time. Even though this would increase the financial burden, the government is willing to accept that temporary financial burden if fertilizer subsidies would no longer be needed after a few years.

3. CREDITS FOR CARBON FARMING IN INDIA: OPPORTUNITIES AND CHALLENGES

3-1. There are also opportunities unique to India

A variety of business opportunities could arise in India, where increasing adoption of carbon farming is anticipated. One such example is the development of technologies needed for credit certification, such as those relating to the measurement, collection, and calculation of field data, including the amount of carbon in the soil.

Another area presenting business opportunities is the development of agricultural materials required for carbon farming, such as bio-pesticides and crops that can easily store carbon[14]. Given these prospects, it is not surprising that companies involved in agrochemicals and seeds in India are entering this field.

Meanwhile, if the transition to carbon farming results in lower yields, that would signal a serious setback as it would essentially mean the farmers are not fulfilling their primary role of food production[15]. Therefore, even under VM0042, it is stipulated that certification will not be granted if a reduction of chemical fertilizer use results in a decrease in yields. This being the case, opportunities are also opening up for the development of technologies that help maintain yields even when fertilizer use is reduced[16], i.e., maintaining the same level of yield with less fertilizer.

Providing financial incentives other than carbon credits to farmers could also be a new business. One example in this area is the development of the entire value chain, connecting farmers who engage in carbon farming with consumers who appreciate and are willing to pay a premium for their efforts[17]. Also, a sustainable finance scheme that offers preferential interest rates to farmers who are engaged in such projects could be explored.

Business opportunities could also be found in connection with India's unique social challenges. India is the world's leading GHG emitter from agriculture[18] (Figure 5), with dairy farming being the main source of emissions. As the country has the world's largest number of cattle, including buffalo, it also produces the world's largest amount of methane emissions from enteric fermentation, such as burping by cows (Figure 6). While there is a significant scope for reduction in this area, prominent initiatives have not emerged yet. In the UK, Mootral, a developer of methane emission-reducing feeds, has developed a VCS-certified methodology, and is generating carbon credits from its activities. It may be worth examining whether a similar approach could be applied to Indian dairy farming.

[14] According to the publication Genetic Engineering & Biotechnology News (GEN) (January 12, 2023), CRISPR-Cas9, the genome editing technology that was the subject of the Nobel Prize in Chemistry, is being used to develop crop varieties that can contribute to agricultural carbon storage.

[15] In Sri Lanka, government policy mandated a transition to organic farming in 2021, but the policy failed as yields plummeted and the country's food security was threatened.

[16] In India, the coating of fertilizers with neem oil, which has the effect of extending the elution of fertilizer components, has become compulsory, and fertilizers that use nanotechnology, in which fertilizer components are more efficiently taken up by plants through nanoparticulation, are being developed.

[17] According to the World Inequality Lab's World Inequality Report 2022, the top 10% of income earners in India in 2021 earned 57% of the total income, a larger share than in other countries such as Japan and China. Therefore, the high-income group is considered to be the main target of the consumer market in India.

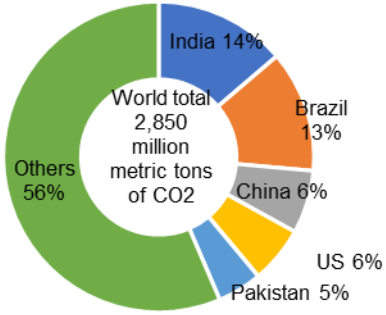
[18] Excluding converted agricultural land resulting from deforestation

Figure 5: Global GHG emissions from agriculture (2020)

Rank	Country	GHG emission volume* (metric ton of CO2 equivalent)	Global share (%)
1	India	776	13%
2	China	662	11%
3	Brazil	540	9%
4	US	386	6%
5	Pakistan	212	4%
6	Indonesia	158	3%
7	Argentina	140	2%
8	Ethiopia	134	2%
9	Australia	106	2%
10	Russia	104	2%
11	Mexico	102	2%
Reference	Japan	23	0%
-	Others	2,689	45%
	Global	6,032	100%

*Based on IPCC Agriculture data
Source: Compiled by MGSSI based on FAO data (accessed on January 9, 2023)

Figure 6: Global methane emissions from enteric fermentation and share by country



Source: Compiled by MGSSI based on FAO data (accessed on January 9, 2023)

Furthermore, rice cultivation in India is also one of the largest sources of methane emissions in the world, alongside rice cultivation in China, suggesting there is room for reduction efforts (Figure 7). The alternate wetting and drying (AWD) irrigation strategy contributes to the avoidance of methane emissions from rice cultivation, and is also effective in saving water because it involves several cycles of draining and flooding in the paddy fields. However, because of the existence of irrigation subsidies in the country, Indian farmers are less motivated to save water. As uncontrolled use of irrigation water is recognized as the main cause of water shortages in the country[19], the introduction of AWD and other such methods is considered essential in the future. Companies should turn their attention to these approaches from the viewpoint of managing Scope 3 emissions[20] and natural capital management as well[21].

Figure 7: Comparison of AMS-III.AU application status and methane emissions from rice cultivation in India and China

	Estimated annual emission reductions for projects submitted under AMS-III.AU			Methane emissions from rice cultivation		Project's estimated reductions as a percentage of total emissions (=a/b)
	Total (a) (metric ton CO2 equivalent)	Registered	Registration and verification approval requested	Emissions volume (b) (metric ton CO2 equivalent)	Share of global emissions (%)	
China	15,299,705	2,153,616	4,021,424	149,256,663	21.8%	10.3%
India	790,436	0	52,158	133,005,600	19.4%	0.6%

Note: AMS-III.AU is a methodology certified by Clean Development Mechanism (CDM). It reduces methane emissions from rice cultivation through direct seeding and the introduction of a water management technique called alternate wetting and drying (AWD).
Source: Compiled by MGSSI based on Verra data (accessed on February 7, 2023) and FAO data (accessed on February 7, 2023)

[19] According to an article in DownToEarth (July 9, 2019), groundwater in India declined 61% from 2007 to 2017, largely due to irrigation, which accounts for 89% of the country's groundwater use.

[20] Singapore-based grain trader Olam is implementing AWD and drip irrigation strategies for Basmati rice farmers in the Indian state of Haryana, its sourcing partner, to manage Scope 3 emissions. The company is using a traceability system that utilizes blockchain technology from TraceX, an Indian agri-tech company, to track GHG emissions in its supply chain.

[21] The Taskforce on Nature-related Financial Disclosure (TNFD), which is scheduled to release its final recommendations in September 2023, requires companies to assess and disclose the impact and dependence of their business activities on the natural environment, including water resources, throughout their supply chains.

In India, new types of businesses are emerging[22] to curtail field burning as an air pollution control measure[23]. Field burning is also a source of methane and nitrous oxide (N2O) emissions, and the reduction of such burning is eligible for carbon credits. New value could be added to the existing business of curtailing field burning, thereby increasing the corporate value.

3-2. Access to smallholder farmers can be an issue

Even though it is recognized that business opportunities abound to such an extent, the unresolved issue is how to access India's 146 million farmers, 70% of whom are smallholder farmers working with less than one hectare of farmland. However, in this regard, the use of local human resources in rural areas, FPOs[24], which have proliferated in recent years, and agri-tech companies that have contacts with farmers may serve as channels for reaching these farmers.

Satoshi Nagata, chief strategy officer at Sagri Bengaluru Private Limited (Figure 3 (3)), which is engaged in carbon farming in India, confidently stated that with the war in Ukraine placing a greater weight on household finances, no farmer would be reluctant to pursue carbon farming if it would save the fertilizer costs and give them extra income. In a country with many low-income, smallholder farmers, carbon farming that offers financial incentives is likely to be welcomed by farmers, and if the policy steadily moves away from the hitherto subsidy-anchored position as mentioned earlier, the speed of acceptance will accelerate dramatically.

4. THE POTENTIAL OF INDIA, THE WORLD'S LARGEST AGRARIAN COUNTRY

Although the issuance of credits for carbon farming is still in the early stages globally, the market is expected to grow.

India, with the world's largest agricultural land area of approximately 170 million hectares and great potential for carbon removal and storage, is a particularly important market (Figure 8). The estimated price of a credit for carbon farming is approximately US$10 per metric ton (CO2 equivalent)[25]. The estimate for emission reductions in India is approximately 3 metric tons per hectare (CO2 equivalent)[26], and if extended throughout the country, the market would be worth over US$5 billion.

India is also an important market when it comes to solving social issues. Modern Indian agriculture is not only destroying the global environment with its GHG emissions, but is also causing damage such as air pollution and water shortages to the country's living environment. Furthermore, an unbalanced and excessive fertilizer application could reduce agricultural production and

Figure 8: Cropland area in the world (2020)

	Cropland area (1,000 hectares)	Global share
India	168,669	11%
United States	160,437	10%
China	134,881	9%
Russia	123,442	8%
Brazil	63,518	4%
Indonesia	51,300	3%
Nigeria	41,500	3%
Canada	38,401	2%
Ukraine	33,777	2%
Argentina	33,701	2%
Pakistan	31,723	2%
Australia	30,996	2%
Others	649,323	42%
World total	1,561,668	100%

Note: Cropland is the sum of arable land and land under permanent crops

Source: Compiled by MGSSI based on FAO data (accessed on January 19, 2023)

[22] In August 2021, Mitsui invested in PRESPL, an agricultural residue supply chain management company in India.

[23] In the northern part of the country, where rice and wheat are cultivated using the double cropping method, field burning is used to clear away the rice stubble that remains in the fields after rice cultivation before the wheat is sown, contributing to winter air pollution in Delhi, where the air pollution level is said to be one of the worst in the world.

[24] Farmer Producer Organization. An organization that aims to enable smallholder and marginal farmers to benefit from economies of scale. The Indian government has promoted the establishment of FPOs in the past as well, but according to an announcement by the National Bank for Agriculture and Rural Development (NABARD) in March 2022, it is now once again aiming to establish 10,000 FPOs by FY2027, with support schemes and tax incentives. According to a study by Cornell University, the number of annual registrations doubled from 2019-20, and is showing a remarkable surge in recent years.

[25] According to an August 2022 report by Forest Trends, the price of a carbon credit in the agricultural sector was US$10.38 in 2020 and US$8.81 in 2021.

[26] Calculated from the estimated acreage and emission reductions for each project in India submitted for carbon credits certification under VM0042.

ultimately threaten the country's food security[27]. Fortunately, however, all of these problems could be solved by carbon farming.

While South America and Southeast Asia are the principal markets for traditional forest carbon credits, such as afforestation, India is likely to become the main stage for carbon farming credits, as it has vast farmland and much room for environmental improvement.

[27] India has maintained self-sufficiency in staple foods such as rice and wheat, but if it were to run short of domestic food supplies and needed to import food, the scale of imports would be huge due to the country's large population, posing a threat not only to its own food security but also to that of the world.