Rice development in the context of climate change in Vietnam

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Abstract:

Rice is the most important crop of Vietnam with a harvested area of 7,835 ha, production of 45.2 million tons of paddies, and export volume of 6,997 thousand tons of milled rice for an export value of USD 2,852 million in 2015. However, if purely considering its economic aspects, rice contributes only 5.45% of national GDP[1] and rice farmer's net income is only USD 419/ha compared to USD 1,128/ha earnings of Thailand farmers. Moreover, it is projected that up to 16.8% of the Red River Delta and 38.9% of the Mekong River Delta will be submerged after sea level rises by 100 cm. If this happens, a reduction in rice production would be more than 30-35%, based on the 2016 climate change scenarios. Therefore, it is necessary to thoughtfully consider rice production and rice export through different perspectives including economic, societal and environmental with a focus on ensuring food security and social stability.

Keywords: ***climate change, rice development, rice production.***

Classification number: ***3.1***

Main challenges in rice production

Rice production is facing many challenges including climate change, population pressure, production efficiency, free market access, diminishing rice cultivation areas, and a low investment in agriculture; however, within the framework of this article, we only address the two most significant challenges: climate change and sea level rise, and low efficiency in rice production.

Climate change and sea level rise

The impact of climate change on Vietnam's agricultural production is increasingly challenging. According to the Ministry of Agriculture and Rural Development (MARD), for the first time in many years, GDP growth from agriculture, forestry and fishery activities for the first six months of 2016 was negative (-0.18%)[2]. The agriculture growth rate was - 0.78%, forestry and fishery increased 5,75% and 1.25% respectively. The main causes leading to the reduction of agricultural production values are due to impacts from climate change and unusually extreme weather conditions. As of the 24th of June, 2016, long term drought and saltwater intrusion damaged 249,620 ha of rice, 19,203 ha of other cash crops, 37,369 ha of fruit trees, and 163,768 ha of perennial industrial crops, altogether valued at VND 142,144 billion[3]. In the North, during the last ten days of January 2016, a deep cold spell in which the temperature fell sharply and even reached the lowest in weather monitoring history in some regions damaged 69,865 ha of rice and cash crops [1].

Climate change mainly relates to temperature increase, drought and sea level rise. According to a notice from the World Meteorological Organization (WMO, 2016), 2015 was the warmest year on record with a global annual average temperature increase of about 0.76°C. According to IPCC (Report 4, 2007), during the past 100 years, global average temperatures increased by 0.5-0.7°C and will continue to increase by 1.5-4.5°C more by 2050.

In Vietnam, the climate change scenario (Draft version 2016) [2] shows that annual average temperatures increased by about 0.62°C during 1958-2014 and continues to trend upward. Compared with 1981-1990, annual average temperature during 20 years from 1995-2014 increased by about 0.38°C, in the recent ten years (2005-2014), it increased by 0.42°C. Note that, when temperatures increase by 1°C, rice yield decreases by 10%, maize

[1]With rice annual production of 31.5 million tons, export price of 353 USD/ton (source: FAO Rice Market Monitor, 2016) for rice with 5% broken total rice value is only USD 11.12 billion compared with USD 204 billion of national GDP, according to Vietnam Development Partner Forum (VDPF) on the 5th December, 2015 in Hanoi.

[2]GDP same period in 2015 increased 2.36%; 2014 increased 2.96% and 2013 increased 2.14%, 6/2016.

[3]1 USD = 22,300 VND.

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Table 1. Sea level rise scenarios in Vietnam, cm.

Scenarios	Timeline							
	2030	*2040*	*2050*	*2060*	*2070*	*2080*	*2090*	*2100*
RCP2.6	13 (8-19)	18 (11-26)	22 (14-34)	27 (17-41)	32 (20-49)	37 (22-56)	42 (25-63)	46 (28-60)
RCP4.5	13 (8-19)	18 (11-26)	23 (14-34)	29 (18-43)	36 (22-53)	42 (26-62)	49 (30-72)	55 (34-81)
RCP6.0	13 (8-19)	18 (11-26)	23 (15-34)	29 (19-42)	36 (23-51)	43 (28-61)	50 (33-72)	59 (38-84)
RCP8.5	13 (9-19)	19 (13-27)	26 (17-36)	34 (23-47)	43 (28-59)	52 (35-72)	13 (42-88)	77 (51-106)

(Source: Vietnam Institute of Meteorology, Hydrology and Climate Change, 2016).

Table 2. Submergence with sea level rise in the key rice production provinces.

Province/City	Natural areas, ha	Percentage (%) to be submerged by sea level rises					
		50 cm	*60 cm*	*70 cm*	*80 cm*	*90 cm*	*100 cm*
Red River Delta	1,492,739	6.93	8.55	10.4	12.5	14.7	16.8
Hai Phong	154,052	5.14	7.61	11.7	17.4	24.0	30.2
Thai Binh	158,131	27.0	31.2	35.4	39.9	45.1	50.9
Nam Dinh	159,394	26.0	32.5	39.1	45.8	52.3	58.0
Ninh Binh	134,700	8.29	11.0	14.0	17.1	20.5	23.4
Mekong River Delta	3,969,550	4.48	8.58	14.7	21.0	28.2	38.9
Tien Giang	239,470	1.56	2.92	4.54	7.08	12.0	29.7
Ben Tre	235,950	6.21	7.58	9.87	12.8	17.0	22.2
Tra Vinh	234,120	0.80	1.02	1.33	2.38	4.93	21.3
Hau Giang	160,240	3.41	10.3	20.6	32.1	42.7	80.6
Soc Trang	322,330	2.46	5.88	10.8	16.7	25.8	50.7
Bac Lieu	252,600	3.65	7.65	14.5	23.4	33.8	48.6
Ca Mau	528,870	8.47	13.7	21.9	30.3	40.9	57.7
Kien Giang	573,690	7.77	19.8	36.3	50.8	65.9	76.9

(Source: Vietnam Institute of Meteorology, Hydrology and Climate Change, 2016).

productivity decreases by 5-20%, and food crop production goes down by 15% on average.

The forecast using RCP4.5[4] low-middle scenario shows that by the middle of this century, national annual average temperature would increase by 1.3-1.7°C. More specifically, it would increase by 1.6-1.7°C in the Northern Region (the Northwest, Northeast and Northern Delta); by 1.5-1.6°C in the North Central Region, and by 1.3-1.4°C in the Southern Region (South Central Region, Central Highland and Southern). By the end of the century, temperatures in the North would increase by 1.9-2.4°C and in the South temperatures would increase by 1.7-1.9°C. According to the high emission scenario, RCP8.5, by the middle of the century, annual average temperatures would increase by 1.8-2.3°C, in the North, it would increase by 2.0-2.3°C and by 1.8-1.9°C in the South. By the end of the century, temperatures would increase by 3.3-4.0°C in Northern and by 3.0-3.5°C in Southern Vietnam.

Climate change not only increases the average temperature, but also increases daily maximum and minimum temperatures. According to monitoring data from 1961-2014, daily maximum temperatures (T_{max}) and daily minimum temperatures (T_{min}) increased by 1°C/10 years. The number of hot days (the days with $T_x \geq 35$°C) tends to increase in most

[4]According to assessment report number 5 (AR5) by IPCC, greenhouse gas emission scenarios SRES (Special Report on Emission Scenarios) replaced by scenarios RCP (Representative Concentration Pathways) describing 4 different greenhouse gas emission scenarios, atmosphere composition, emission of pollutants and land use in the 21st century. RCP2.6 is low emission scenarios, RCP4.5 and RCP6.0 are middle and stable emission scenarios and RCP8.5 is high emission scenarios. In Vietnam, the forecasts are based on two scenarios on low middle greenhouse gas emission (RCP4.5) and high emission scenarios (RCP8.5).

regions of the country with common increments of 2-3 days/decade.

Average maximum yearly temperatures would increase as well having significant impacts on crop and rice production in particular. According to RCP4.5, in the middle of this century, the average T_{max} over the country would increase by 1.4-1.8°C and in the end of the century the increment is from 1.7-2.7°C. According to scenario RCP8.5, in the middle of the century, the average T_{max} temperature would increase by 1.6-2.4°C and in the end of the century, it would increase by 3.0-4.8°C, with highs that could reach 5.0°C [2].

Sea level rise is a serious challenge to agricultural production, in particular to rice production and aquaculture. According to the 2016 climate change scenario, national average sea level rise during 1993-2014 was 3.34 mm/year, of which the highest level was found in the South Central Coastal Region with more than 5.6 mm/year, it was lower in the North Central Coastal at about 2.5 mm/year (Table 1 and Table 2).

The forecast for sea level rise in the East Sea for the end of the 21st century are seen in Table 1 as: 46 cm; 55 cm; 59 cm and 77 cm according to RCP2.6; RCP4.5, RCP6.0 and RCP8.5 respectively.

With a sea level rise of 100 cm, key rice production provinces (Table 2) would be submerged, particularly the most vulnerable provinces are Hau Giang and Kien Giang (80.6 and 77% of total areas), while in other key rice producing provinces the percent of area submerged would be as follows: Thai Binh (58.0%), Nam Dinh (50.8%), Soc Trang (50.7%), Bac Lieu (48.6%), and Ca Mau (57.7%). In general, sea level rise in the Southern provinces is higher than that in the Northern provinces. Looking at the regional level with 16.8% for the Red River Delta and 38.9% for the Mekong River Delta would be submerged. These are the rice bowls of the country and overall rice production would decrease 30-35% under that scenario.

Low rice production efficiency

Vietnam is a large rice production and export country with a harvested area in 2015 of 7,835 thousand ha, production of 45.2 million tons, export of 6,997 thousand tons of milled rice, and a turnover of USD 2,852 million [3]. This accounted for more than 17% of the global rice trade (Table 9). However, for many years, Vietnam has had its focus on increasing the quantity of production. In comparison with key rice production countries over the past 35 years, Vietnam's average rice productivity increased by 3.68 tons/ha, which is equivalent to 169.6%, which is triple the world's average. At the same time, other rice production countries targeted production on mainly high quality rice. In the case of India, after 35 years, rice yield increased by only 80 kg/ha, Pakistan increased by 0.9 tons/ha, and Thailand increased by 0.64 tons/ha (Table 3).

With respect to efficiency, research shows that farmer's income from rice cultivation is very low. According to Vietnam - Household living standard survey (2010), income from rice cultivation is only 19% of total income generated if rice areas per household are less than 1 ha. Income generated from rice cultivation increases to 26%; 36% and 68% when rice areas per household are from 1-2 ha; 2-3 ha and more than 4 ha, respectively. Most importantly, more than 90% of farming households in Vietnam own less than 1 ha of rice cultivation area.

Value made from rice production is low and furthermore the real income which rice farmers earned is the lowest portion of the value chain. Based on research by Can Tho University, farmers' profits earned were only USD 240 per year, while collectors could earn USD 25,000; rice milling actors could get USD 48,400 and exporters could get USD 2.22 million per year (Table 4).

Table 3. Vietnam and World rice productivity.

Country/ Region	Yield, tons/ha		2015 vs. 1980		
	1980	*2015*	*Yield increase*		*Average yearly increase, %*
			ton/ha	*%*	
World	2.75	4.43	1.68	61.1	1.75
Asia	2.79	4.57	1.78	63.8	1.82
USA	4.95	8.37	3.42	69.1	1.97
China	4.13	6.89	2.76	66.8	1.91
India	3.49	3.57	0.08	2.29	0.07
Pakistan	2.43	3.33	0.90	37.0	1.06
Japan	5.13	6.63	1.50	29.2	0.83
South Korea	4.85	7.22	2.37	48.9	1.40
Thailand	1.89	2.53	0.64	33.9	0.97
Vietnam	2.17	5.85	3.68	169.6	4.85

(Source: http://ricestat.irri.org:8080/wrsv3/entrypoint.htm).

Table 4. Rice value chain in Mekong River Delta.

Actors	Profits, VND/kg	%	Volume, tons/ years	Total profits, USD1,000
Rice farmers	507	34	8.4	0.24
Collectors	280	19	1,700	25.0
Milling	186	13	4,949	48.4
Polishing	50	3	74,400	195.8
Transporters	29	2	8,550	13.0
Exporters	422	29	100,000	2,221.0

(Sources: Vo Thi Thanh Loc, Nguyen Phu Son, 2011) [4].

cost and selling price. Selling price of 1 kg of paddy rice in Can Tho is the lowest, compared with that in other surveyed sites at USD 0.195/kg or VND 4,290/ kg in equivalent, while this parameter is VND 5,192 in India; VND 8,404 in Indonesia, VND 8,889 in Thailand and VND 7,700 in the Philippines. This is the one key factor that makes net income from rice production in Vietnam the lowest, at only USD 419/1 ha (VND 9.2 million), which is only

Table 5. Rice production efficiency in some countries.

Criteria	Surveyed regions					
	Zhejiang, China	*Tamil Nadu, India*	*West Java, Indonesia*	*Suphan Buri, Thailand*	*Can Tho, Vietnam*	*Nueva Ecija, Philippines*
Production cost USD/ha/crop	1,621	689	1,591	1,136	910	1,588
Breakdown: USD/ha						
- Seeds	87.19	50.51	20.70	141.51	68.33	69.77
- Fertilizer	149.33	94.91	153.07	205.30	250.81	216.07
- Pesticide	61.44	22.21	185.37	133.93	145.98	39.44
- Labor	1,231.26	299.91	1,001.98	207.65	161.02	765.74
Production price, USD/kg paddy rice	0.244	0.147	0.235	0.206	0.134	0.249
Selling price, USD/kg	0.490	0.236	0.382	0.409	0.195	0.350
Profits, USD/ha	1,633	420	993	1128	419	645

(Source: S. Mohanty, 2014).

IPSARD (2014) also showed that profits (and risks) were not fairly distributed amongst rice actors participating in the rice supply chain. Per export unit, farmers' shares are 52% of total profits, but the cost of goods for farmers is 83%, while the share of rice exporters is 30% total profit with only 4% total costs spent[5]. This is one of the reasons why farmers abandon their farms and choose not to adopt advanced seeds and technology, because it is not worth it for the absolute value earned from their farms, despite impacts from the adoption of science and technology would be relatively high[6].

Research on rice production efficiency in some countries by the International Rice Research Institute (Table 5) also reveals that production efficiency is mainly linked to production

[5]Rice subsector restructure proposal, 5/2016.

[6]According to General Statistical Office in 2011, over the whole country, 85% rice farming households have less than 0.5 ha rice (in Red River Delta, 98% rice farming households have less than 0.5 ha). In Mekong River Delta, in particular, production scale is larger at 1 ha/household in average but there are still 38.4% households cultivate less than 0.5 ha; 48.2% households cultivate from 0.5-2 ha and 13.4% households have more than 2 ha. Rice field ownership limits at 3 ha in Mekong River Delta, 2 ha in other regions are one of the barriers that hinder households when scaling up their production.

37.1% of Thailand's profits, 65.0% of the Philippines and 42.2% of Indonesia profits.

Rice production orientation in the context of climate change and international integration

Rice production makes a significant contribution to Vietnam's economy and society, ensuring political stability and social security. It is, however, necessary to holistically review many issues on the production efficiency and exportation. It is time for us to re-evaluate the production of rice in particular and agricultural products by return per unit area instead of a focus on volume.

High level direction for the improvement of rice production efficiency has been depicted in the national product development framework proposal - "Vietnam's high quality, high productivity rice products", that is, "the development of competitive and high added-value rice production and commercialization through systematic adoption of improved varieties, advanced cultivation and post-harvest technologies in association with the mechanization, re-organization of production, brand development, and market development to improve productivity, quality and efficiency of rice enterprises to strongly ensure the food nation's food security, rice cultivation farmers' income, and rice traders' income improvements, climate change adaptation, greenhouse gas emission reductions, environment protection". Moreover, specific objectives towards 2030 are clearly stated in "restructuring Vietnam's rice sub-sector towards 2020, vision to 2030" include (i) Adopting certified seeds in 100% intensive farming areas in the Mekong River Delta; (ii) Applying IPM in 90% total areas; more than 75% apply sustainable cultivation practices (such as three reduction three gains, one must do and six reductions, alternate wetting and drying techniques, etc.); (iii) Reducing post-harvest loss to less than 6%; (iv) Reducing greenhouse gas emissions by 20%; (v) Producing rice for commercialized use, more than 50% of total areas are integrated and linked between production and marketing or aggregated into large production fields and (vi) Branding 50% of total export rice, out of which 30% is fragrance and special rice.

Vietnam is always ranked in the top 2-3 rice export countries with a market share of approximate 17-20%. Although having abundant rice for export, Vietnam's food security index is ranked 65th globally and 5th among the ASEAN countries, after Singapore, Brunei, Malaysia and Thailand where rice is mostly imported (Table 6 and Table 7). This shows that food security of Vietnam is only at the national level (per capita), but not yet at the household level, because there are still many people who do not have access to sufficient food or do not hold disposable cash to buy food. Addressing food security, high index countries are built on their comparative advantages; they invest in the production of higher income generating commodities that carry less risk, and are willing to import rice. The pride of being a world leading rice exporting country, while its rice cultivating farmers are one of the poorest in the world, is no glory for Vietnam or it's farmers.

Table 6. Global Food Security Index 2015.

Country	Score/100	Rank
United States	89.0	1
Singapore	88.2	2
Japan	77.4	21
South Korea	74.8	26
Malaysia	69.0	34
China	64.2	42
Thailand	60.0	52
Vietnam	53.4	65

(Source: Global Food Security Index 2015).

Richard Silberglitt has further identified that while Vietnam's food security index is ranked 5th, its water security index is one of the lowest in the ten ASEAN countries, ranked at 9th place. This is really a great challenge because 3,000-5,000 liters of water is required to produce 1 kg of rice and a rice crop consumes more than 40% fresh water volume used for agriculture [6]. Furthermore Vietnam is at the downstream end of a big river with two major deltas (Red River and Mekong River), therefore, Vietnam is often in shortage of fresh water flows and is vulnerable to serious inland saltwater intrusion. According to research from the Cuu Long Rice Research Institute, water volume required for Spring - Summer rice crop is 4,038 m^3/ha for each m^3 of water can only produce 0.94-1.45 kg of paddy rice. Therefore, in order to spare about 5-7% area in Mekong River Delta, it may require Vietnam to build reservoirs to reserve fresh water for irrigation and increase aquaculture production areas instead of expecting water from upstream.

The Government and MARD also have an intention to re-structure the rice production sub-sector by shifting to the production of other crops or aquaculture on inefficient rice cultivation areas. In the Mekong River Delta, there are programs to encourage farmers to shift

Table 7. Water and food security index of ASEAN countries (scale 1-5).

No.	Nations	Food		Water	
		Index	*Ranks*	*Index*	*Ranks*
1	Singapore	4.0	1	3.4	1
2	Brunei	3.5	2	3.0	3
3	Malaysia	3.2	3	3.4	1
4	Thailand	3.0	4	2.2	6
5	Vietnam	2.4	5	1.8	9
6	Indonesia	2.3	6	2.6	4
7	Philippines	2.3	6	2.2	6
8	Myanmar	2.0	8	2.2	6
9	Laos	1.8	9	2.6	4
10	Cambodia	1.6	10	1.6	10

(Sources: Richard Silberglitt, 2013) [5].

Table 8. Rice farmer's income in An Giang (2012).

	At scale of 0.75 ha/household	At scale of 1.5 ha/household
Profit (traditional farming), 1,000 VND/household		
- Summer - Autumn crop	1,263	8,711
- Winter - Spring crop	4,171	16,784
Profit (3G-3T), 1,000 VND/household		
- Summer - Autumn crop	4,229	14,385
- Winter - Spring crop	8,080	24,005
Average income from rice, 1,000 VND/person/month		
- Traditional farming household	103	483
- Farming household adopted 3G-3T	233	727
Average income from rice, 1,000VND/person/month		
- Traditional farming household	643	1,857
- Farming household adopted 3G-3T	1,457	2,796

(Source: Nguyen Do Anh Tuan, 2014) [7].

to cultivating maize, fruit trees, and other crops. There was a plan to shift 112 thousand ha in 2015 in Mekong River Delta out of rice production, however, the target was not achieved due to challenges, including the mechanisation of the production processes and irrigation system adjustment required to shift from rice to maize cultivation; marketing, value added processing and moreover, economic efficiency achieved from the shift is not yet attractive.

One institutional reason, which is rarely discussed, is land accumulation, and issues resulting from changes of land use right to land ownership, in order to ensure efficiency of land accumulation. Recent research (Table 8) points out that at a larger rice production scale, higher efficiency is a result of diminished costs, high advanced technology adoptability, and better quality, particularly with more consistent quality.

Together with land accumulation policy, an enabling environment for private sector to invest into agriculture plays a decisive role. Even in a developed country, such as Australia, a policy for international support can shift from "traditional diplomacy for peace to economic diplomacy for prosperity", and private sector's roles are considered vital during the policy shifting process.

In Vietnam, there are very limited enterprises investing into rice production because of its high risks, but low efficiency. It is clear that state-owned enterprises only concentrate on government contracts (currently accounting for 53% total rice export volume); therefore they are only slightly concerned about rice quality, as well as market development and branding. They are mostly granted privileges of having access to low-interest capital and markets, so it is required that Vietnam implement a policy for enterprises to be accountable for activities from rice production to rice trading, while farmers contribute with land use rights as the enterprise's shareholders. If that is the case, various varieties would be eliminated, mixed varieties would be collected, and recognized rice brands would gradually develop. During this process, a support role from the government in capital and land access is very important (Table 9 and Table 10).

Currently, Vietnam exports about seven million tons of rice per year. However, the real costs and benefits resulting from this activity have not been determined yet. How much water is used for irrigation, and how much fertilizer and pesticides are applied for that rice exported volume is still not understood[7]. According to a survey by IRRI (Table 5), fertilizer costs for rice production in Vietnam is 1.21 times higher than in Thailand; 1.63 times higher than in Indonesia; 1.68 times higher than in China, and 2.73 times higher than in India. As consequence of using too many

Table 9. The world rice export and key rice export countries, 1,000 tons (USDA).

Nations	2010	2011	2012	2013	2014	2015
Thailand	10,647	6,945	6,722	10,969	9,779	9,800
India	4,637	10,250	10,480	11,588	11,046	9,000
Vietnam	7,000	7,717	6,700	6,325	6,606	7,000
Pakistan	3,414	3,339	4,126	3,600	4,000	4,400
USA	3,246	3,298	3,295	2,998	3,472	3,350
Cambodia	860	900	1,075	1,000	1,150	900
World	36,486	39,967	49,493	44,115	42,799	41,353

(Source: http://ricestat.irri.org:8080/wrsv3/entrypoint.htm).

[7]As per our calculation, about 70% of 11 million tons fertilizer all kinds (about 3.0-3.5 billion USD) and 130,000 tons pesticide (about 750 million USD) are used for rice crop.

inputs, fertilizer and pesticide costs per ha of rice in Vietnam is also higher than in Thailand 1.1 times, 3.7 times higher than in the Philippines, 2.38 times higher than in China. Furthermore, analysis has not yet been taken into account of how much greenhouse gas is emitted into the environment, how many cubic meters of water (surface and ground water) are affected by eutrophication, and how aquaculture and human health are affected. Vietnam must ask itself, is it sufficient to make a material trade-off and accept environmental costs for annual rice export earnings of approximate USD 3 billion? And are there other alternatives?

According to FAO statistics, the world rice trade is stable at 40-42 million tons and it is unlikely to grow. Looking at the export countries (Table 9) it is evident that they all prioritize production of high quality rice, and the price for the same rice type from Vietnam is always lower than that from those countries. Table 10 shows that for the case of 5% broken rice, price for Vietnam rice is lower than Thailand rice by USD 44; 141; 127; 13 and 33 per ton in 2011, 2012, 2013, 2014 and 2015, respectively. On average it is USD 44/ton lower in the first six months of 2016. Similarly, to 25% broken rice, Vietnam rice price is lower than that from Thailand by USD 44; 163; 1475 and 39 per ton in 2011, 2012, 2013, 2014 and 2015, respectively diminished price trends are evident in the first six months of 2016 (Table 10). Re-structure of rice sub-sector stated that price of Thailand 100% grade B rice during 2009-2014 was higher than Vietnam 5% broken rice 26%, and price of 25% broken rice of Thailand is 22% higher than that of Vietnam (Table 11).

There is obviously a problem in Vietnam's rice development strategy. It is necessary to change from a mindset focused on quantity to a mindset focused on quality and efficiency. We cannot

Table 10. Rice export price from some countries, USD/ton, FOB.

Year	Thailand 5%	Vietnam 5%	Thailand 25%	Vietnam 25%	USA, #1.4%	Pakistan Basmati	Thai Hom Mali, grade A
2011	549	505	511	467	821	1,060	1,054
2012	573	432	560	397	718	1,137	1,091
2013	518	391	504	363	692	1,372	1,180
2014	423	410	382	377	1007	1,324	1,150
2015	386	353	373	334	857	849	1,008
2016							
- January	369	353	361	340	775	734	783
- February	384	344	374	330	770	745	795
- March	384	357	375	341	745	681	793
- April	393	364	383	345	691	679	797
- May	433	365	415	346	658	750	802
- June	441	358	422	337	610	825	830
2015 (Jan. - June)	402	359	385	339	885	931	1,072
2016 (Jan.-June)	401	357	388	340	708	736	800
Increase/decrease,%	- 0.3	-0.6	0.7	0.3	-19.9	-21.0	-25.4

(Source: http://www.fao.org/economic/est/publications/rice-publications/the-fao-rice-price update/en/).

Table 11. The world rice price index.

Year	Common	Indica group		Japonica group	Fragrant rice
		High quality	*Low quality*		
	2002 - 2004 = 100				
2012	231	225	241	235	222
2013	233	219	226	230	268
2014	235	207	201	266	255
2015	211	184	184	263	176
2016					
- January	195	179	181	240	149
- February	197	180	181	244	148
- March	196	180	184	242	142
- April	195	181	187	236	145
- May	199	191	195	230	151
- June	198	191	198	223	159
2015 (Jan. - June)	218	189	188	271	190
2016 (Jan. - June)	197	184	187	236	149
Increase/decrease, %	-9.7	-2.4	-0.4	-13.1	-21.3

(Source: http://www.fao.org/economic/est/publications/rice-publications/the-fao-rice-price-update/en/).

Table 12. Rice balance in Vietnam (2015)*.

Products/Usage channel	Based on USDA/FAO (2013)		Based on calculation (2015)	
	1,000 tons	*% compared to total*	*1,000 tons*	*% compared to total*
Paddy rice production	45,058	-	45,215	-
Rice production	29,374	100.00	29,389	100.00
Consumed price (for eating)	13,252	45.11	13,325	45.34
Seeds (as rice)	881	3.00	404	1.37
For animal feeds	2,711	9.23	0	0
Loss/waste	2,702	9.20	3,526	12.00
Used for other purposes	1,480	5.04	1,480	5.04
Store	1,259	4.29	1,259	4.29
Balance	764	2.60	2,389	8.15
Export	6,325	21.53	6,997	23.81
Consumption, kg/capita/year	144.6		145.0	

*Remarks: Calculation basis: Population: 91.9 million people (2015), milled rice/paddy conversion rate: 65%; Rice seeds used in Mekong River Delta, South Eastern, South Coastal Region and Central Highland are 100 kg/ha; in Red River Delta, North Mountainous Region and North Coastal Region are 40 kg/ha. Post-harvest loss: 12%; other information sourced from FAO/USDA (http://ricestat.irri.org:8080/wrsv3/entrypoint.htm).

and we should not compare ourselves with Thailand, which has much more experience in exporting rice, but compare Vietnam with Cambodia, a country which has lately begun participating in the export markets, and is immediately giving priority to producing rice for diverse markets, with 44% volume of high quality rice. Although Vietnam has participated in the rice export markets for more than 30 years, while Cambodia has only five years, but Cambodian rice has been present in 53 countries and access to high-demanding markets including USA and EU. Vietnam is still limited at exporting to ten middle and low rice quality markets in Asia, Africa and Latin America[8]. Cambodia also has special rice as Phka Malis or Phka Romdoul that are selected as the best rice in the world with price at more than one thousand US dollars.

So, which direction should we develop our rice towards?

First of all, a long-term strategy towards quality, efficiency, and ensuring food security in any situation is required. Rice export, then, is no less a first priority. Rice cultivation land (not only inefficient rice land) is encouraged to be used for other crops and livestock on the principle that converted rice paddy land can be re-converted again for rice cultivation when required. The coastal flooded areas should shift to aquaculture. Products from livestock, aquaculture, fruits and vegetables are not just for export but for improvement of meals in a way of gradually transforming from food security to nutrition security. Rice consumption per capita of Vietnam then can be reduced 30%, from 145 kg currently to 100 kg and catch up with the consumption of South Korea, Japan with 57-67 kg of rice/capita/year. It is helpful in decreasing pressure on rice production.

Table 12 shows that it is possible to export an additional 2.3 million tons of rice in 2015 and obviously can export 10 million tons rice per year, equivalent to the production made from approximate 3 million ha (about 40% current total rice land areas). The surplus of areas and production completely ensure for breakthrough solutions in transforming rice production models.

First of all, production planning is the most decisive stage. The government at the ministries/sectors and provinces should organize enterprise conferences suitable to current orientation with a facilitative government, instead of organizing regional production meetings, with the suggestion of variety structure, and production technology. The government must provide supportive policies, and be adept to respond to market signals, at the same time receive suggestions and feedbacks on mechanisms and institutions in order to be able to advise the provincial government and local authorities of solutions and improvements.

Second, research should be conducted to judge the affect of converting certain rice areas to plant other crops, also for aquaculture. A recent study by Crawford School of Public Policy, Australian National University (2016), shows that if Vietnam can convert 19% of its rice land (about 1.46 million ha) to other crops, there exists the potential to increase GDP by USD 5.5 billion in the next 20 years. The conversion rate in the Red River Delta is at 6.35-9.71% and 8.58-11.75% in Mekong River Delta [8]. It is possible to reduce rice areas by decreasing cropping, cultivating long-day photoperiod sensitive rice cultivars, and perhaps it is required to produce only 1-2 crops per year instead of three crops in Mekong River Delta. However, plans need to take into account how to create employment for farmers.

Third, the enabling environments for the private sector to fully participate in rice value chain including land, capital for development of infrastructure, mechanization, post-harvest management, brand development and market promotion. The government needs to promote realization of agricultural insurance policies soon, which have been developed but are not yet feasible.

Fourth, in regards to technology,

[8]Dat Viet Paper dated 3 September 2015.

it is necessary to review the roles and efficiency of each stage along the production value chain. Currently, production cost is at its very highest, accounting for about 70% total cost, and it should take action immediately to minimize it. There are many technologies that can be applied to reduce materials and labor costs, in particular, advances in fertilization, water savings, and certified seeds production. According to the Chinese Academy of Agricultural Sciences (CAAS), in 1949, contribution from science and technology was only 19.9% into agricultural growth but in 1979 and 2009 it was 27% and 51%, and the impact made by fertilizer was up to 40% of this (Dongxin FENG, 2012).

Post-harvest loss is a significant issue with rice production, and to date, there has not been any systematic and efficient solution available. According to the national post-harvest strategy by MARD, rice post-harvest loss in Mekong River Delta is about 13.7%; in Red River Delta and other regions is 11.6%; particularly in Summer - Autumn crop in Mekong River Delta, sometimes it is up to 30% (it is 10% in ASEAN country, 3,9-5,6% in Japan). Thus, from 45 million tons of paddy, there is a loss of 5 million tons per year which is equivalent to production of almost 1 million ha of rice (FAO provided lower figures at about 9.2% or 2.7 million tons rice or 4.15 tons paddy rice loss in Vietnam). There are significant constraints in rice drying and storage that need to be quickly addressed to minimize loss in quantity and quality as well.

Fifth, we now have a large number of rice cultivars. According to a survey by the Crop Department [9], in Vietnam farmers are planting 379 cultivars, out of them 270 are open pollinated (OP) cultivars and 88 hybrids, with 21 sticky rice varieties. There is a reduction in the number of cultivars in comparison with five years ago (more than 500 cultivars) but it is still high that is easily leading to a loss in homogeneity in rice quality. The rate of areas cultivated with high quality cultivars is increasing (8/10 leading cultivars have good quality in Red River Delta but cultivated in only 30% areas). In Mekong River Delta, the top ten rice cultivars cultivated in 91.7% areas are OP, good quality but not yet have brands developed. Therefore, it is required to divide rice cultivar development into two directions: i) Prioritize improving good quality rice cultivars (including special rice, sticky rice) that are in relatively large scale production and have market access to develop an intensive production zone. This is the popular direction of Thailand and India therefore their rice brands are always maintained with cultivars well-known by the markets; ii) the second direction is research on rice breeding meeting market demands.

Coupled with cultivars, an improvement of certified seed percentage is very important. Only replacement by certified seed can increase productivity by 10-15%. Currently, over the country, the usage of certified seed is only 25-30%.

Sixth, improving productivity evenness of every cultivar in each region and in the country and it is required to review them through applying systematic technical packages. This is one of prioritized direction of IRRI with the program "Closing rice yield gaps in Asia with reduced environmental footprints - CORIGAP". Currently, yield gaps on a single cultivar can be very large, reaching up to 7 tons/ha on average, but in other places, it is only 3-4 tons/ha that make the average yield of the country low. If 50% of this gap is filled we would be able to increase at least 3.5-4 million tons paddy rice. Evenness improvement solutions that can be adopted right now include irrigation system upgrading, seed quality improvement, balanced fertiliser application, efficient crop protection and reduction in post-harvest loss.

Conclusion

Rice development is facing significant challenges caused by climate change, land competition against industrialization, urbanization and road development. Over-farming by intensive farming is increasingly diminishing soil productivity, polluting the environment, and increasing greenhouse gas emission. Moreover, rice production brings in low profits, thus few enterprises choose to invest in rice production. Increasing cost coupled with market fluctuations make farmers uneasy with rice cultivation. It is the time for us to treat rice grains and rice farmers in a fairer way. Rice production must not only be considered as economic object but also social security and macro-economic stability. Converting a part of land for rice or reasonable reductions in cropping patterns together with land accumulation required serious consideration. It is also necessary to develop feasible solutions with effective support from the government for agricultural insurance in general and in rice production in particular. Rice export need to be re-considered in respect of rice farmer's income centered long-term strategy.

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