Adapting the Melon Production Model to Climate Change in Giao Thuy District, Nam Dinh Province, Vietnam

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Summary

Embedded in a package of climate change adaptation, researchers and farmers tested the melon hybrid variety, Kim Hoang Hau (KHH), for yield and disease resistance during the spring-summer season from March to June 2015 in Giao Thuy district, Nam Dinh province. The results were analysed and subsequently discussed with local farmers in focused groups. Analysis showed that the KHH was suitable to local soil conditions. The farmers preferred this new variety over the local melon, because not only did KHH give higher yield and pest resistance, it also showed less vulnerability to climatic stressors. Farmers decided to grow KHH based on the prevailing good market price at that time. However, farmers only shifted away from the old melon when they could anticipate the possibility of selling the new product. Those who did not continue with the KHH had difficulty in actively accessing the market for this new product. This study suggests that the market information does not solely drive the process of the adaptation itself, but it also provides relevant stimuli to farmers enabling them to successfully shift to new crop varieties. This study also implies that such process-based understanding is crucial in formulating strategies that increase the farmer's capacity to adapt to climate change.

Résumé

Adaptation de la production du melon aux changements climatiques dans le district de Giao Thuy dans la Province Nam Dinh, Vietnam

Impliqués dans une approche participative d'adaptation aux changements climatiques, des chercheurs ont évalués la productivité et la résistance aux maladies de la variété hybride du melon Kim Hoang Hau (KHH) avec la variété locale. L'étude a eu lieu entre mars et juin 2015. Les résultats obtenus ont été analysés et ensuite discutés avec les producteurs. L'analyse a montré que les conditions locales du sol étaient appropriées pour la culture du KHH. Les producteurs préféraient la variété KHH par rapport au melon local, car la KHH avait non seulement un rendement meilleur mais aussi une meilleure résistance aux maladies et était également tolérante au stress climatique. Les producteurs ont choisi de cultiver la variété KHH vu que le prix de marché était prometteur. Cependant, les agriculteurs n'ont abandonné la variété locale que lorsqu'ils pouvaient espérer avoir la possibilité de vendre le nouveau produit.. Ceux qui n'ont pas adopté la variété KHH étaient ceux qui avaient éprouvé des difficultés à écouler leur produit sur le marché. L'étude suggère que l'information sur la demande et l'offre sur le marché incite le processus d'adoption et stimule les agriculteurs à adopter la nouvelle variété de melon. Les résultats de cette étude montrent que la compréhension du processus de production est crucial pour la formulation des stratégies afin d'accroître la capacité des agriculteurs à s'adapter aux changements climatiques.

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Introduction

Giao Thuy district of Nam Dinh province is located in the coastal region of Red river delta where crop production is highly vulnerable to climate change. The major agricultural production types in the district include paddy rice and annual crop cultivation, animal husbandry, mangrove forest management and protection, aquaculture, and salt production. Every year, local farmers face high risks due to erratic weather which leads to the reduction of crop yield and farmers' income. Recent research shows a declining trend in quality of soil and water in Giao Thuy (3, 4, 6). The impact of extreme weather events such as erratic rainfall pattern, increased intensity of hot and cold spells and saltwater intrusion has brought major challenges for local agricultural producers (5).

Currently, a number of adaptation solutions to climate change have been tested in Giao Thuy district, such as the RVT salt-tolerant paddy rice variety cultivation, pig raising in organic litter, building community-based adaptation models, community tourism, earthworm farming, fruit plantation using organic fertilizers and renovated home gardening with new fruit trees, such as apple, red dragon and pomelo. These solutions have been implemented effectively at the beginning but could not be sustained, most probably due to the non-inclusion of market information in the research approach (6).

Local farmers, in fact, have demonstrated active adaptation to climate change by spontaneously applying new crop varieties or changing cropping pattern to adapt to impacts of climate change and unstable markets. These adaptation measures have also been identified and studied in previous research study (1). However, the driving force of the changes still has not been well understood. Whether or not shifting crops reflects the adaptation to Climate Change or to market stimuli remains a question.

This study analysed the driving forces of adaptation in annual crops cultivation and determined the adaptation process at individual household-scale for a new melon variety (KHH) known for its many good traits, including resistance to diseases, vigorous growth, high yield, good quality, attractiveness and high selling price.

The efficiency of the local farmer's adaptation process in cultivating this new melon variety and in selling its products parallel to climatic and environmental changes were probed. Other factors, such as agricultural policy, and labour and market demands were also analysed. Key research questions asked in this study were:

(i) Can the introduction of KHH be a suitable CC adaptive solution for Giao Thuy district?
(ii) What is the determinant driving force to make the adaptive solution applicable in the locality?

Materials and Methods

Experimental protocol

Six farm households categorised into 3 groups based on income and skills (2 better-off, 2 middle and two 2 low) were selected for the trial in Giao Thuy district.

Materials used for testing the new cultivation model included

(i) KHH-F1 melon seeds provided by the East-West Seed company (http://www.eastwestseed.com/);
(ii) Seeds of the local pear-shaped melon which is most popular among local growers (Gia Huy variety from Nong Huu company);
(iii) Plastic cover sheet and
(iv) Fertilizers: Song Gianh NPK <20-0-12>, super phosphorus, bio- fertilizer "super humate", manure and lime powder. The characteristics of these two varieties are in Table 1 (8, 9).

At each selected farm, 1440 m^2 of homogenous arable land was split into 2 equal plots: the KHH treatment and the control with local melon. The cultivation technique was applied based on the guideline of East-West Seed Company. The crop was cultivated in the spring-summer season, from March to June 2015. During the experiment, soil quality, plant growth, pest & disease damages, yield, cost, income and labour issues were monitored. The results were analysed and subsequently discussed with local farmers in focused groups.

Table 1

Characteristics of KHH-F1 (experiment) and local pear shaped melon (control).

Variety	Growth period (day)	Fruit weight (kg)	Brix (°)	Yield (ton/ha)
KHH	62 – 65	1.5 – 1.8	16 – 18	22 – 25
Pear shaped (local)	55 – 60	0.4 – 0.5	14 – 17	14 – 20

Table 2

Chemical soil parameters and the analytical methods.

Parameters	Method of analysis
pH-KCl	TCVN5979:2007
OC:	TCVN 4050:1985
P_2O_5 ts	TCVN 4052:1985
K_2O ts	TCVN 8660:2011
K_2O dt	TCVN 8569:2010
P_2O_5 dt	TCVN 5256:1990
Ndt	TCVN5255:2009
EC:	TCVN 6650:2000
SO_4^{2-}	TCVN 6656:2000
Cl^-	Soils & Fertilizer Institute (SFI)

Soil sampling and analysis

Soil samples from the top 20cm layer were taken at the experimental farms. At each farm, 5 samples were taken and mixed into 1 common sample, and analysed in the Soil-Water and Environment Laboratory of Vietnam National University of Agriculture (VNUA) in Hanoi. Table 2 lists the soil parameters and analysis methods. The soil parameters were evaluated by comparing these with the standards in the "Handbook of agricultural land use" (10).

Fruit characteristics

Fruit diameter, fruit height and flesh thickness were measured by using a vernier calliper (cm). The degree Brix was measured with a hand-held Brix degree refractometer. Infection by diseases was scored according to the guideline of the World Vegetable Centre, formerly the Asian Vegetable Research & Development Centre (htttp://avdrc.org) (see Table 9).

Household interview and Focus group discussion

To assess adaptive ability of local communities, three consecutive surveys/interviews were conducted: before melon plantation, immediately after melon harvesting and one year later. The last survey was followed by an in-depth interview to determine which factors influenced the continued cultivation of new high-yielding melon varieties and what reasons made them discontinue with the new melon variety.

To determine the adaptation of cultivation practices in the context of climate change and local market, researchers used semi-structured questionnaire in interviewing 6 selected households who participated in the model design. The questionnaire consisted of 3 components:

(i) general information of the households, crop cultivation, land, farming practices, labour and household income;

(ii) Changes in melon cultivation during the last 5 years (seedling, land cultivated area, harvesting, market and reasons for changes);

(iii) Local farmers' response to external impacts, including climate change, market and ranking the degree of impact, as well as the reaction of the local people.

Focused group discussions (FGD) were conducted to collect information about climate phenomena and market demands. The first FGD with representatives of the six households and the village authorities was held before planting melons. To analyse market accessibility, researchers conducted the second FGD before melon harvesting by engaging the same participants from the first FGD, but adding 5 melon buyers as respondents from the district.

Data analysis

To compare and assess the adaptive ability of local households, this study invited three local authorities and five farmers who had not participated in the experiment. These respondents were asked to score three variables: experimental farm's labour availability, market accessibility and its owner's skills. These three were scored within the range of 0 – 10, a higher mark representing better scores for the households. Farm households were categorized into classes by the K-mean method (2) that was run in SPSS® 16.0 software.

The percentage of fruit produced was calculated by counting the total flowers and the successful fruits from 10 random selected plants at each plot at flowering and before harvesting (%).

Results

The study area

The elevation of the study ranged from 2.3 m to 7.0 m above sea level (Figure 1). Soil of agricultural land in the study area was mostly sandy loam which is quite suitable for melon cultivation (Table 3). The soils were slightly alkaline (pH> 7), and most of the farms had rich total and available phosphorus contents (P_2O_5>0.1% and > 15mg/100g soil). The total and available potassium (K_2O) contents were poor, ranging of 1.0 to 2.0% and <10 mg/100g soil, respectively. Among 6 experimental farms, only one had a good cation exchange capacity (EC=1.07), while the other farms had an EC far below 1. One farm had a moderate saline soil (Cl^- = 0.2%).

The study area is characterised by typical coastal climate of the Red River delta, generally suitable for planting melons. FGDs with participants gathered five extreme weather-based reasons that caused damage on melon production, namely: typhoons, heavy rains, very cold and hot spells, drizzling rains and salty fog from the sea (Table 4).

Farmers in Giao Thuy raise five main crops: peanuts, watermelon, musk melon, kohlrabi and cabbage. A small number of households cultivate rice in summer season (late July to early November). The popular land-use patterns are

(i) spring-summer season with melon/summer-autumn melon or watermelon-winter vegetable, or

(ii) spring peanut/early-summer melon-winter vegetable and potato. The crop calendar is described in Table 5.

For melon crops, the problems causing the most impact were:

(i) salty fog from the sea during the dry season (January-March) which damaged leaves and

(ii) flooding due to excessive rain during summer-autumn melon season. In addition, the pests, thrips and aphids caused major damage to the melon plants. Farmers commonly used pesticides and planted new melon varieties as their adaptive measures.

Two major channels provided them with melon seeds: seed companies coming and introducing their seeds directly; and local dealers/agencies offering seeds to them. Melon fruits went through 3 market channels:

(i) local retailers collecting at the field gate;

(ii) traders collecting at the farm gate and transporting to the cities and

(iii) producers selling at the local market. Market demands and prices are often not stable. New melon varieties with large fruits are often difficult to sell in the local markets due to high price.

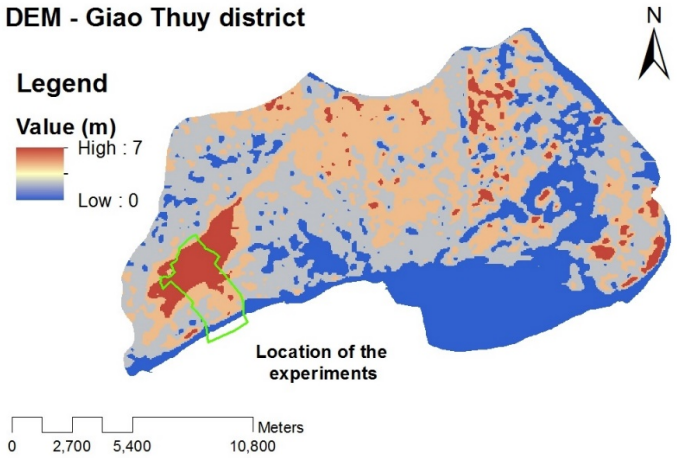

Figure 1: Digital Elevation Model (DEM) for Giao Thuy district.

Table 3

Soil characteristics at the experimental farms.

Farm code	pH_{KCl}	OC (%)	P_2O_5 (%)	K_2O (%)	P_2O_5 mg/100g	K_2O mg/100g	EC	SO_4^{2-} (%)	Cl^- (%)
1	7,45	0,26	0,13	1,68	65,4	5,4	1,07	0,01	0,207
2	7,38	0,21	0,13	1,66	95,1	5,7	0,14	0,004	0,037
3	7,39	0,27	0,14	1,48	60,7	5,7	0,08	0,006	0,028
4	7,32	0,21	0,08	1,66	32,8	16,9	0,13	0,006	0,038
5	7,26	0,44	0,16	1,67	103,4	7,1	0,13	0,006	0,04
6	7,43	0,23	0,18	1,72	98,5	6,6	0,14	0,005	0,035

Table 4

Weather extreme events effecting the melon production.

Phenomena	Period	Local definition
Typhoon	Aug-Oct, late typhoon in Nov	Strong typhoon > 12 Beaufort; destroys crops
Very cold spell	Feb – Mar 3	Very cold (<10°C)
Heavy rain, late rain	End of July – Sep, late rain in Oct	High Intensity, locally flooded
Very hot spell	End of May – July	> 40°C, causes crop' roots rottening
Drizzling rain	Feb – Mar	Mild drizzle, Humid, crop diseases
Salty fog from the sea	Jan – Mar	Fog in the morning and evening, Salt particles cover on the leaves -> withered leaves

Table 5

The crop calendar with pear-shaped melon (PSM), water melon (WM), and mixed PS/WM at Giao Thuy.

Crops	Season	Winter			Spring		Summer				Autumn		
	Month	12	1	2	3	4	5	6	7	8	9	10	11
Spring peanut													
Melon						PSM				WM or PSM/WM			
Winter potato Vegetables (Kohlrabi, cabbage etc)													

Table 6

Characteristics of participating households (HH).

HH code	Skill/ Experience	Labour availability	Market assess	HH group
1	9	8	7	I
2	10	10	10	I
3	9	1	7	II
4	6	3	5	II
5	5	6	3	II
6	-	-	-	-

The scores given by FGD: 10 is best; 1 is worst;

I: High capacity to adopt a new melon variety;

II: Low capacity to adopt a new melon variety.

Local melon growers often find traders selling melon products to big cities. Farmers reported that if they do not want to take risks, they would choose to plant the local pear-shaped melon varieties despite the lower price compared with that of the new melon varieties, because the local fruits were easier to sell at the local markets.

Household categorization

During the experiment, five of six participating households successfully completed the trial. The sixth household did not follow the cultivation technique provided, and all their melon plants suddenly died after about one month of cultivation. Thus, the analysis below includes only the remaining five experimenting farms.

The household classification based on K-mean clustering method provided two different household groups (Table 6). Group one consisted of two households having excellent cultivation skills, good labour availability for melon farming and better market access. The second group had overall lower scores, while one farm scored low only for labour availability.

Melon plant growth

The variation on fruiting rate in the experimental farms is large (Table 7). Therefore, the comparative analysis was conducted only between plots within the same household, but not for groups (see the last column). Both households belonging to group 1 had higher rates, while two of group II had a lower rate; the high fruit rate of one farmer in group II, household 5, can be explained by the high values in available phosphorus and potassium (Table 3). The results show that households with high capacity to adopt a new melon variety (group I) could perform farming techniques better than others.

Fruit characteristics

The fruit of the KHH variety is larger and has thicker flesh than that of the local melon. The degree of Brix measured for the flesh of the KHH was lower; thus, the taste is not as sweet as that of the local melon (Table 8). However, some farmers said that the KHH had better aroma and taste.

Table 7

Percentage of fruit produced in the model in comparison with control.

HH code	HH group	Fruit produced (%)		Ratio KHH/Local
		KHH	Local melon	
1	I	100	60	1,67
2	I	85	70	1,21
3	II	20	70	0,29
4	II	50	60	0,83
5	II	95	65	1,46
Mean ±SD		70 ±30.5	65 ±4.5	

Table 8

Fruit characteristics of KHH and local melons

Variety	Fruit diameter (cm)	Fruit height (cm)	Flesh thickness (cm)	Degree Brix (%)
KHH	15,7	17,3	4,1	13,8
Local melon	11,3	12,6	2,3	14,3

Table 9

Farmers' Scores on seriousness of damage caused by some pests on melon.

HH code	Aphids		Thrips		Downy mildew		Wilt **	
	KHH	Local	KHH	Local	KHH	Local	KHH	Local (%)
1	5	1	3	3	1	1	0	6,7
2	1	2	2	1	1	1	1	2
3	2	2	1	1	1	2	2	4
4	3	1	2	2	2	1	2	5,3
5	3	2	4	3	1	1	1	2

Note: a Scores of infection by diseases were determined according to the guideline of AVRDC as 0: no symptom of disease (no infection), 1: 19% of leaf area was infected (very slight infection), 2: 20-39% of leaf area was infected (slight infection), 3: 40-59% of leaf area was infected (medium infection), 4: 60-79% of leaf area was infected (severe infection), 5: >80% of leaf area was infected (very severe infection).

Diseases

Based on FGD results, KHH scored slightly higher on the incidence of pests and diseases than the local variety (Table 9). However the percentage of plants infected by bacterial wilt was lower for the new variety.

Melon productivity

The yield of KHH was significantly lower than that of the control local melon (Table 10). Average gross income from the control was also higher, but the income obtained from KHH by group I was as good or better than that in the control. This is also demonstrated by the high ratios for the group I farmers and the low ratio for farmers with lower capacity.

Soil environmental impact

The impact on the soil quality of the local melon and the new melon variety KHH together with the improved practice was not conclusive.

The impact on available P_2O_5 was positive at most farms, but for K_2O all, except one farm, had a negative balance for both treatment and control (Table 11). Before the experiment, available P_2O_5 in the soil was quite high, up to 103.4 mg/100g (Table 3). The rate of changes in this parameter (after and before trail) were only slightly positive, with an average of 5.4% and 5.2% in KHH and local melon plots, respectively. The average decline in available K_2O in KHH plots (18.6%) was slightly less than that of the local plots (24.3%).

Table 10

Yield and income from new KHH melon and local Gia Huy, with mean plus SD for five farms.

HH code	KHH (New)		Local melon (Control)		Rate of Income KHH/Local
	Yield (ton/ha)	Income (Mill. VND/ha)	Yield (ton/ha)	Income (Mill. VND/ha)	
1	20,8	208	27,8	139	1,5
2	20,8	153	27,8	167	0,9
3	20,8	96	27,8	139	0,7
4	12,5	46	27,8	150	0,3
5	18,1	97	23,6	181	0,5
Mean ±SD	18.6 ±3.6	132.0 ±49.5	27 ±2	175 ±46	

Table 11

Changes of available P_2O_5 and K_2O before and after experiment.

HH code	Change P_2O_5 (mg/100g)		Balance K_2O (mg/100g)	
	KHH	Local melon	KHH	Local melon
1	9,6	6,2	0,6	-2,6
2	-1,6	-2,0	-1,2	-0,8
3	5,3	3,7	-1,3	-1,0
4	2,4	3,5	-7,8	-5,9
5	-2,1	1,9	-1,0	-0,5

Table 12

Operational cost (OC), gross income and margin for melon production in five farms (million VND/ ha).

HH code	KHH (New)			Local melon (Control)		
	Total OC	Gross income	Gross margin	Total OC	Gross income	Gross margin
1	124,8	208,0	83,2	125,8	139,0	13,2
2	128,3	153,0	24,7	142,8	167,0	24,2
3	107,2	116,0	8,8	128,6	139,0	10,4
4	80,9	86,0	5,1	128,9	150,0	21,1
5	93,6	97,0	3,4	139,4	181,0	41,6
Mean ±SD			25.1 ±30.0			22.1 ±11.0

Table 13

The effect of the score for market access and type of market channel (trader collecting at the field gate) on the field gate price of KHH.

HH code	HH group	Market access score	Market group	Field gate price (VND/kg)
1	I	7	Wholesale trader	10 000
2	I	10	Wholesale trader	8 000
3	II	7	Local retailers	8 500
4	II	5	Local retailers	5 000
5	II	3	Local retailers	6 000

Economic impacts

Results of economic benefits from five participating households are presented in Table 12. The gross margin for the KHH melon of group 1 households who were advanced in cultivation skills, labour availability and market access was higher than that for the other group. Group 1 also had higher margins with KHH than that of the group 2 farmers with the local melon.

Market access

The market accessibility and price for melon products differed for the two groups of households (Table 13). Group I household (better-off and good skills), sold the product through the wholesale market channel. The middle men, with vehicles, purchased and collected the melon directly at the farm gate and sold melon at wholesale markets in Nam Dinh, Long Bien fruit market (Hanoi) and Gia Loc market (Hung Yen). The price received by farmers through the wholesale channel was higher than that received by the group selling their product to local retailers. The consumer markets for high quality melons are normally located in large cities, in this case through Long Bien and Gia Loc markets). The minimum quantity of products per vehicle is 3.5 tons, the volume that usually middle men prefer to collect directly at the farmer fields and discharge at the wholesale markets. The price for KHH melon is higher due to the larger size and weight, from 2.5 - 3.0 kg per fruit; usually, not preferred by local households who prefer to buy melon fruit at the price below 40,000 VND per kg. There is no contract for melon delivery between farmers and middle men or between regional retail dealers. They trade based on verbal agreement that the price for buying and selling will depend on the market price. None of the participating households sold directly at the local market.

The pre-processing of the fruits by the farmers is restricted to washing and cleaning the melons, before selling to local retailers, middle men or regional wholesale traders. If melons are bought for marketing in other provinces then the farmers need to pack around 10-15 kg of melons per bag for the middle men or traders.

Acceptability and driving forces of the changes in adopting new melon varieties

The survey conducted one year after the experiment showed that four households continued to grow the newly introduced KHH; two of these households belonged to group I, while two others did not participate in the experiment. These farmers preferred to replace the local melon with HHK because this new variety is less vulnerable to climatic stressors. Besides this, the decision to grow the new variety is due to its higher price and higher tolerance to specific diseases that often affect the local melon.

The in-depth interview after one year, revealed that two new households started to cultivate the new melon variety because they had sufficient capital and learned about the success from the two households who had continued growing KHH even after the trial. Farmers reported that they only shifted to a new crop when they could anticipate the possibility of selling this new product. Farmers who discontinued with the KHH had difficulty in actively accessing market for this new product.

Discussions

Both the new hybrid melon and the local melon varieties maintained soil P_2O_5 content.

The K_2O content was reduced in both practices, although somewhat less when propagating KHH together with the improved fertiliser practice. At short term these unbalances of soil chemical elements might not cause environmental problem because farmers always apply NPK fertilizers at the beginning of each cropping season. However, the one farmer who succeeded to improve both these soil parameters presents an interesting case for learning by research, extension services and other farmers.

The financial gain from KHH were either improved or remained the same compared with that of the local melon, while the disease risk decreased for KHH. The size and other characteristics of KHH were comparable to those of other melons that are cultivated in the Red River Delta in recent times (7). The lower Brix, indicating lower flesh firmness of the new variety compared with that of the local melon, was compensated for by thicker flesh, better aroma and taste making KHH attractive for the more selective consumers in the cities.

This study suggests that the market information did not drive the process of the adaptation itself, but rather provided relevant stimuli to skilled farmers enabling them to successfully shift to new crop varieties. This study also implies that such market process understanding is crucial in formulating strategies to increase farmer's capacity to adapt to Climate Change.

Conclusion

Skilled farmers producing the new KHH melon earned a higher income than those who produced the local variety. This newly introduced melon variety was well accepted by the more skilled farmers who actively accessed the wholesale market channel in cities. However, the market information did not drive the process of the adaptation, but rather provided relevant stimuli to these farmers enabling them to successfully shift to new crop varieties.

The introduction of a new melon variety and cultural practice in Giao Thuy, accompanied with suitable soil conditions for annual melon cultivation, contributed to climate change adaptation of these experienced and skilled farmers. The KHH melon variety was suitable for the summer-spring season of Giao Thuy. It had vigorous growth, good flowering and fruiting, high yield and good quality. The agro-chemical properties of the soil were more reduced by the local practice compared with that of the KHH produced according to the seed company's cultivation guideline, which is thus a first step to a more sustainable melon production model.

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