Discussion on Influencing and Limiting Factors on Sustainable Grape Farming in Yamanashi Prefecture of Japan

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Abstract Viticulture has been an important agricultural sector throughout history in many countries. In Japan, grape-growing areas cover 17,800 ha, and the estimated annual grape production is 172,700 tons. The leading prefecture for grape production and winemaking is Yamanashi Prefecture. The land area under grapevine cultivation in Yamanashi Prefecture is around 3,780 ha with an estimated production of 36,900 tons per year, while grape production and winemaking are two key sources of income for local farmers. However, despite many advances in grape and wine production, these sectors face significant challenges both in Yamanashi Prefecture and across Japan, including a shortage of qualified labor. There is a lack of information and studies that focus on examining factors impacting the grape and wine industry in Yamanashi Prefecture. The objectives of the current study were 1) to examine the economic characteristics of grape farmers in Yamanashi Prefecture, 2) to evaluate factors influencing and limiting the contribution of grape farming to household income, and 3) to assess challenges facing grape farmers and wine producers in the study area. Field surveys in the form of structured and semi-structured questionnaires were conducted with grape farmers and wine producers during the ripening and harvesting grape season in 2022. Data were analyzed descriptively using SPSS software. The result indicated that on average, 80% of farmers in Yamanashi Prefecture were part-time farmers and had 1 to 3 ha of land, of which 40% was under grape cultivation and 60% under peach cultivation. The majority of respondents (88%) had a university education, while 12% had only a high school education, with female grape growers predominating (60%). The majority of the produced grape (80%) was sold fresh and only 20% was used for making wine. Most of the grape growers used the pergola method for training vines and preferred sandy and silty soil, with 90% of respondents using sprinkler irrigation. The results indicated that key environmental factors affecting grape bunches were light exposure, temperature, humidity, wind, rainfall, and the physiology of the grapevine by water and nutrients. The result showed that initial investments, labor inputs, small size of land parcels, and the depopulation of rural areas are the core factors that influence and limit the contribution of grape farming to household income. Therefore, if these issues are not considered, the long-term viability of sustainable grape production and winemaking in Yamanashi Prefecture will be at risk.

Keywords grapevine, challenges, influences, and limiting factors, Yamanashi Japan

INTRODUCTION

Viticulture has been an important agricultural arm throughout history in many countries. The main reason is that it can economically evaluate table grapes as fresh food, dried fruit, fruit juice, wine, and other processed products. Like other crops, grape growing is impacted by environmental conditions, such as soil and climate (Helder et al., 2019). The environmental conditions play an

important role in determining yields and grape quality potential (Cornelis et al., 2019). Also, climate is an important influencing and limiting factor on grapevine physiological development, vegetative growth, phenology, and production, and consequently on grape quality and sustainable grape farming (Petrie et al., 2017). In Japan Yamanashi prefecture is one of the leading grape producers and people are mainly farmers and they economically depend on agriculture. Grape production and making wine are two of the sources on which their income depends (Fig. 1a). In Yamanashi Prefecture the revenues from agricultural production are driven largely by yield and table grape price was around 3,000 to 3,500 yen per kilogram and wine price can vary from 1,000 up to 4,000 per bottle. According to Figure 1b, in Yamanashi Prefecture of Japan, the annual grape production value is 60.7 billion yen and Yamanashi, Nagano, Yamagata, and Okayama are the main grapes producing Prefectures. Although prosperous and full of facilities, Yamanashi Prefecture consists of major problem that exists in the whole agricultural society of Japan. The aging issue in the agricultural society and low birth rates is a huge and growing problems in Japan. In Yamanashi Prefecture, the total population is 817,192, and the geographic area is 4,465 km^2. In 2019, the population aged 65 years and above Yamanashi was 250,000 persons 2019 growing at an average annual rate of 1.94% (Statistics hand of the book of Japan, 2021). Hiring has become an issue at vineyards and wineries, although wine grape cultivation is not as laborious as table grapes cultivation. As they mentioned, an experienced farmer can only manage up to 1 ha of vineyard.
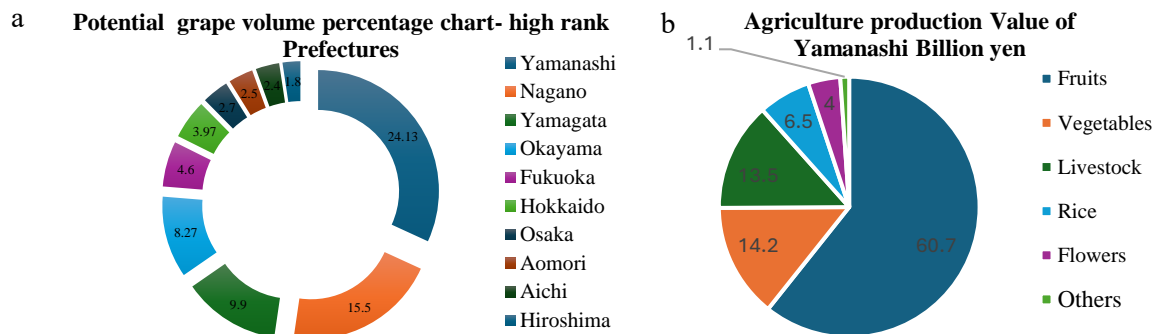
Source: Ministry of Agriculture, Forestry and Fisheries

Fig. 1 (a) Main grape producing Prefectures in Japan and (b) Agriculture production value

The output of grape production in terms of yield and quality can be optimized through the choice of plant material, such as variety, clone, and rootstock, and through the choice of viticulture techniques, such as training system, and Production costs can be reduced largely through mechanization. Based on Table 1 the average grapes yield was 10.47 tons/ha, and according to the interviewer's response the quantity and quality of grapes were significantly affected by rainfall rate and humidity. Temperatures have become increasingly warmer during the period of grape ripening. This resulted in differences in annual production and quality. Additionally, as increased temperatures increase the evaporative demand driving both vine transpiration and soil evaporation, the soil water balance over the season will become increasingly dry (Jackson, et al., 1993). Grape growers and stakeholders should become aware of this problem to timely plan and adopt these measures to ensure the future sustainability of this important crop.

Table 1 grape growing areas and production of five years all prefectures of Japan

Production years	Growing areas (ha)	Fruiting areas (ha)	Production (ton)
2015	18,100	17,100	180,500
2016	18,000	17,000	179,200
2017	18,000	16,900	176,100
2018	17,900	16,700	174,700
2019	17,800	16,600	172,700
Average yield in five years			10.47

Source: Annual Report, MAFF 2019

OBJECTIVE

The people of Yamanashi prefecture of Japan are mainly farmers, They economically depend on agriculture. Grape production and making wine are two of the sources on which their income depends. Therfore the objectives of this study were 1) to examine the social economic characteristics of grape farmers, 2) to find factors influencing and limiting the contribution of grape farming to household income, and 3) to assess challenges facing grape farmers and wine producers in the area.

METHODOLOGY

The research study was conducted during the harvesting season of grapes in 2022 in Katsunuma, one of the nine main grape-producing districts of Koshu city in Yamanashi Prefecture, Japan. As you can see in Fig. 3, which is located near the center of Honshu. Katsunuma has a favorable climate that nurtures the grapevine. The main material of the study was the data collected from grape-producing households and wine producers in the village of Kami Kuribara in the Katsunuma district. The total number of grape-producing households was 50 in the study area. The data were obtained randomly from 30 head of grape-producing households through face-to-face interviews using pre-prepared structured and semi-structured questionnaires related to socio-demographic characteristics of the grape-producing household, farm size, yield, farm management, and influencing and limiting factors (questionnaires translated into Japanese).

Source: https://www.nippon.com/en/guide-to-japan/pref19/

Fig. 3 Map of the study area

RESULTS AND DISCUSSION

Increasing grapevine farms will cause difficulty in the capability of managing the grape farms. According to table 2 result indicated that the average age of those involved in grapevines and wineries is above 60 years old, with a minimum of 30- to 40-year-old. This can quickly become a problem for vineyards and get more serious in the coming years. On top of this, skill and knowledge are only strengthened at maturity age so, if these experienced farmers passed away the next generation will feel short of knowledge. Another problem was emigration, the majority of the younger generations immigrated to the cities in finding better job opportunities. In addition, grapevines take on average three to five years before their harvest can be made. During this period no profit can be made from the harvest. Profits are only earned at a later stage and may not be enough at the beginning.

According to Table 2, the majority of grape producers (76%) were aged 50-60 years and 24% were less than 40 years. Grape farming was more predominantly 60% female activity, 40% male, followed by married individuals who constituted 80%. On the other hand, political and economic obstacles, such as licenses and taxes make it harder for young generations to join which was expressed during interview by grape producers. The majority of the respondents (88%) had university education, while (12%) had high school. Household members less than 3 constitute (80%) of farmers and 4 and above were (20%). Compare with Afghanistan grape producers; in Japan, grape growers

are highly skilled, constantly updating their knowledge of cultivating and management, and are interested in adopting new technologies and practices (Yusufi, 2019).

There is a comprehensive education program at all levels. Many universities are active in the field of practical skills of grape cultivators, and government agricultural agencies properly introduce education in new ways and technology arising from research centers. It proved that knowledge and skill, research, and extension are the core influencing factors for sustainable grape farming.

Table 2 Socio-demographic characteristics of grape farmers

Variable	Grape farmers of Kabul N=30	Grape farmers of Yamanashi N=30
Age		
30-40	10(33.3)	12(24)
50-60	20(66.0)	38(76)
Sex		
Male	25(83.3)	12(40)
Female	5(16.60)	18(60)
Marital status		
Married	20(66.6)	24(80)
Single	10(33.3)	6(20)
Education		
None	12(40)	0(0)
High school	15(50)	9(12)
University	3(10)	21(88)
Household size		
<= 3	10(33.3)	24(80)
4 and above	20(66.6)	6(20)

Source: Field survey, 2022 (Parentheses shows percentage)

According to Table 3, in Yamanashi Prefecture around 80% of farmers were part-time farmers and land size was between 1 and 3 ha (40%) of the land was covered by vineyards and (60%) by peach. Distance between rows and plants 7x10 meters and plantation of 50 up to 100 plants per ha was common and the majority of the farmers prefer sandy and silt soil for grapevine with the application of 1 to 3 tons of chemical, organic, and compost fertilizer per ha only one time in the winter season. Most of the grapevines trained Pergola with sprinkler irrigation method which was very popular and gave good results for grape production, especially varieties such as Kyoho, Muscat Bailey A, Koshu, Delaware, Merlot, and Chardonnay.

In this connection, (80%) of produced grape was used as fresh grapes and only (20%) of the total grape was used for winemaking. Regarding grapes, the yield result indicated an average of 10.47 tons per ha with approximately 90 kg per vine. Despite existing problems, the contribution of grape farming to annual household income was around (20%).

Average Rank Formula

Descriptive statistics, particularly tabulation, were used to summarize the data. To determine the constraints and factors that influenced decline in agricultural production, average ranking for each of the ranked causes was used to determine the most influential factors using the formula given below.

$$\text{Average rank} \quad P_a = \frac{X_1 P_1 + X_2 P_2 + X_3 P_3 + \cdots + X_n P_n}{Total\ response\ count} \qquad (1)$$

Where xi is the response count for each choice and Pi is the ranked position.

Based on Table 4 the results revealed that initial investment, resistant seedling to pests and diseases, influence of climate and shortage of labour average rank were 1.3, 1.3, 1.6, 1.6 respectively and the severest problems which were expressed by (80%) of grape growers followed by high planting materials 70%, high cost of fertilizer 63.3%, replacement of varieties 66.6%, and high cost

of fertilizer 63.3% average ranked were 1.5, 1.5, 1.6, 1.6, respectively. Pests' leafhoppers and spider mites, and major diseases were powdery mildew and downy mildew. All above factors had significant influence on growth, yield, quality of grapes and sustainable grape farming.

Table 3 Shows respondents results in Yamanashi Prefecture

Characteristics of grape farms	Respondents' results
Occupation	Occupation of majority (80%) of the grape farmers was agriculture
Size of land per grape farmer	Most of farmers had from 1 to 3 hectares, and 60% land was for peach
Part time farmers	80% of farmers are part time farmers
Purpose of grape production	Table grape consumption and making wine
Share of grape to annual income household	Contribution of grapes to annual income of household is 20%
Fresh grape consumption	Majority (80%) grape is produced used as table grape consumption
Grape to process to wine	Only 20% of the total grape production is used for making wine
Wineries	In Yamanashi Prefecture 39 wineries are producing wine
Varieties of grape cultivated in Yamanashi	Kyoho, Muscat Bailey A, Koshu, Delaware, Merlot, Chardonnay
Grapevine training method	Most of grape farmers used Pergola method for training of vines
Distance between rows and plants	7 x 10 with plantation of 50 to 100 plants per hectare is common
Grapevine age	Most of the grapevines were between 10 to 30 years old
Yield of per grapevine	The average yield per grapevine was 90 kg
Good yield giving age grapevine	Over 5 years old
Kinds of soil is good for grapevines	Majority of the respondents prefer sandy and silt soil for grapevine
Kind of fertilizer apply in grapevine	Chemical fertilizer, organic fertilizer, and compost
Amount of fertilizer apply in grapevine	Commonly 1-3 tons applied each year in grapevines
Appropriate season to apply fertilizers	The best season to apply fertilizer is winter season
Noticed of pests and insects	Nematode, powdery mildew
Source of irrigation	Surface water such as river, lake, and rainfall
Method of irrigation	Majority 90% use sprinkler irrigation method in grapevines

Source: (Field survey, 2022)

Table 4 Shows the most influential and limiting factors experienced by grape farms

Constraints	Rank				
	1st	2nd	3rd	4th	Average
High initial investment	24(80.0)	3	2	1	1.3
High cost of planting materials	21(70.0)	4	3	2	1.5
Replacement of variety is very difficult	20(66.6)	5	4	1	1.5
High cost of fertilizer	19(63.3)	5	4	2	1.6
Shortage of labour	18(60.0)	7	3	2	1.6
Pests and diseases	16(53.3)	6	5	3	1.8
High cost of new agriculture technologies	15(50.0)	10	3	2	1.7
High resistant seedling to pests and diseases	23(76.6)	4	2	1	1.3
Impacts of climate (rain and humidity)	22(73.3)	3	3	2	1.6
Limited access to quality seedlings	12(40.0)	8	7	3	2.3
Limited access to financial services	10(33.3)	8	7	5	1.9
Land fragmentation	17(56.6)	7	4	2	1.7
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Limited access to financial services	10(33.3)	8	7	5	1.9
Land fragmentation	17(56.6)	7	4	2	1.7

Source: field survey, 2022 (Parentheses indicate the percentages) (Average rank low number shows severe problems)

Environmental conditions play an important role in determining not only yield but also grape quality potential. In winegrowing regions, growers have historically adjusted their plant material

selections and viticulture techniques through trial and research to achieve the best possible compromise between yield, quality, and production costs. In each location environmental conditions are different, so there is no general recipe that can be applied everywhere. This explains why plant materials and viticulture techniques vary so much across grape-growing regions of the world. According to Table 5, in July 2012 there were 167.2 sunshine hours while in July 2020 total sunshine was 78.5 hours the rainy season was long, and the precipitation was so heavy in July 2020. Therefore, the respondent mentioned that the harvested grapes were good that year, but the yield was relatively low because the rainy season was long, and the precipitation was so heavy in July. The quality of harvested grapes was good, but the yield was relatively low because of heavy rainfall around 317 mm more in 2020 in comparison with the rainfall in July 2012.

Table 5 Effects of rainfall, temperature and sunshine on grape yield and quality

2020	Total rainfall (mm)	Average temperature			Total sunshine (hrs.)
		Daily Max. temperature	Daily Min. temperature	Daily Ave temperature	
July	432.0	33.9	18.0	23.8	78.5
Aug	50.0	39.3	20.9	28.0	245.8
Sep	48.5	35.8	9.9	23.4	125.7
2012					
July	115.5	31.3	21.4	25.3	167.2
Aug	23.0	34.8	21.8	27.0	238.6
Sep	22.0	30.6	18.5	23.5	173.8

Source: Ministry of Agriculture, Forestry and Fisheries, 2020

CONCLUSION

Grape is one of the important economic fruit crops found in the Yamanashi Prefecture of Japan. Findings indicated that in Yamanashi Prefecture around (80%) of farmers were part-time farmers and had between 1 and 3 ha of land which (40%) of the land was cultivated grape and (60%) peach. The majority of the respondents (88%) had university education, while (12%) had high school. Female grape growers were (60%) more predominantly than male farmers and (80%) of the produced grape was used fresh and only (20%) for making wine. Most of the grape growers used the Pergola method for training vines and prefer sandy and silt soil with (90%) of responders using sprinklers irrigation. Results on influencing and limiting factors indicated initial investment, resistant seedlings to pests and diseases, heavy rainfall and humidity, shortage of labor, high cost of fertilizer (63.3%), replacement of varieties (66.6%), and high cost of planting materials (70%), were the core influencing and limiting factors on sustainable grape farming which were expressed by (80%) of grape growers. The use of late-ripening and humidity-resistant plant material (varieties, clones, and rootstocks) is an environmentally friendly and cost-effective tool for adaptation and sustainable grape farming in Yamanashi Prefecture of Japan.

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