

ICTs they used. News and information (94.4%) as well as communication (94.4%) were the main causes for the respondents to use ICTs in their daily life. However, power supply was not stable in their local communities. Power cut usually happened several times a week (85%) and might cause inconvenience to the usage of TV, DVD player, and other devices that rely on electricity.

Information is decisive to farm management and market competitiveness. Farmers seek for related, accurate, and up-to-date information [18]. Therefore, this study attempted to explore the information needs of green bean producers in Dakar Region. Results suggested that wholesale price (100.0%), retail price (97.2%), input price (77.1%), new technology (66.0%), wholesale volume (64.6%), and retail volume (63.9%) were the key information that the respondents wanted to obtain (Figure 5).



Figure 5. Green bean producers' information needs.

Moreover, several studies have acknowledged illiteracy and language multiplicity as major barriers to extensive ICT adoption in Africa [18-20]. Results of this study also showed most of the respondents (63.3%) reported difficulties in reading. Less than one quarter of the respondents (22.9%) stated French proficiency, whereas the generality (95.1%) showed confidence in speaking their own local languages.

3.3 Socio-Demographic Relationship Analysis

3.3.1 Marketing risks

Marketing risks often hamper farmers' potential profits from their produce [10, 11, 21]. It is important to clarify the relationship between socio-demographic characters of the producers and their marketing risks to apprehend the group of people vulnerable to certain risks. This study covered five socio-demographic variables: gender, age, education, ethnic group, and membership of producers associations. A chi-square test of independence and Fisher's exact test were jointly used to examine demographic differences in the six identified marketing risks. Figure 6a, b, c illustrate the radar plots of significance in relationship of demographic variables with market risks, ICT usage, and information needs, respectively. Results indicated that the marketing risks in transportation, price, seasonality, incidents, and intermediary were significantly associated with social-demographic variables (Figure 6a). However, no strong relationship was shown between social-demographic variables and marketing risks in

perishability and competition. These connections with each marketing risk will be elaborated in the following discussion.

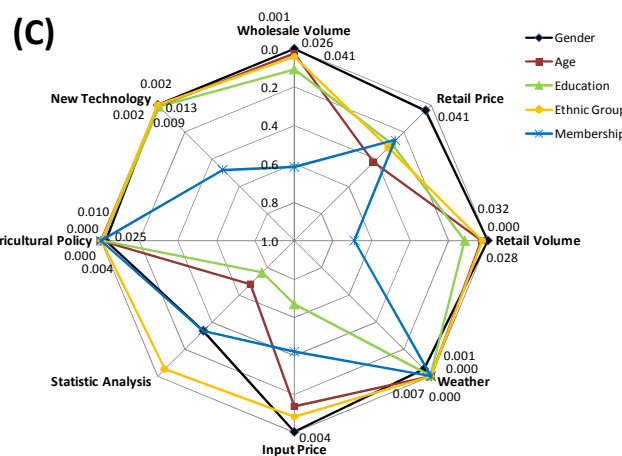
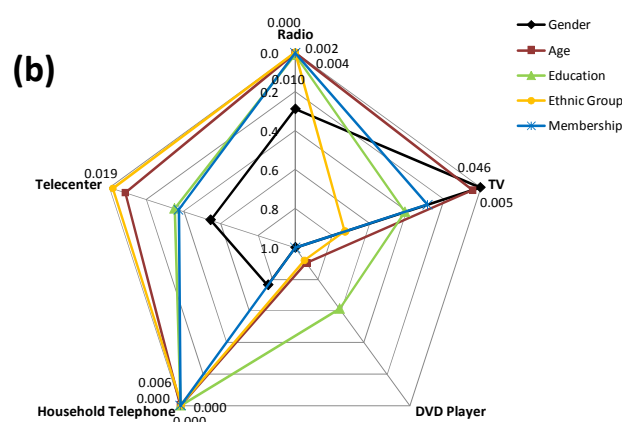
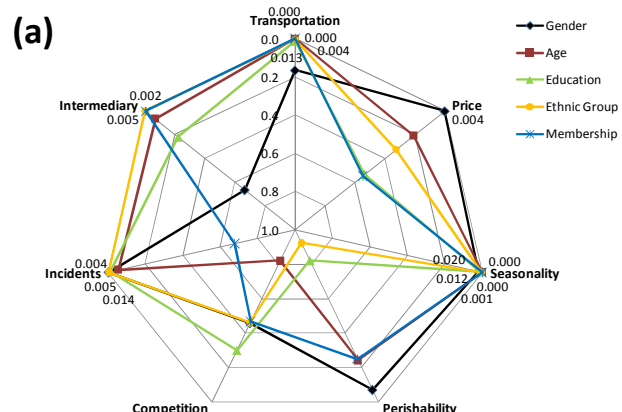


Figure 6. Radar plots of significance (p -values) in relationship of demographic variables with marketing risks (a), ICT usage (b), and information needs (c).

Transportation: Transportation from the fields to the distributing centers and urban markets can become difficult due to flooded roads in raining season, traffic jam during rush hour, and the absence of transportation tools. The results showed that transportation risk was significantly associated with the respondents' age, education, ethnic group, and membership, but not with gender. No significant difference in concerning transportation risk was uncovered between male and female respondents. On the other hand, the younger respondents showed relatively greater concern about transportation risk than the older ones did. Moreover, higher levels of education revealed higher concern about transportation risk. Serer also appeared to be much more vulnerable to transportation risk than other ethnic groups. The reasons might relate to the village locations and resources of ethnic communities. Meanwhile, respondents with membership were less concerned about transportation risk than those without membership were. This may imply participation in producers' associations would have more access to transportation tools or more efficient strategies for product collection and distribution to lower transportation risk.

Price: Price fluctuation directly affects the income of vegetable producers. It also appeared to be one of the major concerns for green bean producers, particularly female, in Dakar Region. Results showed that female respondents seemed to be more vulnerable to price risk than males. This may also imply that females have relatively weaker price negotiation power with traders. Nevertheless, other socio-demographic variables like age, education, ethnic group, and membership were not proven to have significant difference in price risk.

Seasonality: Seasonality limits the period of crop cultivation and may easily cause a large surplus of products in the markets during the same period. Farmers do their utmost to produce and harvest as early as possible by adopting new crop varieties and farming technologies as well as applying more inputs and means to accelerate the growth of crops. Accordingly, suffering from seasonality risk may infer disorganization in marketing planning management or disability in accessing current agricultural information, effective technical assistance, and sufficient farm capital. Results of this study indicated that seasonality risk is associated with all of the five socio-demographic variables, including gender, age, education, ethnic group, and membership. Males were more worried about seasonality risk than females were. Young respondents also seemed to be more sensitive to seasonality risk than the elders. Furthermore, higher levels of education were associated with higher awareness of seasonality risk. Lebou, Wolof, and Fula appeared less concern about

seasonality risk than Serer and other ethnic minority groups did. As for membership of producers' associations, those without membership seemed more likely to worry about seasonality risk than those with membership did.

Perishability: Perishability has been identified as the dominant marketing risk concerned by the green bean producers in Dakar Region. Results of the chi-square test also indicated that perishability risk was prevalent among the producers regardless of gender, age, education, ethnic group, and membership. No association between perishability risk and social-demographic variables was revealed.

Competition: Competition is the second highest marketing risk to green bean producers in Dakar Region. Analysis revealed that competition risk was not significantly associated with social-demographic variables. In other words, respondents of any gender, age, education level, ethnic group, and membership status generally reported their concern about competition risk.

Incidents: Results showed incident risk was significantly associated with gender, education, and ethnic group, but not with age nor membership. Male respondents paid more attention to incidents risk than females did. The respondents with secondary education level seemed relatively less concerned about incidents risk than those with other education levels did. Meanwhile, Fula showed highest concern about incidents risk, followed by other ethnic minority groups, Serer, Wolof, and Lebou orderly. As one of the primary concerns to the respondents, unexpected incidents (e.g. fire, thief) added more uncertainty to the profit of producers.

Intermediary: The intermediary is a major information source and an important marketing channel of farmers. However, an intermediary usually seeks for self-interest instead of mutual interests. Therefore, there is often no firm relationship between producers and intermediaries [21]. Unreliability of the intermediary also made some green bean producers annoyed. Results indicated that intermediary risk appeared to be highly associated with ethnic group and membership. The ethnic minority groups seemed to be most vulnerable to intermediary risk. Moreover, the respondents without membership also appeared to be more vulnerable to intermediary risk than those with membership. This may imply the producers' associations somehow encouraged the exchange of more effective and reliable information among the fellow members. It might also provide more organized and trusty marketing channels, and hence reduce the fallibility of intermediary.

In brief, females seemed to be more vulnerable to price risk than males. This may imply weak price negotiation power of females. Males and the youth appeared to be more sensitive to risks in transportation and seasonality. Higher education levels were also

associated with higher awareness of risk in transportation, seasonality, but lower in incidents. Serer and other ethnic minority groups generally were most vulnerable to marketing risks in transportation, seasonality, incidents, and intermediary while Lebou seemed to be least bothered by these marketing risks. Fula, on the other hand, showed highest concern about incidents risk among the ethnic groups. Non-members of producers' associations also appeared to be more concerned about marketing risks in transportation, seasonality, and intermediary. This suggests joining or organizing producers' associations may support producers to access more resources and mitigate marketing risks.

3.3.2 ICT Usage

Many social-demographic factors, including gender, age, education, and ethnic group have been indicated to connect with ICT usage [22, 23]. This study attempts to shed light on the nature of these connections. Among the six types of ICT that have been used by green bean producers in Dakar Region, mobile phone was accessed and adopted by all the respondents whatever their social-economic statuses were. Therefore, mobile phones will be excluded from this relationship analysis and the following discussion. Totally, five types of adopted ICT were examined with a chi-square test of independence to further understand their relationship with social-demographic variables. The p -values of the significance tests ($\alpha = .05$) on these variables' association were presented with a radar plot as **Figure 6b**. Results showed the usage of radio, TV, household telephone, and telecentre was highly related to social-demographic variables. The usage of DVD player, on the other hand, did not reveal significant association with any social-demographic variable.

Radio: Radio is so far the prevailing ICT in Africa with the largest signal coverage and the most numerous users [13]. Most of the respondents in Dakar Region also used it in their daily life. Results of further analysis also indicated radio usage was associated with age, education level, ethnic group, and membership. However, radio usage seemed to be not closely related to gender. Male and female respondents did not show significant difference in radio usage. On the contrary, older age groups showed relatively higher percentage in radio usage than younger age groups. Particularly age above 60, all of them used radio in their daily life. Moreover, lower education levels show relatively higher percentages in radio usage. In addition, large percentages of Lebou, Wolof, and Fula used radio while a few Serer and other ethnic minority groups did. Furthermore, members of producers' associations had nearly double radio usage rate than non-members did.

TV: TV is not in widespread use by green bean producers in Dakar Region. The analysis of the relationship with socio-demographic variables showed that TV usage was significantly associated with gender

and age. Nevertheless, education, ethnic group, and membership seemed to be not related to TV usage. Female respondents showed higher TV usage than males did. Young and middle age groups also used TV in their daily life more than old respondents did.

DVD Player: DVD player is rarely used, probably due to the price and practicality to producers' daily life. The scarcity of usage also likely caused no strong relationship was found between DVD player usage and any social-demographic variable.

Household Telephone: The expansion of fixed-line telephone service is currently hindered by the booming of mobile phone in Senegal [7]. Nevertheless, Dakar Region has the best equipped telecommunication facilities of the nation [6]. Most of the respondents have adopted household telephone in their daily life. Results also indicated strong associations of household telephone usage with many social-demographic variables, including age, education, ethnic group, and membership. However, no significant difference was found in household telephone usage between male and female respondents. Unlike gender, younger age groups showed higher usage of household telephone than older age groups. Older respondents, particularly age above 60, seemed to be less likely to use household telephone. Meanwhile, higher education levels also showed higher percentages in household telephone usage than lower education levels. Moreover, there was significant difference in household telephone usage among ethnic groups. Less than half of Fula used household telephone while all of Serer and most of Lebou, Wolof, and other ethnic minority groups were familiar with household telephone. In addition, non-members of producers' associations also showed a higher percentage in household telephone usage than the members did.

Telecentre: Senegal has an outstanding number of telecentre among African countries. By year 2000, there were more than 9,000 telecentres over the nation, with about two third in Dakar Region [24]. Telecentre basically provides public telephony service while recently fax and internet services are increasing too. It is one major source for rural population to access telephone. Most of the respondents also reported the usage of telecentre in their daily life. Moreover, results indicated a clear relationship between telecentre usage and ethnic group. Lebou had relatively lowest percentage in telecentre usage while nearly all of other ethnic groups used telecentre. Meanwhile, no significant connection was found with gender, age, education, and membership.

Overall, female producers showed higher usage of TV than males. Older producers seemed to prefer using radio while younger producers preferred using TV and household telephone. Producers with lower education level mostly adopted radio while those with higher education level adopted household telephone. Serer and other ethnic minority groups had relatively low usage rate of radio, but high usage rate of household telephone

and telecentre. Wolof also had highest telecentre usage rate while Fula had lowest household telephone usage rate among the ethnic groups. Moreover, members of producers' associations mostly used radio while non-members mostly used household telephone.

3.3.3 Information Needs

The assessment of information needs is the key to increase the value and usefulness of information for users. Equally, it is also important to identify the relationship between information needs and the nature of users in order to provide more proper information when approaching different target groups. In this study, nine types of information have been considered. Given that wholesale price information was noted by all the respondents, no significant difference will be revealed among socio-demographic variables. Accordingly, except wholesale price, other eight types of confirmed information needs were analyzed with a chi-square test of independence as well as Fisher's exact test to examine their connections with socio-demographic variables. The *p*-values of the relationship tests were compared to a significant level of 5% and given in a radar plot as **Figure 6c**. Results showed that information needs on wholesale volume, retail price, retail volume, weather, input price, agricultural policy, and new technology were all significantly associated with social-demographic variables. However, no significant correlation was uncovered between information needs on statistic analysis and any social-demographic variable. More details about their relationship would be interpreted in the following discussion.

Wholesale Volume: While wholesale price is the leading information provided by general market information systems, information about wholesale volume is often omitted. Reasons might have to do with the chaotic markets that lack of unity and a formal management system. However, information about wholesale volume can help producers better understand the supply and demand of the current markets. More than 60% of the respondents wished to obtain this absent information. Moreover, there were significant associations between information needs on wholesale volume and socio-demographic variables like gender, age, and ethnic group. But no strong relationship was revealed with both education and membership. Male respondents showed more interests in wholesale volume information than females did. Older age groups also seemed to be more in need of wholesale volume information than the youngest age group. In addition, Fula, other ethnic minority groups, Serer, and Wolof all showed relatively higher interests in wholesale volume information than Lebou did.

Retail Price: Retail price as well as wholesale price reflects the potential profit may be obtained by traders and intermediaries. Therefore, information about retail price and wholesale price can both help producers estimate reasonable farm price to sell their products.

Retail price information also followed wholesale price information and ranked second among the information needs of the respondents. The relationship analyses further indicated retail price information was significantly associated with gender, but not with other social-demographic variables. Male respondents showed relatively higher interested in retail price information than females did.

Retail Volume: Similar to wholesale volume, information about retail volume can provide a clearer picture about the market demand. However, there are a vast number of local markets over the nation, and the sellers hardly record their sales. Thus retail volume information is seldom collected, estimated, and disseminated. More than 60% of the respondents looked forward to accessing this information. Meanwhile, the information needs on retail volume was also found to be connected to gender, age, and ethnic group. However, no significant associations were uncovered between information needs on retail volume and both education and membership. Male respondents showed higher interests in retail volume information than females did. The older age groups also seemed to be more interested in retail volume information than the youngest age group. Moreover, Fula, other ethnic minority groups, and Serer showed relatively highest interest in retail volume information than Wolof and Lebou.

Weather: Information about weather is helpful to farmers in terms of planning the time schedule for sowing, irrigation, harvest, and distribution to market. Results of this study showed information needs on weather was strongly related with most of the social-demographic variables except gender. Younger age groups showed relatively higher interest in weather information than older ones did. The respondents with higher education level also appear to be more interested in weather information. Furthermore, Serer and other ethnic minority groups showed relatively highest interest. The respondents without membership also showed a relatively higher percentage in need of weather information than those with membership.

Input Price: Information about input price can assist farmers in farm management decisions, including where to get inputs with fairer prices and how much capital (or profit of one season) may be required to pay for inputs. The majority of the respondents also identified input price as one of the important information they needed. The analysis also showed a significant difference in information needs on input price between genders. Male respondents showed higher interests in input price information than females did. But no strong relationship was found between input price and the rest social-demographic variables.

Statistic Analysis: Agricultural statistics analysis and social-demographic variables were not shown to be significantly related. Respondents with any social background rarely showed interests in information about agricultural statistic analysis.

Agricultural Policy: Information about agricultural policy may provide long-term guidelines for producers to decide the items, volumes, and timing for crop production. It also guides extension workers and traders to promote or deal with certain crops and markets. The results of this study showed a strong relationship between information needs on agricultural policy and all the social-demographic variables, including gender, age, education, ethnic group, and membership. Male respondents showed relatively higher interests in agricultural policy information than females. Similarly, younger respondents also seemed to be more interested in agricultural policy information than elders. Moreover, higher education levels showed higher interests in agricultural policy information. In addition, Wolof, Lebou, and Fula did not show much interest in agricultural policy information while Serer and other ethnic minority groups addressed much more on it. The respondents without membership also seemed to be more interested in agricultural policy information than those with membership did.

New Technology: New varieties and technologies are beneficial to accelerate the growth of crops and to improve the quantity and quality of production. Most of the respondents were seeking for this technical information. Information needs on new technology was also found to be significantly related with several social-demographic variables except membership. Male respondents (72.7%) seemed to be more interested in information about new technology than females (44.1%) did. Age above 60 all showed interest in new technology information while only one third of age under 31 did. Moreover, the respondents with secondary education level showed relatively lowest interest in new technology information among all education levels. Information needs on new technology also revealed difference among ethnic groups. were significantly different. Fula, Serer, Wolof, and other ethnic minority groups all appeared to pay more attention on new technology information than Lebou did.

To sum up, male producers showed more information needs in wholesale volume, retail price, retail volume, input price, and agricultural policy, and new technology than females did. Elders also seemed to be more in need for information about wholesale volume, retail volume, and new technology than the youth. Meanwhile, younger producers and those with higher education levels both showed relatively higher interest in information about weather and agricultural policy. On the other hand, those with lower education levels had more interested in new technology information. Serer and other ethnic minority groups generally expressed greater information needs on wholesale volume, retail volume, weather, agricultural policy, and new technology. Fula had high information requirements for wholesale volume, retail volume, and new technology while Lebou usually showed relatively low interest in information regarding the wholesale

volume, retail volume, weather, agricultural policy, and new technology. In addition, weather and agricultural policy information are the main point of interest for non-members of producers' associations.

3.4 Key Variables Interaction Analysis

3.4.1 ICT Usage and Marketing Risks

To deepen the knowledge about the potential effects of information dissemination on marketing management, this study examined the relationship between ICT usage and marketing risks of the respondents. Results indicated that the marketing risks in transportation, seasonality, price, competition, incidents, and intermediary were found to be associated with ICT usage. However, the marketing risk in perishability was not closely related to the usage of any ICT. **Table 2** presents the values of chi-square tests with significance level of alpha equals to .05. The usage of radio and TV both showed negative relationship with the marketing risks in transportation, seasonality, incidents, and intermediary. The respondents who used radio or TV had relatively less concern about these marketing risks. However, TV users had greater concern about price fluctuation risk than TV non-users did. Results also suggested the users of household telephone had relatively lower marketing risk in incidents but relatively higher marketing risks in transportation, seasonality, and intermediary. In addition, telecentre users seemed to be more vulnerable to the marketing risks in transportation, seasonality, competition, incidents, and intermediary than telecentre non-users did. Given that telecentre is highly adopted by green bean producers, it may play a crucial role in the future dissemination of market information to support its vast users.

Table 2 Relationship between ICT usage and marketing risks of the green bean producers in Dakar Region.

ICT Usage	Radio	TV	DVD Player	Household Telephone	Telecentre
Marketing Risks	<i>Chi-Square</i>				
Transportation	101.080 ^{a***}	50.655 ^{a***}	1.000 ^b	26.553 ^{a***}	12.788 ^{a***}
Price	0.141 ^a	4.181 ^{a*}	0.203 ^b	1.285 ^a	0.525 ^b
Seasonality	103.459 ^{a***}	51.094 ^{a***}	1.000 ^b	27.554 ^{a***}	11.706 ^{a**}
Perishability	1.000 ^b	0.371 ^b	1.000 ^b	1.000 ^b	0.119 ^b
Competition	0.097 ^b	0.747 ^b	0.077 ^b	0.300 ^b	0.000 ^{b***}
Incidents	28.808 ^{a***}	69.398 ^{a***}	0.301 ^b	18.113 ^{a***}	31.042 ^{a***}
Intermediary	49.452 ^{a***}	30.476 ^{a***}	1.000 ^b	17.837 ^{a***}	0.006 ^{b**}

a. Pearson χ^2 value

b. *p*-value of Fisher's Exact Test

p* < .05; *p* < .01; ****p* < .001

3.4.2 Information Needs and Marketing Risks

To reveal the dynamics between information gap and marketing deficiency and also to confirm whether the supply of satisfying information may help cover against marketing loss, the relationship between marketing risks and information needs of the respondents was also

analyzed in this study. Results showed information needs on wholesale volume, retail volume, weather, input price, statistic analysis, agricultural policy, and new technology were associated with marketing risks (Table 3). However, information needs on retail price was not found significantly related to any marketing risk. The marketing risks mostly showed positive connection with information needs. Only price fluctuation risk seemed to be negatively related to information needs. Respondents who suffered from marketing risks in transportation, seasonality, or intermediary, would tend to need information about wholesale volume, retail volume, weather, input price, statistic analysis, agricultural policy, and new technology. Similarly, those who worried for competition risk seemed to be more in need for information about weather and agricultural policy while others who concerned for incidents risk tended to pay more attention on information about wholesale volume, retail volume, weather, agricultural policy and new technology. On the other hand, the respondents without price risk showed greater interest in information about wholesale volume, retail volume, weather, agricultural policy, and new technology than those suffered from price risk did. This may imply those producers who had stable customers (or markets) were more active in accessing comprehensive information.

Table 3 Relationship between marketing risks and information needs of the green bean producers in Dakar Region.

Marketing Risks	Transportation	Price	Seasonality	Perishability	Competition	Incidents	Intermediary
Information Needs	Chi-Square						
Wholesale Volume	46.739 ^{****}	9.979 ^{***}	47.381 ^{****}	0.354 ^b	0.197 ^b	107.550 ^{****}	28.309 ^{****}
Retail Price	1.000 ^b	0.402 ^b	0.297 ^b	1.000 ^b	1.000 ^b	1.000 ^b	1.000 ^b
Retail Volume	38.914 ^{****}	10.450 ^{***}	43.955 ^{****}	0.361 ^b	0.205 ^b	112.098 ^{****}	21.293 ^{****}
Weather	123.913 ^{****}	6.911 ^{***}	127.439 ^{****}	1.000 ^b	0.007 ^{b**}	38.016 ^{****}	72.157 ^{****}
Input Price	10.686 ^{***}	0.448 ^a	11.765 ^{***}	1.000 ^b	0.457 ^b	0.681 ^a	4.486 ^a
Statistic Analysis	0.003 ^{b**}	0.096 ^b	0.002 ^{***}	1.000 ^b	1.000 ^b	0.178 ^b	0.000 ^{b***}
Agricultural Policy	120.139 ^{****}	5.267 ^{a*}	123.411 ^{****}	1.000 ^b	0.007 ^{b**}	10.435 ^{***}	67.872 ^{****}
New Technology	43.774 ^{****}	9.073 ^{***}	39.846 ^{****}	0.340 ^b	0.510 ^b	114.523 ^{****}	22.667 ^{****}

a. Pearson χ^2 value

b. *p*-value of Fisher's Exact Test

p* < .05; *p* < .01; ****p* < .001

3.4.3 ICT Usage and Information Needs

In order to improve current market information systems, it is necessary to evaluate the relevance and potential usefulness of ICT in providing tailored information. Therefore, this study examined the relationship between ICT usage and information needs of the respondents. Results may also suggest how to meet users' information needs through handy media to reduce marketing risks effectively. From Table 4, most of information needs, including wholesale volume, retail volume, weather, input price, statistic analysis, agricultural policy, and new technology, were significantly associated with ICT usage. However, no strong connection was found between information needs on retail price and the usage of any ICT. The usage of both radio and TV showed negative relationship with

most of information needs. Information about wholesale volume, retail volume, weather, input price, statistic analysis, agricultural policy, and new technology appeared to be more important for the respondents who did not use radio than radio users. Likewise, TV non-users showed greater information needs on wholesale volume, retail volume, weather, input price, agricultural policy, and new technology than TV users did. On the other hand, the usage of household telephone showed negative connections with information needs on wholesale volume, retail volume, and new technology, but positive connections with information needs on weather, input price, and agricultural policy. Non-users of household telephone preferred the former three types of information while household telephone users showed greater interest in the latter three types of information. Moreover, telecentre users appeared to have greater information needs on wholesale volume, retail volume, weather, agricultural policy, and new technology compared to telecentre non-users. Therefore, telecentre should be included as one of the key media in the information system to meet users' information needs.

Table 4 Relationship between ICT usage and information needs of the green bean producers in Dakar Region.

ICT Usage	Radio	TV	DVD Player	Household Telephone	Telecenter
Information Needs	Chi-Square				
Wholesale Volume	36.741 ^{****}	92.363 ^{****}	0.350 ^b	13.906 ^{****}	29.688 ^{****}
Retail Price	1.000 ^b	0.144 ^b	1.000 ^b	1.000 ^b	0.401 ^b
Retail Volume	33.595 ^{****}	82.301 ^{****}	0.357 ^b	17.710 ^{****}	23.239 ^{****}
Weather	110.948 ^{****}	51.094 ^{****}	1.000 ^b	27.554 ^{****}	11.706 ^{***}
Input Price	7.406 ^{***}	16.118 ^{****}	1.000 ^b	7.556 ^{***}	0.543 ^b
Statistic Analysis	0.020 ^{b*}	0.085 ^b	1.000 ^b	0.180 ^b	1.000 ^b
Agricultural Policy	99.474 ^{****}	49.591 ^{****}	1.000 ^b	26.598 ^{****}	11.362 ^{***}
New Technology	30.139 ^{****}	78.797 ^{****}	0.336 ^b	22.125 ^{****}	20.593 ^{****}

a. Pearson χ^2 value

b. *p*-value of Fisher's Exact Test

p* < .05; *p* < .01; ****p* < .001

4. Concluding Summary

Information is vital for green bean producers to enhance their farm management and income. However, the adoption of current market information systems (MIS) among producers in Senegal is disappointing. There is a need to reveal users' concerns and constraints to improve the effectiveness of MIS and empower the competitiveness of producers. In this study, therefore, a survey was conducted in Dakar Region, the chief production area of green bean in Senegal, to identify the marketing risks, ICT usage, and information needs of green bean producers. Results showed perishability, competition, price, and incidents were their main marketing risks. Mobile phone, telecentre, household telephone, and radio were the most commonly adopted ICT in their daily life. Key information needs included wholesale price, retail price, input price, new technology,

wholesale volume, and retail volumes. Language and cost were two limiting factors in further usage of ICT. Only few could use French or afford the electronic devices and the required electricity.

Furthermore, results indicated significant differences in marketing risks, ICT usage, and information needs between green producers with different social backgrounds. Female producers showed vulnerability in price risk and relatively higher usage of TV. Young producers appeared to have relatively higher marketing risks in transportation and seasonality, and also higher usage of TV and household telephone. Older producers, on the other hand, had higher radio usage and greater information needs on wholesale volume, retail volume, and new technology. Also, young producers and those with higher education levels both showed relatively higher information needs on weather and agricultural policy. Higher education also reflected higher household telephone usage while lower education often implied higher radio usage. Serer and other ethnic minority groups appeared to be more vulnerable to marketing risks and had relatively low usage of radio but high usage of household telephone and telecentre among ethnic groups. Fula also had highest concern about incidents risk and lowest usage of household telephone. In addition, members of producers' associations seemed to have less concern about marketing risks and higher radio usage. Instead, non-members of producers' associations mostly used household telephone and had higher information needs on weather and agricultural policy.

Meanwhile, results also suggest strong relationship among marketing risks, ICT usage, and information needs. The usage of radio and TV both showed negative relationship with most of marketing risks and information needs. However, TV users seemed to have greater concern about price risk than TV non-users. Household telephone users appeared to have relatively higher marketing risks, except incidents risk; they also showed greater information needs on weather, input price, and agricultural policy. Telecentre users, on the other hand, seemed to be more vulnerable to most of the marketing risks and have greater information needs. Moreover, most of the marketing risks, except price risk, showed positive connection with information needs.

In sum, green bean producers generally need to advance post-harvest skills and marketing efficiency. The extension of produce storage life as well as the enhancement of supply chain connectivity will greatly help preserve the quality, quicken the delivery, increase the sales, and reduce the loss. Therefore, it is important to provide green bean producers useful technical knowledge and better market linkage through the cooperation with extension workers and traders. Additionally, numerous competitors in local or even foreign markets also caused great challenges for not only producers but also traders, NGOs, and the government to reach competitive market balance with

satisfying prices. Regional plantation coordination, new market exploration, and processed product development, joined by quality improvement (refinement) and crop diversification (reduction), may all be advocated as possible solutions. Accordingly, the current MIS may expand the role and serve as an interactive platform of the broader agricultural knowledge system and an effective linkage between farms and markets.

Given that the rural communities strongly rely on informal social contact to access information, MIS should be placed as a complement to, instead of a replacement for, the existing information network. Moreover, information contents of MIS should be more than simply market prices since the value of other information, including new technology and sale volume, have been recognized by producers in this study. Similar results were also found in another African country, Zimbabwe [25]. Furthermore, tailored information will require handy media and proper format to reach rural producers. There is a need to develop an information system supported by voice service in local dialects as well as reliable and cost effective power sources. To reduce marketing risks and to facilitate access to the needed resources and information, individual producers are suggested to be organized into groups. Based on the findings of this study, a research model for horticultural market information systems (**Figure 7**) is also proposed to consider producers' characters, marketing risks, ICT usage, and information needs. This model may help further improvement of MIS to meet users' needs and enhance growth opportunities for horticulture industry in Senegal.

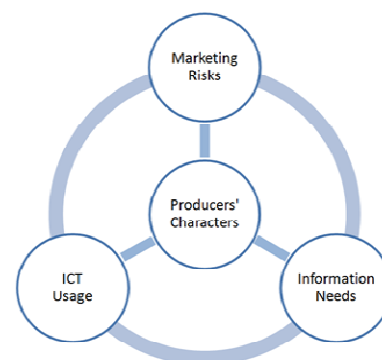


Figure 7. Proposed research model for horticultural market information systems.

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