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RISK MANAGEMENT IN AGRICULTURE THROUGH INFORMATION AND COMMUNICATION TECHNOLOGIES IN SELECTED STATES OF MALAYSIA

MUHAMMAD ALI

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RISK MANAGEMENT IN AGRICULTURE THROUGH INFORMATION AND COMMUNICATION TECHNOLOGIES IN SELECTED STATES OF MALAYSIA

By

MUHAMMAD ALI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Doctor of Philosophy

January 2018

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DEDICATION

TO

MY GREAT MOTHER, WIFE, AYYAN AND ALL FAMILY

&

ALSO DEDICATED

TO

DR. KRISTIN E. DAVIS (IFPRI/GFRAS)

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

RISK MANAGEMENT IN AGRICULTURE THROUGH INFORMATION AND COMMUNICATION TECHNOLOGIES IN SELECTED STATES OF MALAYSIA

By

MUHAMMAD ALI

January 2018

Chairman : Associate Professor Norsida Man, PhD
Faculty : Agriculture

Agricultural risk management is getting priority by the farmers to overcome problems prevailing due to climatic variations and affecting farms and farmers' behavioral intention to use ICTs for managing agriculture related risks. As ICTs have proved cheap, speedy, easy to operate in sharing, learning various practices for managing risks at individual and collective level, so, existing condition of ICT usage alongwith risk management techniques were deemed necessary to examine at various parts of the country. Agriculture extension services in this context were also required to determine at the field level.

Therefore, the prime focus of this study was to examine management of risk in agriculture through Information and Communication Technologies at selected states in Malaysia. The emprical research was conducted: 1) to identify the ICT technologies, sources of information use, agriculture extension services, existing networks and adaptation by the respondents in managing agriculture risk; 2) to examine attitude level, subjective norm level, perceived behavioral control level and intention level to use ICTs for agricultural risk management; 3) to evaluate the relationship between socio-demographic factors and intention to use ICTs for managing agricultural risks by the respondents; 4) to assess relationship between attitude, subjective norm, perceived behavioral control and intention to use ICTs for agricultural risk management; and 5) to determine the influence of attitude, subjective norms, perceived behavioral control (IVs) on the intention (DV) of farmers to use ICTs for risk management in agriculture.

The data were collected through suvery method in which pre designed questionnaire was used as research instrument. Multistage cluster sampling technique was used to gather data from total 360 farmers. The data were randomly collected from three states which were reflecting East zone (Pahang and Terengganu), South zone (Johor) and North zone (Kedah). The statistical analysis techniques administered in this study were descriptive analysis, chi square, Pearson correlation and multiple regression.

The results showed that mobile was used by majority of farmers. Additionally, the results of chi square revealed that education, dependent size, land ownership and income had significant association ($p<0.05$) with intention of farmers. The result of bivariate correlation matrix revealed that there was statistically significant plus positive relationship between attitude ($r = 0.705$), subjective norms ($r = 0.551$), perceived behavioral control ($r = 0.642$) and intention at 0.01 level with $p=0.0001$. The results of regression analysis depicted that there is high relationship ($R= 0.730$) between IVs and intention to use ICTs for agricultural risk management. Moreover, about 53% (adj. R^2) variance in intention to use ICTs is explained by IVs.

In conclusion, farmers' intention to use ICTs for agricultural risk management was influenced by attitude, social pressure and personal control. Additionally, extension services providers need to pay more attention towards farmers to integrate digital technologies in order to get equipped in advance for any kind of disasters. The study recommends that capacity building programmes should be initiated to use ICTs for agricultural risk management for the extension field staff and farmers.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENGURUSAN RISIKO DALAM PERTANIAN MELALUI TEKNOLOGI MAKLUMAT DAN KOMUNIKASI BAGI NEGERI TERPILIH DI MALAYSIA

Oleh

MUHAMMAD ALI

Januari 2018

Pengerusi : Profesor Madya Norsida Man, PhD
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Pengurusan risiko pertanian kini mendapat keutamaan daripada petani bagi mengatasi masalah yang wujud disebabkan variasi cuaca dan ini menjejaskan ladang serta niat dan tingkah laku petani untuk menggunakan ICT bagi menguruskan risiko berkaitan dengan pertanian. Memandangkan ICT terbukti murah, pantas, mudah untuk dikendalikan dan sememangnya efektif dalam perkongsian, pembelajaran pelbagai amalan untuk menguruskan risiko pada peringkat individu dan kolektif, maka tahap penggunaan ICT sedia ada di samping teknik pengurusan risiko perlu diuji di pelbagai bahagian negara ini. Perkhidmatan pengembangan pertanian dalam konteks ini juga diperlukan bagi menentukan penggunaan ICT pada peringkat lapangan.

Oleh itu, fokus utama kajian ini adalah untuk meneliti pengurusan risiko dalam pertanian melalui penggunaan Teknologi Maklumat dan Komunikasi di beberapa negeri terpilih di Malaysia. Penyelidikan empirikal telah dijalankan: 1) untuk mengenal pasti teknologi maklumat dan komunikasi (ICT), sumber penggunaan maklumat, perkhidmatan pengembangan pertanian, jaringan sedia ada dan adaptasi oleh responden dalam menguruskan risiko pertanian; 2) untuk meneliti tahap sikap, tahap norma subjektif, tahap kawalan tingkah laku terjangka dan tahap niat untuk menggunakan ICT bagi pengurusan risiko pertanian; 3) untuk menilai hubungan antara faktor sosiodemografik dan tahap niat untuk menggunakan ICT bagi mengurus risiko pertanian oleh responden; 4) untuk menaksir hubungan antara sikap, norma subjektif, kawalan tingkah laku terjangka dan niat untuk menggunakan ICT untuk pengurusan risiko pertanian; dan 5) untuk meneliti pengaruh sikap, norma subjektif, kawalan tingkah laku terjangka (IV) ke atas niat (DV) petani untuk menggunakan ICT untuk pengurusan risiko dalam pertanian.

Data telah dikumpul melalui kaedah tinjauan yang menggunakan soal selidik prareka bentuk sebagai instrumen penyelidikan. Teknik persampelan kluster pelbagai peringkat telah digunakan untuk mengumpul data daripada sejumlah 360 orang petani. Data telah dikumpul dari zon Timur (Pahang dan Terengganu), zon Selatan (Johor) dan zon Utara (Kedah). Teknik analisis statistik yang digunakan dalam kajian ini ialah analisis deskriptif, khi kuasa dua, korelasi Pearson dan regresi berganda.

Dapatan kajian menunjukkan bahawa telefon bimbit digunakan oleh majoriti petani. Tambahan pula, keputusan khi kuasa dua menunjukkan bahawa pendidikan, saiz dependen, pemilikan tanah dan pendapatan mempunyai perkaitan yang signifikan ($p<0.05$) dengan niat petani. Keputusan matrik korelasi bivariat memperlihatkan bahawa terdapat kesignifikanan secara statistik beserta hubungan positif antara sikap ($r=0.705$), norma subjektif ($r=0.551$), kawalan tingkah laku terjangka ($r=0.642$) dan niat pada tahap 0.01 dengan $p= 0.0001$. Keputusan analisis regresi memperlihatkan bahawa terdapat hubungan yang tinggi ($R= 0.730$) antara IV dan niat untuk menggunakan ICT untuk pengurusan risiko pertanian. Tambahan pula, lebih kurang 53% (adj. R^2) varians dalam niat untuk menggunakan ICT telah diperjelaskan oleh IV.

Kesimpulannya, niat petani untuk menggunakan ICT untuk pengurusan risiko pertanian telah dipengaruhi oleh sikap, tekanan sosial dan kawalan personal. Tambahan lagi, penyedia perkhidmatan pengembangan perlu memberikan perhatian yang lebih kepada petani untuk mengintegrasikan teknologi digital supaya dilengkapi terlebih dahulu untuk sebarang jenis bencana. Kajian ini mencadangkan agar program pembangunan kapasiti perlu dilaksanakan kepada pegawai perkhidmatan pengembangan dan para petani untuk menggunakan ICT dalam menguruskan risiko pertanian.

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I certify that a Thesis Examination Committee has met on 18 January 2018 to conduct the final examination of Muhammad Ali on his thesis entitled "Risk Management in Agriculture through Information and Communication Technologies in Selected States of Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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I hereby confirm that:

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- the research conducted and the writing of this thesis was under our supervision;
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LIST OF ABBREVIATIONS

ARM	Agricultural Risk Management
DoA	Department of Agriculture
DoI	Diffusion of Innovation
EAS	Extension Advisory Service
EFS	Extension Field Staff
FAMA	Federal Agriculture Marketing Authority
FAO	Food and Agriculture Organization
FOA	Farmers Organization Authority
GDP	Gross Domestic Product
GSIAC	Global Science and Innovation Advisory Council
IT	Information Technology
ICT	Information and Communication Technology
IFAD	International Fund for Agriculture Development
IPCC	Intergovernmental Panel on Climate Change
JKKK	*Jawatankuasa Kemajuan dan Keselamatan Kampung*
LKIM	Malaysia Fisheries Development Board
MARDI	Malaysian Agriculture Research and Development Institute
MCMC	Malaysian Communication and Multimedia Commission
MPOB	Malaysia Palm Oil Board
NDMA	National Disaster Management Authority
NGOs	Non Governmental Organizations
PBC	Perceived Behavioral Control

R&D	Research and Development
RISDA	Rubber Industry Smallholder Development Authority
SPM	*Sijil Pelajaran Malaysia*
SPMV	*Sijil Pelajaran Malaysia Vokasional*
SPSS	Statistical Package for Social Science
TMP	Tenth Malaysia Plan
TPB	Theory of Planned Behavior
TRA	Theory of Resasond Action
UTAUT	Unified Theory of Acceptance and Use of Technology

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter explains the background of the study, overview of Malaysia and its agriculture, national agriculture policy on food security, climate change scenario in Malaysia, risk management and ICTs, role of agriculture agencies in agriculture and ICT usage, future vision on the usage of risk management and ICTs, problem statement, research questions, objectives of the study, significance of the study, conceptual and operational definitions of terms and thesis organization.

1.2 Background of the Study

Agricultural extension services are aimed to educate, facilitate in learning and expand knowledge and skills of farming community on various farming activities and change their attitude as favorable about innovations in agriculture (Baig and Aldosari, 2013). Through extenion education, farmers are being helped to increase production and cultivation techniques, improve agricultural activities, income, livelihood and ultimately accelerate their socio-economic and standards of education (Anderson and Feder, 2004; Van den Ban and Hawkins, 1996; Antholt, 1991). According to Tiraieyari and Uli (2011), the effectiveness of extension education is rely on extension agents' ability to transfer sustainable practices to farming community who can play pivotal role in the context of Malaysia. Therefore, extension agents in Malaysia are expected to transform farmers' lives through paying regular visits, supporting through linkages development and organizing farmers, updating their knowledge, skills, attitude and behavioral intentions to use ICTs for agricultural development.

Agriculture is equally important for Malaysia as other development sectors. Multiculturalism as a distinct feature of Malaysia also mirrors in the versatile farming and farmers, as the farming community is attached to this sector since ages. All the farmers in the country are not facing same problems because it depends on the location and available resources (Alam *et al.,* 2012). Certain areas are prone to natural disasters which have been devastating plenty of national and individual resources in many forms. The current century has given variety of digital technologies to solve the problems and make profits in almost all spheres of life. However, agriculture has not used fully the potential of so-called Information and Communication Technologies (ICTs) (Milovanovic, 2014).

Pickerrnell *et al*. (2004) stated that big impact of ICT usage on agriculture is certain as it has open windows of opportunities for farmers and ultimately improves their quality of life. Hassan *et al.* (2011) observed that ICTs are playing pivotal role in transformation of Malaysian rural community and achieving national vision 2020

through establishment of k-community (knowledgeable community). So, it seems that importance of ICTs cannot be ignored in agricultural sector of Malaysia.

The agriculture sector has proved to be one of drivers of economy in many developing countries, despite being faced with numerous obstacles mainly due to risk and uncertainty even in the current era of digital revolution. Agricultural sector is influenced by unexpected risks and often beyond control. These risks affect crops, prices of commodities, demand of consumer, source of pests and diseases and also adversely impact on economy, social fabric and psychology of the victims. Additionally, frequent floods and other major or minor natural tragedies have adversely affected farms, producers and are halting the development mechanism (Austin and Baharuddin, 2012). According to Legg and Huang (2010), approximately 14% of greenhouse gas emissions at global level is directly contributed by farm sector which is higher than transport and industry combined.

The term risk and uncertainty are being used invariably in various sectors and revealed unexpected events which lead to various forms of losses. The literal meaning of both terms are different. Like, risk is scanty of knowledge where the possible impacts are known whereas, uncertainty is when likelihoods are unknown. Agriculture system is faced by different kinds of risks on account of lack of awareness and probability of unexpected events which create hurdles in the agricultural development process. In order to further understand the issue, agriculture in Malaysia is presented in the next topic.

1.3 Agriculture in Malaysia

Malaysia is a country having tropical climate and fits into the Sunderland bio geographical area. It occupies about 33.27 million hectares of an area, with composition of Peninsular Malaysia, the states of Sabah and Sarawak in the eastern region and the Federal Territory of Labuan in the northwestern coastal area of Borneo Island as shown in Map 1.1. The South China Sea bifurcate the two regions which is approximately 540 kilometers. Malaysia lies completely in the equatorial zone and the average daily temperature throughout Malaysia varies from 21^0C to 32^0C. The multi-racial and ethnic population of Malaysia is estimated at 29.7 million in 2013 (Government of Malaysia, 2014).

Map 1.1 : Map of Malaysia
(Source : Google Maps)

Agriculture sector is still vibrant to Malaysia's economy. Agriculture contribution to the GDP of national economy is 8.1% (Department of Statistics Malaysia, 2017), which is comparatively low as compared to the year 2014 which was 11.2% with occupied labour force of 11.1% (CIA, 2014). Moreover, among the agriculture products in Figure 1.1, oil palm is the main contributor to agriculture sector GDP which is 43.1%. While in agriculture sector, the other contribution is made by livestock (11.6%) followed by fisheries (11.5%), rubber (7.1%) and forestry (7.2%) respectively (Department of Statistics Malaysia, 2017).

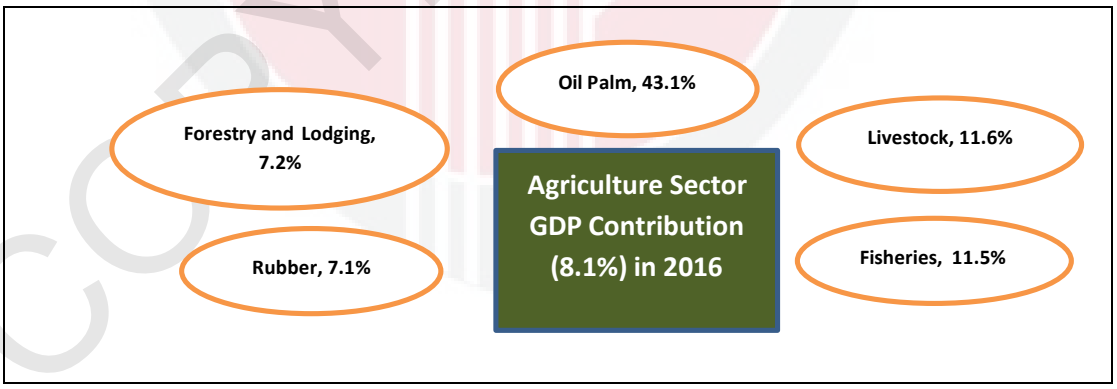

Figure 1.1 : Agriculture Sector GDP Contribution, 2016
(Source : Selected Agriculture indicators, Malaysia, Department of Statistics, Malaysia 2017)

Agriculture is not only the source of food but also provide jobs to the people who are directly or indirectly involved in this sector. It can be seen from the following Figure 1.2 that agriculture sector has provided employment to 1,609.9 thousands people

which is decreased by 8.2% as comapred to last year. Additionally, agriculture sector has also absorbed 600.4 thousands non Malaysian people in 2016 with the 7.1 percent decreased from the year 2015. Furthermore, gender absorption in this sector shows that male with 70% is dominant as compared to female gender who are just 30% absorbed in the agriculture sector. Thus, agriculture sector is dominant by more than 70% male gender in the country.

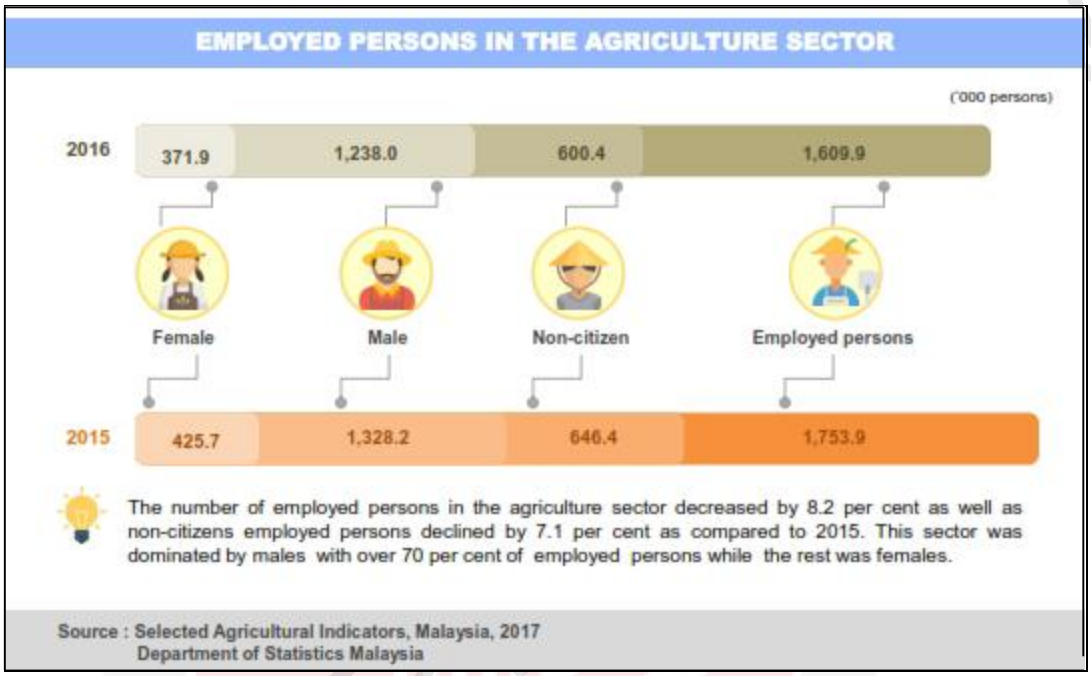

Figure 1.2 : Employment in the Agriculture Sector
(Source : Selected Agriculture indicators, Malaysia, Department of Statistics, Malaysia 2017)

Agriculture is still 3rd engine of economic growth. The 11th Malaysian Plan (2016-2020) with the theme "anchoring growth on people" aimed to become fully developed country and welfare state. The vision would transform people and boost economic growth. The efforts are being made to excel in the region and modernise agriculture sector which will ultimately improve the livelihood of farmers. Additionally, the modernisation of agriculture would be ensured by promotion of sustainable and advance technology adoption to ultimately generate high agricultural income. In the plan, various agriculture based initiatives have been mentioned such as promoting private sector investment to speed up economic growth alongwith diverting focus from imports to the export of commodities. This sector is forecasted to expand by 3.5% with 7.8% contribution in GDP annually by modernising agricultural secor (Government of Malaysia, 2015). Support to ICT adoption as modern technology is also an encouraging intervention for agriculture and other sectors. Additionally, a noteworthy focus is on climate change at the national level with one of the strategies to manage risk. On top of that, 11th plan also reflect institutional support and extension services stregthening including capacity building of extension service providers under

the domain of modernising agriculture. These all efforts would lead to increase income and productivity of farmers including small landholding farmers of the country.

It is expected that these efforts would burgeon the agriculture sector in right way and reduce poverty at large. It is one of the encouraging elements of the policy that ICT-based agriculture have got attention to expedite the agriculture development process by introducing innovation based technologies. After seeing agriculture situation in Malaysia, current scenario of food security with regard to ICT application is mentioned next as it is very important at the country level.

1.4 Current Scenario of Food Security and ICT Application

Jere and Maharaj (2017) stated that ICTs have potential in the context of agriculture as these can facilitate farm condition to generate more profit, increase crop production and enhance efficiency which ultimately reflect food security. Muriithi *et al.* (2009) also emphasized that ICTs have demonstrated potential in the frame of food security in African continent. Food security for sustainable agriculture and livelihood of small scale farmers has been stressed in Malaysia. Government of Malaysia is struggling to increase food production for ensuring self food sufficiency level and enhace export of food products (Tiraieyari and Uli, 2011). According to Singh and Grover (2013), ICTs role to ensure food security cannot be overlooked because this issue has been jeaopardized by climate changes and there is a need to sensitize farmers through information provision.

Moon *et al.* (2016) stated in the context of Bangladesh that different actors are focusing on food security of the growing population and extension service providers are one of the important partners in this regard. Jan *et al.* (2008) also highlighted in the context of Pakistan that good farmer-extension linkages are vital to ensure food security of the population explosion. According to Ismail (2010), it is a crucial time when Malaysia dreams to achieve the status of advanced high income economy. As the population is growing rapidly and income level is also escalating, the policy is useful to secure food for dense population and less dependency on imported food items.

Policy is a living document and road map showing activities to follow and implement for achieving development targets. Malaysia is also one of those countries, which devise policies to achieve national goals in a smooth way. In this regard, Malaysia ratified its National Agro-Food policy for 2011 to 2020 and replaced the National Agriculture Policy (DPN3) (Ismail, 2010).

The policy pointers show that it is also helpful in controlling disease outbreaks, reducing gap between demand and supply, malnutrition and exclusively hidden hunger and on the other side, the availability of safe and quality food, more versatile food items and hazard analysis are good frames of picture. All these efforts would be

fruitless if farmers and allied stakeholders do not pay attention to the risk management side of agriculture.

Furthermore, Arshad *et al.* (2011) stated that Malaysia's main focus of food security is on rice on account of wider consumption however, still self sufficiency even in paddy production is uncertain. On the other hand, Indrani *et al.* (2001) argued that food sufficiency level is decreasing on annual basis in Malaysia because agriculture sector is more focusing on cash crops but less on food. They further added that food is being imported even there is potential to furnish local food demand. They suggested that all the players particularly government is required to change the priorities in order to ensure food security in Malaysia and role of new technologies are still unclear.

So, ICTs have potential to help in curbing issues which might create hurdles in the way of progress and prosperity. However, it is still unclear that how these digital technologies could directly influence food security at national, regional and international level. There are natural disasters and climate change issues at the national level which need to be understand. Therefore, natural disasters and climate change is presented next.

1.5 Natural Disasters and Climate Change in Malaysia

Natural disasters are natural phenomenon and occur due to the climate changes and mostly produce economic shocks. These natural disasters appear in the form of earthquakes, floods, hill torrents, tsunamis, eruptions of volcanoes, droughts and hurricanes. National Security Council of Malaysia has defined disaster as "an incident that occurs unexpectedly, complex in nature, resulting in the loss of lives and damage to properties and the environment as well as interfering in the daily activities of the local community" (Shaari *et al*., 2016).

Climate change has become burning issue not only in Malaysia but also in other developing and developed countries. Oxford dictionary has defined it as "changes in the earth's weather, including changes in temperature, wind patterns and rainfall, especially the increase in the temperature of the earth's atmosphere that is caused by the increase of particular gasses, especially carbon dioxide".

Agriculture sector has been facing many climatic variations which directly or indirectly affecting crop yield and quality of food. There are growing concerns of climate variations and its impact on agriculture sector. On account of these changes, agriculture has become riskier and risk management is mandatory to mitigate the impacts. History reveals that Malaysia has faced many floods and other catastrophes.

The flood history depicts that more than 300, 000 of population affected in the flood of 1965. Moreover, the series of floods were also recorded due to tropical storm Greg in the Sabah in the year 1996, caused 97.8 million US dollars damage to physical infrastructure including houses and other valuable properties. Floods due to heavy and continuous rain in Terengganu and Kelantan caused more than 0.35 million US dollars damage to properties and infrastructure in 2000. Additionally, the floods in Johor (2007) caused 489 million US dollars damage to physical infrastructure and properties. So, in light of the aforementioned facts and figures, the total cost of damage also affected economic growth (Shaari *et al*., 2016).

Malaysia has also witnessed severe disasters in the form of droughts. Like drought in Malacca (1991) became cause of drying Durian Tunggal Dam and affected water availability in almost all areas of the state. Similarly, 1997-1998 El Nino-associated droughts are perceived as the most significant drought which had adversely affected society and environment at the national level. In addition, widespread of forest fires on account of long dry conditions endangered many areas of the country. This situation was further jeoperdized the health situation of common people in the country after similar situation was observed in the bordering country and became cause of haze problem (Mustafa, 2007).

Drought in the 1998 severely affected the state of Sabah due to scarcity of rainfall. The rainfall was absent for a period of four to nine months. In result, 170,000 people and approximately 2,797 km^2 were affected. Moreover, wild fires affected nearly 1580 Km^2 in which 100 Km^2 were occupied by agricultural lands and there were >7200 farmers who also got affected. The mostly damaged crop was paddy crop as it was completely wiped out. The total loss was measured nearly 87 million Ringgits. The similar condition was also observed in the northern side of Sarawak (around Miri). Due to continuous dry spell, wild fires damaged a huge agricultural area (Mustafa, 2007).

El Nino linked drought in the period 1997-1998, a huge rainfall deficiency of 75% was witnessed nearly all parts of Sabah for a duration between four to nine months and even in few areas the rainfall deficit was approximately 90%. Additionally, the longest drought was recorded > 100 days in Miri (Sarawak) and in this context, Sulaiman (2007) stated that it was the longest drought, as per records. Zakaria and Shaaban (2007) stated that climate changes would produce more droughts in the upcoming dry years (2028, 2029, 2034, 2042 and 2044) and more adverse hydrological conditions might be occured including floods and droughts at the national level.

As the country either receives a large amount of rainfall in a year or experience dry spell, so, it draws the attention to take measures and get equipped in advance for any adverse situation in the upcoming years. Alam *et al*. (2010) cautioned that Malaysia is one of the high prone countries to climate change variations where livelihood and agriculture sustainability is at risk. In this regard, Malaysia containing population

more than 27 million and 5.9 million tons greenhouse gas (GHG) emitter (per capita) (Salahudin *et al*., 2013), 2nd largest (per capita) GHG emitter in the list of ASEAN countries (Saxena, 2009), and shares 0.3% globally (Olivier *et al*., 2012), need to plan accordingly. The activities show that the rank will step up in the list if temperature rises by 0.3°C - 4.5°C, which will result about 95 cm sea level rise over a century period. Hamdan *et al.* (2011) also confirmed that the negative impacts of climate change on farms and farmers are irresistible and farming community is lacking ability to adapt. After brief discussion on natural disaster situation on account of climate changes, the situation of ICTs is presented in the next heading.

1.6 ICTs in Malaysia

ICTs are actually the advance form of mass media. Radio, T. V, newspapers, postal services are mainly considered types of mass media as information and knowledge is communicated to large number of people in a society (Hassan *et al.*, 2010). However, there is a limitation of coverage in mass media case but due to globalization, the new forms of communication methods, tools and technologies have been invented to speed up the process with the salient feature of instant feedback. From the future perspective, it might be perceived the usage of ICTs as a local or national development parameter.

Malaysia is becoming a technology loving country as it reveals from the continuous adoption of technologies for effective communication and technology transfer which further highlights the endless future of ICTs in all spheres of life. Similarly, use of ICTs is mushrooming in Malaysia as these facilitate business and social interaction. From the business perspective, ICTs are making business more stronger than the past due to enabling environment and friendly policies at national and international level. In order to bridge the digital divide (BDD) gap at the national level, special budget were allocated for investment with the aim to connect all citizens of Malaysia by establishing 1,945 telecentres across all 13 states (Norizan and Jalaluddin, 2008).

Digital Malaysia master plan was developed to transform the country as the way to achieve socio-economic development and digital penetration for national prosperity by the year 2020. It is assumed that there would not be digital divide in the year 2020 as it could be used in all sectors. In this regard, Global Science and Innovation Advisory Council (GSIAC), Malaysia has been established in 2011. This council has been given mandate to give valuable insights and provide roadmap for Digital Malaysia in order to bolster national economy. This initiative would lead to become ICT based leading nation among the ASEAN countries. More importantly, it seems that these efforts would boost agricultural sector and ultimately affect farmers and their behavior.

In the current scenario, the development of industries and social activities are not just rely on employees' skills but also proper execution of digital policies. The studies on association between ICT friendly policies and GDP have uncovered positive

correlations along with socio-economic developments as these have produced socio-economic advantages (Mody, 1995).

In this context, first survey report about ICT usage and access by individual and household level was issued by Department of Statistics, Malaysia in 2013. The ICT usage by an individual contains three items namely mobile phones, computers and the internet. On the other hand, household level access and usage comprised six ICTs which were landline phone, radio, T. V, T. V channel (paid), computer and internet. It would be worthy to mention here that their survey was based on International Telecommunication Unit (ITU) manual instructions and guidelines.

The survey findings show that mobile phones were used by 94.2%, computers were used by 56% and internet was used by 57% at the individual level in the country. So, among these, mobile phones were used by majority of Malaysian people. They further found that there were about 60.3% of the individuals who used internet on daily basis (Figure 1.3) while, 30.2% individuals used on weekly basis and only 2.8% of the individuals used less than one in a month basis. The activities on internet were mostly social activities like sending and receiving messages, emails; watching or downloading games, movies; buying food or personal items; travel inquiries; and reading electronic books, magazines or newspapers. In a nutshell, similar researches have been also done to assess the individual use of ICTs in various other countries but use of ICTs in agriculture and agricultural risk management have been a matter of limited researchers' concern.

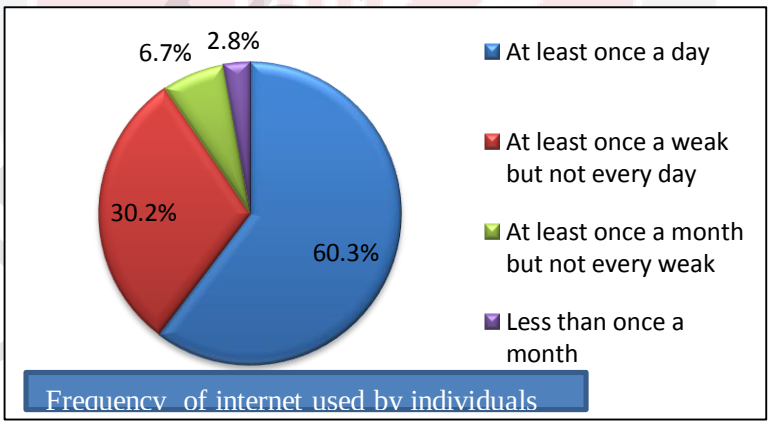

Figure 1.3 : Frequency of Internet used by Individuals
(Source : Department of Statistics, Malaysia 2013)

As far as ICTs access at household level is concerned, the survey results indicate that T. V was accessed to 98.2% of the household, followed by mobile which was 97% accessible. Whereas computer by 59.4%, internet to 58.6%, T. V channel (paid) to 56.1% and landline phone were in the access of 31.1% households. So, television and mobile were the main ICTs which were in the access of mostly households.

In fact, internet access is improving day by day but still 41.4% of the households are lacking home internet access, as the report declared. The reasons of lacking access were high cost, lack of proper skills or confidence, limitation of time, lack of personal interest and language problem. High cost and lack of interest, skills or confidence were comparatively higher in rural parts than urban areas at the national level. After getting picture of ICTs at national level, the ICTs situation in rural areas of Malaysia is pictured in the next topic.

1.7 ICTs in Rural Malaysia

ICTs are not only flourishing in urban areas but also in rural areas of Malaysia too. The concept of urban and rural digital divide is diminishing day by day if the infrastructure is good, connectivity is remarkable, access and affordability is not issue for the common users. The recent progress in ICT sector has opened new horizons due to flow of knowledge (Chapman and Slaymaker, 2002) and information sharing and has become prime source of personal capacity strengthening (Nor Iadah *et al*., 2010).

The previous studies reveal that there were many projects and programmes in rural areas of Malaysia to reduce gap in digital divide concept and connect rural areas with the modern world of technologies. The involvement of public, private and NGOs sector to bring development in rural communities by the introduction of ICTs is remarkable. The programmes by the Government in sensitization and development by the use of ICTs in rural communities were telecentres, Medan InfoDesa, Universal Service Provision and Rural Internet Centre (PID) are name a few. According to Rashid and Hassan (2012), these programmes are now act as ICT training centers in promoting knowledge and creating various development activities and particularly rural entrepreneurship.

The telecenter programme for rural areas was initiated in the year 2000 with the help of government agencies namely Ministry of Rural and Regional development, Ministry of Water, Energy and Commission, Malaysian Communications and Multimedia Commission (MCMC) and state level governments (Tahir *et al.*, 2016). According to Tahir *et al.* (2016), the teleccenters can be divided into three phases starting from 2001 to 2020. The 1st phase was between the years 2001 to 2010 in which these were established in rural areas on account for solving digital gap. The 2nd phase was between 2011 to 2015 in which bridging the digital gap was done. And the 3rd phase was started in 2016 and will end up in 2020 with the aim to upgrade these telecentres to become independent, advance and vigorous.

In the context of telecentres, Abu Samah *et al*. (2013) opined that these centers were aimed at bringing digital access, helping rural masses to increase their level of ICTs literacy and facilitating to access information and knowledge about various fields like general development, agriculture, business, health and local governance. Whereas, Norizan and Jalaluddin (2008) highlighted that these centers bolsters online activities of the rural masses in e-government and e-commerce programmes, helps to control

youth migration from rural to urban areas for employment along with socio-economic development through the use of ICTs.

Rashid and Hassan (2012) described the benefits of telecentres for rural communities were many, ranging from socio-economic development at local level, help in saving costs and time to diversified knowledgeable societies. On the other side of the coin, there were some challenges as well. These were lack of perception and motivation of the rural communities' specially illiterate and aged strata of society, technical and infrastructure hurdles, location and space issues, weaknesses in implementation of programmes, vested interests of the role players and underutilization of the programmes by the communities. While Zahurin *et al*. (2009) have also highlighted problems like absence of motivation, lack of proper physical facilities, scarcity of technical manpower, uncategorized users, inadequate hours of operation and less training programmes for IT.

Samsuddin *et al.* (2016) emphasized that ICTs have become very important in people's lives as they are helpful in information sharing, developments and bridging rural-urban digital divide even in Malaysia. They further added that ICTs are important communicating tools and also act as liaison in the context of community advancement so, communication among masses is difficult without ICTs in the present scenario. All in all, it depicts that ICTs in rural Malaysia is as important as ICTs in urban areas of the country.The links between risk management and ICTs are discussed in the upcoming topic.

1.8 Risk Management and ICTs

Risk management has become policy issue and striking attention of policy makers in the present agricultural policy reform in Malaysia and other developing nations (Chukwukere and Baharuddin, 2012). Lack of awareness to timely address the issue of risk management in agriculuture lead people and specially small holding farmers into poverty and food scarcity which is ultimte cause of socio-economic and food insecurity issue (Hansen *et al.*, 2018). Therefore, public and private sectors of Malaysia are struggling to reduce the impact of natural calamities.

In order to provide information on time regarding strong winds plus weather situation, likelihood of disasters (floods, drought, hill torrents, heavy rains, cyclones, tsunami), price variations of produce in market or policies of goverment, knowledge regarding farmers and their nature of required data is a pre-requisite (NDMA, 2007). Indeed, if the required information or data is inaccurate or absent, then farmers feel uncertain and may face more risks. Thus, awareness and knowledge play vital role in taking decisions for adaptation, mitigation and addressing the issue in order to avoid production, market and other kinds of risks.

According to Chong *et al*. (2018), risk reduction need various actions in order to prepare the community and capacity building is also required to reduce impacts. The socio-economic and human losses may be reduced when community is having high level of awareness and advance knowledge on preparation of disasters and mitigation techniques.

Aziz and Yusoff (2014) conducted study in Malaysia and concluded that different kind of risks were faced by Malaysian agropreneurs. The authors added that the respondents had limited knowledge and financial access but still willing to face any kind of natural disasters to continue their projects. While, Bekhet and Latif (2018) argued that technological innovation and strategic policies are mandatory for Malaysian sustainable growth. These technological innovations may be slow but surely help in future progress if well planned and executed.

The use of ICTs in the agricultural sector is not a novel approach. However, the latest tools, techniques and technologies such as cell phones, portable devices, internet, digital softwares, web portals are in the initial stages. Therefore, various questions regarding their use, role and potential in the domain of agriculture are important. Torero and Braun (2006) stated that access to ICTs could positively lead to poverty alleviation and sustainable rural development. However, awareness may also reduce poverty and burgeon economic growth but evidences are still missing (Bhavnani *et al*., 2008). Importantly, weaknesses at institutional level could further halt the pace of ICT contributions on account of ability to explore. Thus, assessment of various aspects of institutions involved could help in enhancing benefits to the poor directly (Mittal, 2012).

The prospective role of ICTs may be bifurcated into two elements; a) information access and networking -which are important in the research–extension–farmer–market interface and b) the technology diffusion process. For the first role, ICT usage may give many benefits to farming community and other plays like timely information about inputs (price and availability of seed, fertilizer, pesticides, irrigation); easy approaches to animal and crop insurance and credit facilities. For the second role, numerousstudies that have revealed the ICT usage in disseminating knowledge and technology to producers, but there are concerns about the limited understanding of the impact of this intervention on the farmers' behavior, and its capacity to act as an enabler of technology adoption (Ali and Kumar, 2011; Aker, 2011). There is a need to examine the role of agriculture agencies which is highlithed next in the context of extension services and ICT usage in agriculture as a whole.

1.9 Role of Agriculture Agencies and ICT Usage in Agriculture

Agriculture agencies either public or private are key players from technology transfer to technlogy acceptance among farming community around the globe. The role of both important agencies kept changing due to need and demand of the users and end users. According to Swanson and Samy (2002), the public extension role in agriculture has

been changing in developing world since decades due to budget constaints and intervention of private extension agencies. Actually, in the extension linear system, innovations in agriculture are generated from researchers (innovators) which are extended by extension professionals and ultimately adopted by farmers (Pamuk *et al.*, 2013). Agriculture extension system plays leadership and coordinating role among stakeholders so they need to continue work for sustainability of agriculture sector (Rajalahti, 2012; Swanson, 2008).

From the lens of history, public sector based extension system remained dominant before the late 20th century however, after that many kind of organizations including private agencies started delivering extension services to the farming community. Interestingly, even public and private agencies joined hands to provide extension services for better livelihood of farmers (Swanson and Samy, 2002).

Christoplos (2010) has highlighted the importance of extension and advisory services as package of activities which offers valuable information and services required by farming community and related stakeholders to help in building their various skills like technical, managerial and organizational alongwith practices to ameliorate their living standards. The author further maintained that extension agencies can help in making informed decisions and also increase the resilience capacity of farming community by transferring knowledge and information about weather forecasts, market prices and demands by the buyers.

According to Singh and Grover (2013), there is prime role of public and private agencies as agriculture extension and advisory service providers in transferring information, education and technologies related with climate change and mitigation. Additionally, extension links farmers with researchers and other important players in the whole system. Another important activity of extension agencies is capacity development through adult and non formal education particularly in the context of climate change (Singh and Grover, 2013). That is why Ozor (2010) emphsized that there is a change required in roles and capacities in the whole extension scenario to overcome issues caused by climate change. Ani *et al.* (2015) stated that there is a nexus between resilience of farmers regarding agriculture risks and extension services. In this regard, Mittal (2012) noted that risks can be minimized when a farmer gets updated, quality oriented information and able to use that information. Thus, this valuable knowledge and up to date information is provided by agriculture extension agencies in any area.

According to Takenaka (2006), state departments (agricultural extension) in Asian countries are aimed to educate farming community but they have not been able to make any significant changes on account of various shortcomings namely weak structure (organizational), less contribution of farmers in the existing development progress, lack of mechanism for appreciation and rewards for good extension work and communications gaps among various stakeholders (policy makers, farmers,

extension staff, planners and researchers). Thus, there is dire need to revise extension mechanism to become more proactive to handle the issues (Baig and Aldosari, 2013).

Baig and Aldosari (2013); Kulkarni and Sonawane (2017) and Rohila *et al.* (2017) also highlighted the emerging role of ICTs grafted with extension services and would have significant impacts (Rao and Meera, 2017). The authors (Baig and Aldosari, 2013) further added that IT has also brought revolution in the agriculture agencies (extension) role however its true potential has yet to be made clear.

In fact, agriculture agencies are more inclined naturaly to incorporate ICTs for quick transfer and delivery of information to the end users. In this context, Behera *et al.* (2015) pointed out that agriculture extension has started relying on IT due to information transfer on quick basis which could be apt to the area and situation on the basis of farmers' perceptions. Sanusi *et al.* (2010) revealed that agriculture professionals and farming community have started using digital means for effective message delivery, information exchange and managing the received information for good results which is a sign of agriculture development as a whole.

However, There could be number of factors which influence decision of farmers to use ICTs in agriculture. Some important factors pointed out by Caseli and Coleman (2001) are high cost, skills and competition and lacking these could inhibit the farmers to use ICTs. But, staff of agriculture agencies try to mould the attitude, intention and behavior of farmers to use and adopt various technologies for personal and agricultural development.

Similarly, extension workers are act as important link between government and farming community, transfer important pieces of information (Tiraieyari *et al*., 2014) and facilitate farmers in solving agriculture related problems. Cristoplos (2010) explained that farmers and particularly smallholders are facing numerous problems with reference to climate change. So, in order to deal with risk, small holding farmers required new methods of extension services which can help them in understanding and managing agricultural risks. In order to deal with these kind of resource-poor farmers, extension and advisory service (EAS) must be demand driven, farmer friendly and facilitate in providing up to date information and knowledge about climate variations, rain and windfall patterns, latest input prices in market, microfinance and other requirements.

It can be forecasted that future generations will harness ICTs for maximum agriculture production and receive more profits than the existing one. As everything is becoming digitalised, so this digitalization will attract more users to manage variety of risks in an expert manner. However, science cannot compete with nature but the only option is to manage in certain boundaries. Next, conceptual and operation definitions used in this study are presented and later, the picture about the issue in the form of problem statement is presented next.

1.10 Problem Statement

Agriculture sector plays a significant role in food security at the regional and national levels but this sector is still countering problems with nature in the form of floods, drought and diseases (Alam *et al*., 2010b). Similarly, it is a dilemma that the effects and after effects are being faced by farmers directly who have been adhered with this sector since a long time as a prime source of bread and butter. Ultimately, these issues are influencing human behavior and their decisions. If this probelm persists, then country and its inhabitants (farmers) would face more serious problems.

Beyond doubt, public and private sectors have facilitated farmers to harness potential of ICTs to solve the issues (Istikoma *et al.*, 2015; Yusop *et al*., 2013). Even, Malaysian government has tried to establish good physical infrastructure so that people can take benefits through digital means (Shaffril *et al.*, 2012). The stakeholders involved in agriculture sector have motivated, mobilized and disseminated these digital technologies among farming community to cope with the natural problems. Now, it is dire need to understand farmers' behavioral intention to use ICTs in the risk management of agriculture sector as these are speedy, cheap, timely and easy to operate.

Mittal (2012) in his one of the working papers reported that if the farmer is well informed and skilled to use ICTs then the expected risks can be minimized. In addition, the author further found that among various latest ICTs, cell phones have proved to be widely accepted on account of their use and medium of exchanging information in India, other Asian countries and Africa. The use of mobile phones have been increasing due to easy availability of particular information and it is enhancing awareness, source of education, support in technology adoption, fewer costs on transactions, superior market efficiency and better risk management linked with climate. According to Chhachar and Hassan (2013), farmers of Malaysia have also started using ICTs particularly mobile phones in the agricultural sector. However, there is a still need to identify various ICTs being used by farmers of selected sates of Malaysia in the context of agricultural risk management.

The existing literature revealed that there were many factors which could influence the intention of farmers to use ICTs. The factors related to socio-demographic are (Srinuan, 2016; Jiriko *et al.*, 2015; Moghaddam and Khatoon-Abadi, 2013; Venkatesh *et al.*, 2003; Cheong, 2002) age (Cheong, 2002), educational level (Ali and Kumar, 2011; Cheong, 2002), income (Cheong, 2002), experience (Cheong, 2002), farm size and land owenership. Additionally, there are other influencing factors like attitude (Adegbidi *et al.*, 2012; Hsu and Chiu, 2004), subjective norms (Venkatesh and Morris, 2000), perceived behavioral control and behavirol intention which are related with ICT use (Ajzen, 1991). On the other side of the coin, there is lack of literature which could reveal the factors influencing farmers intention to use ICTs for agricultural risk management.

Furthermore, this study was designed to determine the existing level of attitude, subjective norms, perceived behavioral control and intention of respondents to use ICTs for agricultural risk management. On top of that, the role of extension agencies rendering services in transferring information and technologies to manage agricultural risk also demands to be clarified in Malaysia. Although extension functionaries are providing services to farmers (Tiraieyari *et al*., 2014) through mass media as form of ICTs (Hassan *et al.*, 2010) but, their services to use ICTs for managing agricultural risk are still questionable. If the problem is not given priority yet then it will affect on livelihood of farmers particularly and agriculture sector generally.

The research questions and objectives are very important in all the empirical studies, so these important points are mentioned next.

1.11 Research Questions

The research questions for this study:

1) What are the ICT technologies used by farmers, their sources of information, adaptation toward risk management, social networks and agriculture extension services?
2) What are the respondents' attitude, subjective norms and perceived behavioral control toward intention to use ICTs for management of agricultural risk?
3) What are socio-demographic factors that can affect the intention of farmers to use ICTs for agricultural risk management?
4) What is the relationship between attitude, subjective norms, perceived behavioral control and intention to use ICTs for agricultural risk management?
5) What is the influence of attitude, subjective norms and perceived behavioral control on farmers' intention to use ICTs for agricultural risk management?

1.12 Objectives of the Study

1.12.1 General Objective

The overall objective of this study was to determine management of risk in agriculture sector through the application of ICTs in selected states of Malaysia.

1.12.2 Specific Objectives

Specifically, the objectives of this study were:

1) To identify the ICT technologies, sources of information use, agriculture extension services, existing networks and adaptation by the respondents in managing agricultural risk.
2) To examine attitude, subjective norms, perceived behavioral control and intention level to use ICTs for agricultural risk management.
3) To evaluate the relationship between socio-demographic factors and intention level to use ICTs for managing agriculture risks by the respondents.
4) To assess relationship between attitude, subjective norm, perceived behavioral control and intention to use ICTs for agricultural risk management.
5) To determine the influence of attitude, subjective norms, perceived behavioral control (IVs) on the intention (DV) of farmers to use ICTs for risk management in agriculture.

1.13 Significance of the Study

The significance of this study is manifold. It would help in realizing the importance of ICTs and agricultural risk management in the present and future context. From the theoretical point of view, this study would contribute in understanding perceptions about respondents attitude, subjective norms, perceived behavioral control and behavioral intention of farmers toward ICTs use for agricultural risk management. The researchers have also opined that agricultural risk management through ICTs is still naive as some work has been done in developed countries but for Malaysia and other developing parts of the world, it may be comparatively new and less focused particularly in the field of agriculture extension and rural advisory services.

The present study would also add value in understanding existing situation of ICTs adotion as perceived by farmers. These would further capture attention of policy makers, extension service providers, academia and farmers to harness untapped potential of digital technologies in the agriculture sector. Similarly, various types of ICTs which are being used and further can be used would assist development agencies in the future projects. This might also urge the opinions of various actors in planning to support or not to support ICTs in management of various risks in farming.

From the lens of real life, this study would contribute in enabling various stakeholders associated with the agriculture sector to manage the risks by using ICTs as speedy and effective means of communication. This would also help extension staff of public and private sector to reach and transfer technologies among farmers quickly. Many countries are already experiencing the shortage of extension field staff so ICTs can be proper and timely remedy in the present scenario.

The results of the study would benefit a number of relevant players namely farmers, policy makers and in practice theories. The Malaysian farmers could be in a better position to use and adopt new types of ICTs for agricultural risk management. In addition, paradigm shift from traditional agriculture to ICT based practices would enhance production and protection of self food security issue at the local level. It is

expected that farmers and farmers' organizations would be ready in advance to tackle any natural hazard forecasted to occur.

The results would also be useful for policy makers from public and private sectors. As a need and demand, the government officials will propagate digital activities on state of the art design. It would help in adding ICTs in the policy pointers for farmers and especially for smallholder farming strata of Malaysia. It would open doors for Malaysian state officials attached with agriculture sector to devise and revise policy in favor of farmers who are prone to natural disasters. On top of that, the best practices of risk management could be replicated in other states through the adoption of digital means.

This study would also contribute towards the theory development as it could offer new insights for researchers towards ICT as technology acceptance in the context of agricultural risk management. Additionally, the role being played by rural advisory service providers in technology transfer and technology acceptance could stimulate the stakeholders including farmers to integrate digital means for agricultural risk management. The present study would also offer assistance to the researchers in understanding influence of socio-demographic features on behavioral intentions of farmers regarding ICTs usage for agricultural risk management.

1.14 Conceptual and Operational Definitions of the Terms

There are certain terminologies which have been used and required to understand for clarity. These terms are given below:

1.14.1 Knowledge

a) Conceptual

According to Nonaka (1994), knowledge is "justified true belief".

b) Operational

In this study, knowledge refers to the personal belief of respondents about agricultural risk management.

1.14.2 Attitude

a) Conceptual

Ajzen (1991) has defined as "the degree to which an individual favors the behavior being examined".

b) Operational

Attitude in this study has been understood as farmers' positive or negative assessment of behavioral performance to use or not to use ICTs for managing agriculture risk (s). It can be unveail through individual belief pertaining to the behavior.

1.14.3 Subjective Norms

a) Conceptual

According to Ajzen (1991), subjective norms is "the social pressure that makes a person to perform a particular behavior".

b) Operational

In this study, subjective norms means the perception of individual farmer to socially accept ICTs for managing agriculture risks.

1.14.4 Perceived Behavioral Control

a) Conceptual

Perceived behavioral control is described by Ajzen (1991) as "the perceived ease or difficulty of performing the behavior".

b) Operational

In this study, PBC means how well respondents (farmers) are able to use different ICTs and manage agriculture risks.

1.14.5 Intention

a) Conceptual

According to Ajzen (1991), the most close behavioral predictor is the behavioral intention. It shows the strength of an individual that how that individual is self motivated and willing to perform that specific behavior.

b) Operational

In this study, intention means behavioral intention which mirrors the motivation and self inclination of respondents to use ICTs for agricultural risk management.

1.14.6 Extension Services

a) Conceptual

Extension services are defined by Rivera and Qamar (2003) as "a non-formal educational function that involves the dissemination of information and advice with the intention of promoting knowledge, attitudes, skills and aspirations".

b) Operational

In this study, the agriculture extension services mean the services rendered by public and private sector in facilitating farmers to manage agricultural risks and/or use ICTs for agricultural risk management. Thus, extension services rendered by public and private sector have been evaluated through the frequency of meetings, support extended, trainings imparted, information delivered at the farmers' level. Ultimately, a brief picture of extension service providers appeared to further distil the role played regarding agricultural risk management and promotion of ICTs among farming community.

1.14.7 Agricultural Risk Management

a) Conceptual

According to Williams and Schroder (1999), a state of risk is supposed to exist whenever knowledge of the situation enables the likelihood of the numerous possible events to be evaluated in advance. So, risk management is "the process for designing, implementing and evaluating strategies, policies and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response and recovery practices,

with the explicit purpose of increasing human security, welfare, quality of life and sustainable development" (IPCC, 2012).

b) Operational

In this study, risk management has been seen in the context of farms and farmers. Additionally, awareness, perception of knowledge, adaptation, sources of risks and components of TPB were also captured.

1.14.8 Information and Communication Technologies (ICTs)

a) Conceptual

According to Selwyn (2002), ICTs is an umbrella term which comprises computer software and hardware, telecommunication technologies, broadcasting through digital means along with digital sources of information which may be online or offline. The European Commission (2001) has defined it in a more comprehensive manner as "a wide range of services, applications and technologies, using various types of equipment and software, often running over telecommunications networks".

b) Operational

In the domain of this study, various types of ICTs use and/or intention to use for agricultural risk management to facilitate in communication and information sharing have been seen.

1.15 Thesis Organization

The thesis is divided into five (5) chapters and the further detail is given below.

1) Chapter 1 covers the introduction, background, Malaysian agriculture sector, national agriculture and food security policies, climate change and its impacts, risk management and its use in ICTs, role of agriculture agencies and ICT usage in agriculture. Furthermore, this chapter has also described problem statement, study objectives, research questions, significance and conceptual and operational definitions of important terms.
2) Chapter 2 explains literature review about climate change in agriculture, natural disasters, risk management in agriculture, use of ICTs in agriculture and risk management, extension services, farmers based associations and social networks, theories and models related to technology acceptance including Theory of Planned Behavior and its components, and empirical literature related with ICTs and agricultural risk management.

3) Chapter 3 reveals conceptual framework, sampling frame, primary and secondary data sources, instrument design, problems faced during data collection, data processing and analysis techniques, reliability test, hypotheses formulation, chi square test, Pearson correlation and regression analysis.
4) Chapter 4 elaborates study results and detailed discussion along with statistical results. Moreover, results and discussion have deliberated keeping in mind research objectives, questions and hypothesis. Results are presented in descriptive and inferential form.
5) Chapter 5 highlights conclusions, policy implications, limitations of the study and recommendations for farmers, policy makers and allied actors.

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LIST OF PUBLICATIONS

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Ali, M., and Man, N. (2017). Reaching the millions: Accelerating agricultural extension services through information and communication technologies (ICTs). *World Applied Sciences Journal*, 35(3): 352-355. (Published) DOI: 10.5829/idosi.wasj.2017.352.355

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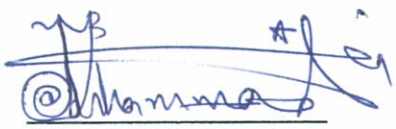

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