CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Tropical AgriSciences

Information-based approaches to addressing risk and vulnerability in agriculture: evidence from the Republic of Moldova

MASTER'S THESIS

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Declaration

I hereby declare that I have done this thesis entitled **“Information-based approaches to addressing risk and vulnerability in agriculture: evidence from the Republic of Moldova”** independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague 27th April, 2018

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Valeriya Timoshenko

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Abstract

This thesis examines factors and constraints influencing farmers' decision to use the internal Weather Forecasts Information Module of the Moldovan Agricultural Marketing Information System (AMIS). Field survey took place in three specific districts of Moldova: Singerei, Telenesti and Anenii Noi. In addition, online survey was conducted with collected responses from fourteen various districts. Using a Binary probit model it was found that gender of farmer, level of education and experienced hail in years 2015-2017 played a significant role in farmers' decision of Weather Forecast Services (WFS) adoption. It was suggested that female farmers were less likely to subscribe for WFS utilization, whereas farmers with more high education attainment and experienced hail over the last three years, they were more likely to adopt WFS of the AMIS. Majority of farmers subscribed for WFS evaluated its information as useful and very useful. Applying the Pearson's Chi-square two sample test indicated that the main constraint to the use of WFS depended on high service price, particularly from SMS-subscribers' perspectives. Descriptive statistics results showed that farmers in the study area searched agricultural information from a range of sources. Based on this thesis, extension services (consulting agencies), the Internet and mass media (radio, television and printed media) were the most used information sources. Farmers became aware of WFS mainly through the Internet and contact with consultants from National Agency for Rural Development (ACSA-NGO).

Key words: The Republic of Moldova, Agricultural Marketing Information Services (AMIS), Information and Communication Technologies (ICTs), weather forecasts, agricultural producers.

Content

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List of the abbreviations used in the thesis

ACSA	National Agency for Rural Development
AMIS	Agricultural Marketing Information Services/System
CTA	Technical Centre for Agriculture and Rural Cooperation
CULS	Czech University of Life Sciences
DMBC	Dutch Moldovan Business Council
EWS	Early Warning System
FAO	Food and Agriculture Organization
FTA	Faculty of Tropical AgriSciences
ICTs	Information and Communication Technologies
IMF	International Monetary Fund
IOM	International Organization for Migration
MIEPO	Moldovan Investment and Export Promotion Organization
UNDP	United Nations Development Programme
UNISDR	United Nations Office for Disaster Risk Reduction
USAID	United States Agency for International Development
WFS	Weather Forecast Services

1. Introduction and Literature Review

1.1. Introduction

In the 21st century climate change is recognised as priorities challenge that humanity to be exposing, and it is no longer a distant outlook. Some of its effects – like increased frequency and intensity of natural hazards are already to be sensed. For Republic of Moldova it has meant, most recently, the catastrophic drought in 2007 and devastating floods in 2008. Reality is that developing countries will take the hardest hit among all countries affected by climate change. They tend to be more vulnerable to the negative impacts, have fewer resources with which to withstand and to recover losses caused by extreme weather events. These countries are more dependent upon the environment for their citizens' livelihoods (UNDP 2009). Agriculture is of vital importance field to Moldova, in terms of employment, rural livelihoods, rural growth and exports (World Bank 2010). Because this sector is highly climate sensitive, it creates a challenging environment particularly for farmers of rain-fed annual crops. Therefore, the role and functions of ICTs, particularly AMIS to enhance the capacity and delivery of information to farmers, with special reference to climate change and the implementation of adaptation options can be crucial (FAO 2017). The early warning, including the publication and distribution of weather forecasts on a frequent basis through simple text messaging (SMS) and Email notification can help farmers to avoid economic losses and have a positive impact on their crop productivity (Laureys 2016). In Moldova the main AMIS administrator for operations and management is National Agency for Rural Development – ACSA, which provides WFS (ACSA 2017). The main objective of the thesis was to analyze factors and constraints influencing farmers' decision to use the internal Weather Forecasts Information Module of the Moldovan Agricultural Marketing Information System (AMIS). The utilization of a weather forecasting system for several study areas were assessed in the context of supporting farmers' information needs. However, there is no current evidence from the Republic of Moldova about such services, their operations and activities.

1.2. Literature Review

1.2.1. General information about the Republic of Moldova

The Republic of Moldova is one of the poorest countries in the European Union's neighbourhood (World Bank 2017a). Whereas it has strong economic growth in recent years, the proportion of the population living in poverty, the rate of unemployment and school enrolment rank nevertheless among the worst in Europe (Wood-Ritsatakis & Makara 2009). More than 20 % of households consume less than the recommended level of calorie intake, and 9.6 % of the population living below the national poverty line (World Bank & World Food Programme 2015). A key role in poverty and food insecurity alleviation plays the agricultural sector and domestic food production (FAO 2016).

1.2.1.1. Geography

Moldova, officially the Republic of Moldova, is located in the central part of Europe in the north-eastern Balkans and occupies an area of 33,843 km^2. On the North, South and East Moldova is bordered by Ukraine, and on the West it is separated from Romania by the Prut River. The capital city is Chisinau located in the middle of the country (Republic of Moldova Official Website 2011). Moldova is divided into 32 districts, 3 municipalities (Chisinau, Balti, and Bender) and 2 autonomous territorial units: Gagauzia (officially “Autonomous Territorial of Gagauzia”) and Transnistria (officially “Territorial administrative unit from the left part of Nistru River”). Transnistria's status has not been settled yet, as the region. Such as defined administratively, in fact it is not under the control of Moldovan authorities (NBS 2016). The geographical and physical position of the Republic of Moldova has determined the characteristic features of its natural conditions. The relief of the country represents a hilly plain sloping from the northwest to the southeast with an average elevation of around 147 m above the level of the sea. The central part is covered by Codrii woods, the most elevated in pitch topographical region with the maximum altitude of 430 m at Balanesti Hill. Nisporeni Raion (district) and a terrain heavily fragmented by dales and valleys (Republic of Moldova Official Website 2011).

1.2.1.2. Demography

The total population of the country is 3,550,852 people with density 124 people/km^2. 57.3 % of the population is rural (2,034,039 in 2017). Distribution of population by sex is arranged as 48.1 % of men and 51.9 % of women (NBS, 2017). According to The NBS (2016) the economically active population of Moldova amounted to about 1,337,000 of people. The level of active population aged from 15 years old and older was 44.8 %, registering higher values in men (47.8 %) than women (42.1 %) and in urban areas (45.1 %) compared to rural areas (44.5 %). The highest level of activity (66.4 %) was in the age group from age 45 to 49 years old. According to the national definition, rural poverty rate was 11 % age points higher than urban in 2015. The poverty rate was 14.5 % in the countryside, decreasing almost by 2 % over the previous year. In urban areas the poverty rate decreased up to 3.1 %, which is 1.9 % less than in 2014 (IMF 2017).

The official language in Moldova is Romanian (80.2 %). With 56.7 % of people identify their mother tongue as Moldovan, which is virtually the same as Romanian, 23.5 % determine Romanian as their mother tongue and 9.7 % Russian (Central Intelligence Agency 2013).

1.2.1.3. Economic performance

The Republic of Moldova is a small lower-middle-income economy which depends on emigrants' remittances and agriculture, especially cultivation of fruits, vegetables and tobacco (Heritage Foundation 2018). Moldova's development potential is linked to its trade and investment integration strategy. Moldova is situated between two large markets: the European Union (EU), which absorbs more than half of Moldova's exports, and the Russian Federation (Varela GJ, Piontkivsky R 2015). The Gross Domestic Product in Moldova was worth 6.75 billion US dollars in 2016 (World Bank 2016) that ranked it 40th among 44 countries in the European region (Heritage Foundation 2018). The World Bank (2017) provides data of GDP per capita for Moldova from 1995 to 2016. The minimum value during that period amounted 321 US dollars in 1999, and the maximum amount of 2245 US dollars in 2014. After the collapse of the USSR, Moldova experienced one of the sharpest economic and social slowdowns in its history with the worst terms of trade of all post-Soviet countries and deterioration by

40-50 % (Solonari 2003). Two decades of steep economic downfall and decline in the living conditions have instigated a massive out-migration of the Moldovan population in search of job opportunities and sources of income (International Organization for Migration 2012). According to destination countries' statistics of NBS (2016), a number between 390,000 and 615,000 Moldovan migrants resided abroad in years around 2012. Poorest households are the most vulnerable groups of population of Moldova. Poverty in this country still tent to be mainly a rural issue: 28.1 % compared to 9.9 % for urban areas (UNDP 2011).

1.2.2. Agriculture and climate profile of the Republic of Moldova

Agricultural production and land use of agricultural households

Agriculture is extremely important for rural livelihoods in Moldova, with more than 29 % of the population employed in the sector (World Bank 2017) and 14,3 % of the country's GDP derived from agriculture (World Bank 2016). According to The Moldovan Investment and Export Promotion Organization (2016) total agricultural lands cover 2,480,000 hectares, what is 75 % of the country's territory. With 1,820,000 hectares are arable land and perennial plantations spread on 300,000 hectares. According to World Bank (2016) in Moldova large majority farm households (86 %) focus on subsistence production, and less than 9 % of farmers sell on the markets over half of their output. The results of General Agricultural Census (2011) show that the largest percentage of farm holdings was in the smallest land size groups. About 71 % of the agricultural holdings had less than 1 hectare and the area operated by them represented 10.1 % of the total utilized agricultural area. Holdings having between 1 to 5 hectares (27 % of the total holdings) operated 19.3 % of the total utilized agricultural area and only 0.3 % of the largest holdings (with at least 100 hectares) utilized 63.4 % of the total agricultural area.

According to Moroz et al. (2014) small-scale farmers have a significant share in total agricultural production. They deliver essential quantities of agricultural products together with population households. A significant part of the production of maize, potatoes, fruits, vegetables and grapes are concentrated in the community of small-scale farmers that supply mostly to the local market. Recently, in Moldova has been formed a poorly diversified structure of sown areas. Cereals and technical crops occupy about 90 % of the sown area cultivated by large-scale agricultural farms.

Fruit and vegetables sector

Fruit-growing sector represents one of the main strategic branches of the national economy, accounting for around 40 % of the agricultural production value. The area under fruit plantations in 2014 counted 122,000 hectares. Regarding production of vegetables, the annual yield totals, on average, around 500,000 tons. Vegetables are exported into 23 countries of the world (MIEPO 2016). The most important products in terms of export volumes and values are apples, table grapes, cherries, plums and walnuts (DMBC 2013). In drying industry sector depending on the growing conditions, from 2013 to 2016 were produced between 2,000 – 3,500 tons of dried fruits per year: mostly plums, apples, sweet and sour cherries, apricots, pears and some vegetables. Most of the dried fruit exports are destined for the markets of western side, such as Germany, Poland, Slovakia, Latvia, Lithuania, and the Czech Republic (MIEPO 2016).

1.2.2.1. Vulnerability profile of agriculture and impact of climate change on the agricultural sector

Many agricultural producers placed in low income and less developed countries are usually operating below their potential production capacity. As noted by the FAO (2007) the developing countries already strive with chronic food problems. Estimates suggest that this situation could worsen: around 11 % of arable land in developing countries could be affected by climate change, including a decrease of cereal production in up to 65 countries, and in some cases loss of up to 16 % of GDP (Keane et al. 2009).

Agriculture is a highly climate sensitive sector in Moldova, and thus, much of Moldova’s rural population and livelihoods are vulnerable to climate change. Historical data indicate that Moldova is exposed to a highly variable climate that has already experienced an increase in mean temperature, moisture deficits and extreme events, such as droughts, floods and frosts (World Bank 2010).

Exposure to draughts in Moldova

One of the significant problems that Moldovan people face in the field of agricultural production is drought. Since the 1980s this natural event increased in intensity and persistence compared to the past, mostly due to decreased precipitation and increased temperatures in the region. Especially the south of Moldova is vulnerable to droughts (Potopová et al. 2016). For the period spanning from 2000 to 2012 the Republic of Moldova has already experienced four years (2000, 2003, 2007, and 2012) with the devastating droughts (see Table 1).

Table 1. Impact area, duration and economical losses from droughts, 2000-2012 (Republic of Moldova)

Droughts of year	Affected area, %	Duration, season	Economic losses	
			Million Moldavian Lei (MDL)	Million $ USA
2000	75	spring-autumn	2098,1	169,7
2003*	86	summer-autumn	-	-
2007	78	summer-autumn	11970,0	987,0
2012	80	summer-autumn	2500,0	200,5

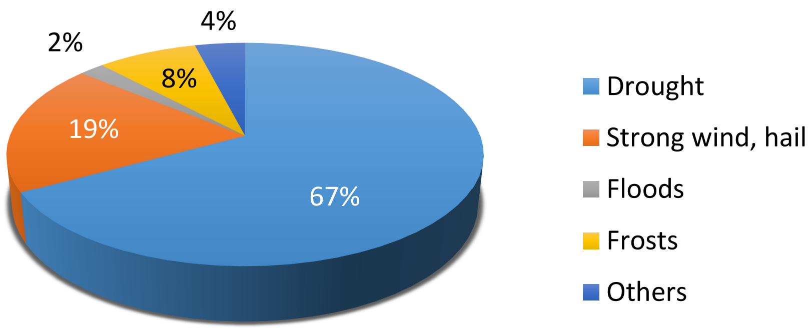
* No data

(Source: Cazac & Daradur 2013; UNDP 2012)

The frequency of recent droughts is uncertain because many values of meteorological indicators as temperature, precipitation and soil moisture were above average in the climate history of Moldova (State Hydrometeorological Service 2012). Some experts consider that the recurrence time of the devastating drought has become shorter during recent years and climate change is likely to increase risk of extreme drought in Moldova (Daradur et al. 2015). Droughts have a broad range of impacts across all sectors of development in the Republic of Moldova. In some years drought impact measures the scales of a nationwide socioeconomic and environmental catastrophe. As in year 2007, the estimated losses caused by drought reached 23 % of the gross domestic product of Moldova (UNDP 2012). The extreme droughts in 2007 and 2012 strongly reduced agricultural production of winter wheat by 50 and 38 %, production of maize dropped by 67 and 46 %, of sugar beet by 23 and 23%, of sunflower by 54 and 27 %, respectively (Potopová et al. 2016).

Socio-economic and natural subsystems of the Republic of Moldova are highly vulnerable to drought owing to the high level physical exposure to water related extreme climate events, the same as unsuitable capacity to reduce risks. Amounting to 13 % of the total number of natural hazards, droughts make up 67 % of the economic losses from climate and weather related risks (see Figure 1).

Figure 1. Attribution (%) of the economic losses to climate and weather related hazards (Republic of Moldova 1998-2005)



(Source: Cazac & Daradur 2013; UNDP 2012)

In the catastrophic drought in 2007, 80 % of the rural population depending on agricultural sector and 90 % of the country's territory was affected by the declined harvest. According to official estimates, the income and savings of the rural population were lost and total losses accounted to one billion of USD. Output of cereal crops declined by 70 % compared to 2006, and the wheat yields reduced by 10 %. Due to the lack of fodder, majority of households were not able to maintain their livestock. Bovine livestock reduced by one quarter, pigs declined by almost half, and goats with sheep by 10 %, the number of poultry reduced by 25 % (UNDP 2009).

1.2.3. Information-based approaches to addressing risk and vulnerability in agriculture

The incidence of natural disasters is increasing, and climate change is expected to further increase their frequency and harmfulness. Poor farmers will be the hardest hit, because they oftener live in risk located areas, their livelihoods are dependent on natural resources, and they have less capacity to protect themselves. It is vital that impacts are reduced before these extreme climate events occur, rather than responding after disasters have caused widespread depletion (UNDP 2012). In this regard, the role of ICTs is truly significant in responding to challenges in the agricultural sector as: disaster risk management, food security and nutrition, and climate change adaptation issues (FAO 2015).

ICTs and extension services

Information and Communications Technology is an umbrella term that includes computer software and hardware: digital broadcast and telecommunication technologies as well as electronic information storage. It represents a broad and continually evolving range of elements that includes television (TV), radio, mobile phones, and the further policies and laws that govern all these devices and media. The term of ICTs is often used in plural sense to mean a wide range of technologies instead of a single technology (Shaik et al. 2012). ICT has great potential and its potential could be used in fighting the problems of environment and climate change. It has untapped potential in this field (Mohammad et al. 2005).

ICT has already been used in various countries and in various forms ranging from reduction the emissions to developing a data base of occurring changes. It is being used in satellite communication to provide weather forecast, terrestrial systems that are also used for dissemination of information concerning different natural and man-made disasters (early warning) (Upadhyay & Bijalwan 2015).

Market information in developing countries

Access to recent and updated market information in developing countries is low and insufficient. A number of factors have been qualified to this failure including high illiteracy level, high cost in terms of time and needed resources, lack of regular reliable information, isolation from the necessary infrastructure and an enabling policy environment. ICTs have emerged as an instrument to bridge the information division between the rural farmers and the global community (Mawazo 2015). The utilization of such tools as mobile phones and the Internet can contribute to community based environmental monitoring, while ICTs capacity building can increase local empowerment and the ability of self-organisation in response to external climatic shocks (Shaik et al. 2012). There are a number of initiatives to connect small-scale agricultural producers to markets and marketing information. Although there are a number of applications providing this service in sub-Saharan Africa, Esoko and NAFIS are two well-known and successful ones and are discribed below (Mawazo 2015).

Esoko Company has established call centres in Ghana where farmers call and get rich detailed advisory agricultural advice. Esoko provides an internet communication platform to enable farmers to obtain market information and trade using mobile phones and websites. It focuses on agricultural value chains in order to get better the transparency of markets and the operational effectiveness of organisations. It collects and provides content such as prices, bids and offers, agricultural and weather advices to which users can subscribe (Esoko 2018).

Using push technology, the Collecting and Exchange of Local Agricultural Content (CELAC) project in Uganda contains a database of agricultural producers in 15 districts to whom it on a regular basis distributes agricultural information via SMS, phone calls and phone conferencing (CELAC 2018).

The Kenya's National Farmers Information Service (NAFIS) serves farmers' needs throughout the country as well as the rural areas where internet access is limited. It enables farmers obtain important extension information by either browsing its website or through access of summarised voice-based service information via mobile phone (NAFIC 2017).

The mobile application iCow Soko in Kenya, allows subscribed livestock farmers to get text messages about the breeding, nutrition, milk production efficiency and other relevant dairy practices through regular SMS messages (ICOW 2017).

1.2.3.1. The role of Agricultural Market Information Services and their application around warning farmers about potential weather changes

Agricultural market information services are a set of integrated and coordinated tools and processes to collect and deliver agricultural market information and services to farmers, traders, food processors, government functionaries and other stakeholders that may benefit from obtained market data (Zoltner & Steffen 2013). The stakeholders of agricultural sector of developing countries are in need of AMIS. Access to marketing information and agricultural markets are essential factors in promoting competitive markets and strengthening development of agricultural sector. The field of agriculture employs majorities in developing countries and it strongly contributes to the development of these areas. Unluckily, majorities of agricultural producers are small-scale holders living in isolated rural areas and thus having lack appropriate access to markets for their production and besides they are denuded of agricultural market information (Magesa et al. 2014). In addition, farmers also need easy access to information about the weather in their localities to make right decisions about when to plant, fertilise, irrigate or harvest their agricultural crops. The better the information they have about temperatures, rainfall or storms, for example, the better placed they are to take advantages of favourable conditions or reduce damages from extreame weather (CTA 2017). For developing countries, creation of WFS to produce reliable forecasts often does not appear as a priority. Such services more often are seen as a luxury product, rather than a necessity, in low income countries (Hallegatte 2012).

To this day, many developing countries have not benefited as much as they could have from the progress in EWS, and significant gaps still remain. A key challenge has been in reaching the most vulnerable and remote population with timely, accurate, objective and actionable warning information. Further, despite the progress in EWS, the world has seen an increasing trend of losses from the impact of extreme natural hazards such as storms in the United States, Myanmar and Philippines; floods in Europe, Africa, and South and Southeast Asia; heat waves in Europe and West Asia; droughts in Africa; and the most powerful tsunamis in the Indian Ocean and the Northwest Pacific Ocean (UNISDR 2015).

1.2.4. Agricultural Market Information Services in the Republic of Moldova

In the Republic of Moldova Agricultural Market Information System (AMIS) was established as a part of the Czech Republic Development Cooperation Project in years 2006-2009 by the Faculty of Tropical AgriSciences and covered by Czech University of Life Sciences, Prague. Project "Support to Rural Development - Increasing Qualifications of Management and Advisory Capacities" was implemented with close cooperation with Moldavian partner organization situated in Chisinau called National Agency for Rural Development (ACSA-NGO) (FTA 2018).

ACSA is a non-governmental, non-profit and non-political organization that carries out its activities throughout the entire territory of the Republic of Moldova. In years 2001-2012 ACSA was a branch of the Rural Investments and Services Project which was financed by the Government of Moldova and World Bank. The mission of the Agency is sustainable development of rural communities through setting up and developing a professional network of information, consultancy and training service providers for agricultural producers and rural entrepreneurs. ACSA-NGO ensures the access of rural population to knowledge, experience and abilities related to a wide range of fields oriented to economical development of villages from the Republic of Moldova (ACSA 2017).

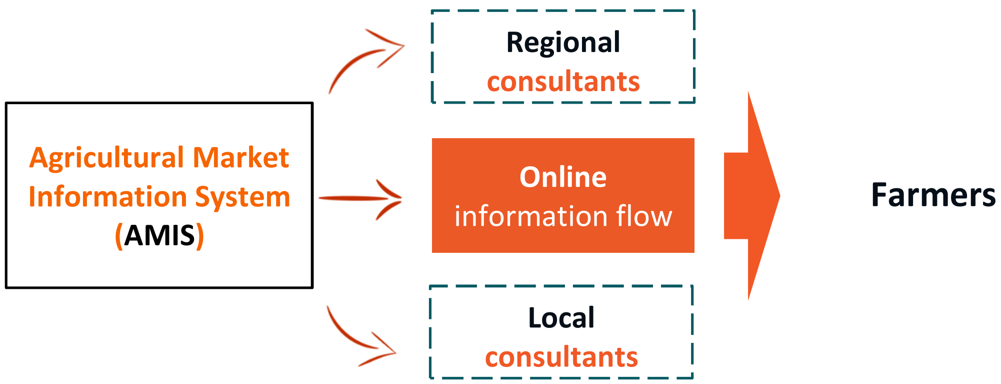
The network of rural advisory Agency ACSA-NGO covers all regions of Moldova. ACSA organize a network of 35 teams of service providers and in total 425 consultants supply their consulting services, out of which 350 local and 75 regional consultants (Figure 2 shows the location of centres). The consultancy, information and training services are available to cover 60% of rural population. Offices of service providers and local consultants are located in the premises of local authorities (ACSA 2017). Each of the regional team of consultants specialized in various fields of agricultural and rural development, including: fruit production, grape growing, vegetable production, animal breeding, plant protection, agricultural economics, rural entrepreneurship and development, agrotourism, disaster risk management, agricultural marketing, agricultural laws and ecology.

Figure 2. Location of regional and local centres of ACSA consultants

Source: ACSA 2017

The process of professional development and improvement of practical abilities of ACSA consultants and its clients is a continuous one. The training programs are organized at national, regional as well as community level involving as trainers ACSA consultants outsources national consultants and foreign experts. The goal of these programs is to improve the professional consultancy capacities assuring a high quality of consultative services provided by ACSA network (ACSA 2017). AMIS in Moldova was created as a system of modules with many connections cooperating also with outside terminals. It is directly proposed to gather information from diverse sources and keeping data in its database and process information for users. Basic idea was to create a simple and consistent information system that will be accessible to the general community anywhere in Moldova with the development potential in the future. Establishment of program for database of agricultural food products and producers was necessary requirement for design of database itself (FTA 2018). Fully-featured agricultural marketing information system was connected online and presented at official AMIS website under the National Agency for Rural Development (ACSA) web page (FTA 2018). The AMIS was established and put into operation on the market of consultancy (Figure 3 shows AMIS online information flow). It should allow answering the next questions of its potential user: what – product, where – market, how much – price and how – marketing. Primarily it was composed of three modules and linkages among them: *Product database*, *Producers database* and *Market Research database* (provides data about maximum and minimum prices of agricultural products from 6 major agricultural regional markets) (Kandakov & Havrland 2012).

Figure 3. AMIS online information flow



Source: Kandakov 2012

In 2010 two additional information modules were developed to reduce the risk accociated with climate conditions and dynamics of crop diseases and pests: "*Weather Alerts (Forecasts) Information Module*" and "*Diseases and Pests Information Module*" (Figure 4). Risk prevention platform, which is administrated by ACSA-NGO,provides a list of services and information distribution about: natural hazards and danger alerts, natural geological threats alerts, alerts about biological threats, daily agro-meteorological conditions and forecast of potential negative impacts (ACSA 2017).

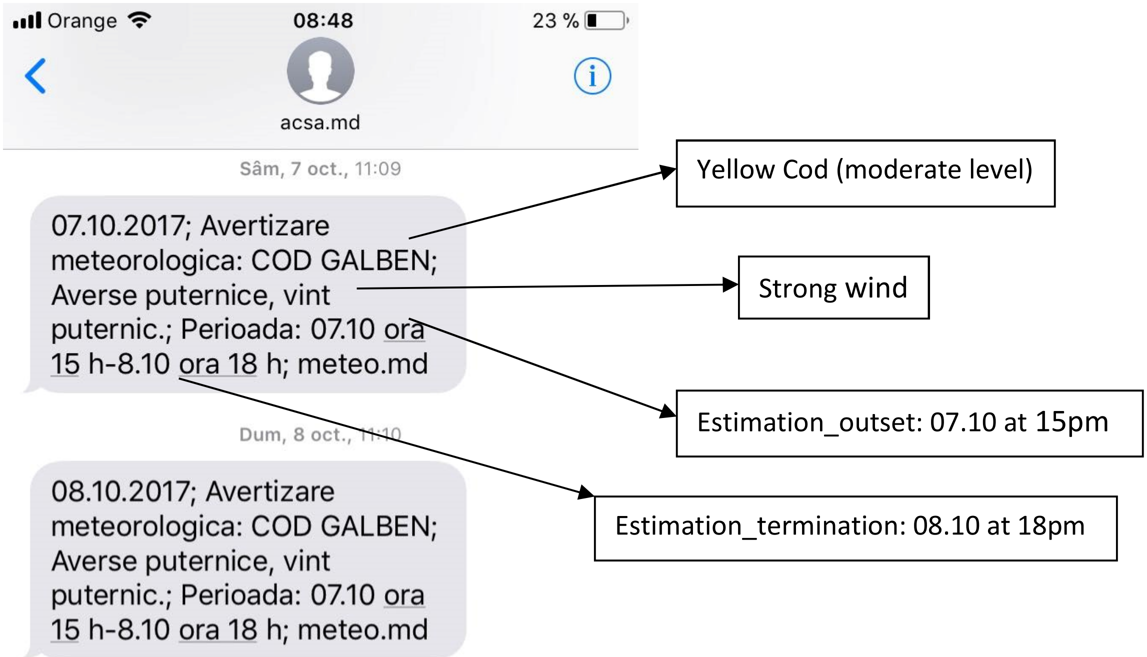
Figure 4. Final AMIS information system with five complete information modules

Source: ACSA 2017

To obtain the necessary weather data about upcoming conditions, agricultural producers have a possibility to subscribe for this information on a scheduled basis. Weather forecasts subscription is going through simple technologycal innovations such as: Email and SMS notifications. Depending on the level of threats these notifications conveniently classified into three colors: "green", "yellow" and "red" that means: safe hazard level, moderate hazard level and dangerous hazard level, respectively (Figure 5).

Getting of WFS through Email-based messages is a free of charge service for all interested subscribers (mainly for local agricultural producers), whereas SMS-based notifications is a payable subscription for users and costs 240 MLD per one year or 20 MLD per one month. WFS for SMS-users work with connection of abonents of three Moldovan mobile phone providers: Orange Moldova, Moldcell and Moldtelecom (ACSA 2017).

Figure 5. Example of SMS Weather alerts



Source: Author 2017

2. Objectives of the Thesis

2.1. Main objective

The main objective of the thesis was to analyze factors and constraints influencing farmers’ decision to use the internal Weather Forecasts Information Module of the Moldovan Agricultural Marketing Information System (AMIS).

2.2. Specific objectives

The main aim of the thesis was accomplished through more specific objectives:

1. To analyze factors likely to influence farmers’ decision to utilize Weather Forecast Services;
2. To assess the usefulness and constraints of Weather Forecast Information Module utilization;
3. To describe the existing sources of agricultural information and their usage preferences by local farmers.

3. Methods

3.1. Data sources

This thesis was based on two types of data collection through secondary and primary data sources. Secondary data sources facilitated to better understanding of the issue before the survey in the determined field. During the primary data collection was represented new data.

3.1.1. Secondary data sources

The main types of sources were available scientific journals such as: International Journal of Information and Communication Technology Research, International Journal of Climatology, Journal of Development Studies, Journal of Economics and Sustainable Development. Therefore, secondary data sources include research projects, overviews, reports and statistic databases of World Bank, IMF, UNDP and National Bureau Statistics of the Republic of Moldova. Searching of relevant data sources was mainly conducted through scientific databases as Web of Science, ScienceDirect, EBSCO, and Google Scholar. Important data was also obtained through the official website of ACSA NGO. To find necessary data sources was used keyword research tool.

3.1.2. Primary data sources

Several data collection methods were used for obtaining more precise information. Structured questionnaires as well as interviews with local farmers and ACSA NGO experts were utilized as methods of primary data collection and resulted in a better understanding of the subject. In addition, to get information from specific target group of SMS-users of WFS was used a web-based method through online structured questionnaires. Online survey system called "Survio" was applied for preparation of questionnaires, their distribution and analysis of results. In the Appendix 4 photo-documentation from questionnaire investigation is included.

Structured questionnaire

The main tool for collection of primary data was chosen structured questionnaire. It was accounted as the most appropriate research instrument for data collection due to short period of time allowed for gathering information from target groups, and high number of respondents.

Questionnaire was elaborated in Russian language and included 20 questions of various forms: single response with nominal categories, multiple choice responses and scaled questions (see Appendix 3). It contained sections about:

(i) **Basic characteristics of respondents:** gender, age, family status, level of completed education, region and household composition.

(ii) **Agricultiral indicators**: total area of cultivated land, average monthly income from farming, type of irrigation system, utilization of fertilizers/agricultural equipment, access to a loan and quantity/price of cultivated crops.

(iii) **Sources of farmers' information needs**: access to agricultural information, types of used sources.

(iv) **Natural disaster matters:** type of experienced natural phenomenon,subjection to crop loss.

(v) **WFS utilization (only for WFS subscribers)**: source of awareness about service, source/duration/frequency of utilization, rating of usefulness of weather alerts and its main constraints.

Pilot testing

After composition of questionnaire draft, it was possible to apply pilot testing. During the first days in Moldova, pilot testing was carried out with 5 local consultants from ACSA in the Chisinau municipality. Questionnaires were examined on feasibility of questions which were intended to be used in the following survey. Consequently, small modification of questionnaire was conducted and final composition of questionnaire was modeled.

Observations

Formal observations were done in the Anenii Noi district of Moloda and Chisinau municipality. Information received from the observation of the surroundings of the survey participants, allowed me to design a more complete picture of their living as well as more realistic insight about natural environment in general.

3.2. Description of study area

Firstly, the web-based research through online structured questionnaire was conducted and responses from target group of **SMS-subscribers** were obtained in July 2017. The location of respondents varied throughout most of Moldova territory. However, the highest concentration of respondents was focused mainly in two areas of country: north-central and south-central parts of Moldova (see Figure 6). Farmers subscribed for WFS via SMS were situated in fourteen different districts as: Anenii Noi district, Calarasi district, Causeni district, Criuleni district, Donduseni district, Drochia district, Floresti district, Gagauzia autonomous, Laloveni district, Leova district, Orhei district, Rezina district, Singerei district and Telenesti district.

My field survey took place in three specific districts: Singerei district, Telenesti district and Anenii Noi district (see Figure 7). It should be noted that several previous studies and projects of FTA CULS were also carried out in these areas and several theses of FTA students were conducted there. Each of these districts is situated in the different part of the country. For the purpose of my research in total six specific communes were chosen.

To reach the respondents of my target group of **Email-subscribers** were visited three communes: *Dobrogea Veche commune* in Singerei district, *Cazanesti commune* in Telenesti district and *Puhaceni commune* in Anenii Noi district. To obtain information from my target group of **Non-subscribers** of WFS, I visited three other communes located in above mentioned districts: *Cotova commune* in Singerei district, *Brinzenii commune* in Telenesti district and *Speia commune* in Anenii Noi district. Position of visited communes within each district was not far away from each other.

Singerei district

Singerei district is located in the north-central part of the Republic of Moldova, at a distance of 114 km from Chisinau municipality and 25 km away from the municipality of Balti. The relief of this district is predominantly hilly steppe plain with a maximum altitude of 350 meters reaching by the hills Ciulucuriolor. The east side is bordered by the Dniester River. The space occupied by surface waters constitute 3265 hectares and represent 3.2 % of the district surface area. District has two cities (Singerei and Victory), 70 villages that are administratively divided into 26 municipalities. Total population in 2014 was 79,814 persons (Consiliul Raional Singerei 2014).

Singerei district is characterized by a temperate continental climate with a short, mild winters (average January temperature is -3 to 5 ºC) and long, hot summers with relatively small amount of precipitation. The annual quantity of rainfalls varies in the range of 450-550 mm. The annual amount of precipitation is about 65-70 % fall during the warm season (from April to November) and only 30 % during winter (from December to March) in the form of snow and sleet. The first snow appears at the end of November and early December. Droughts start in July and last during 2-3 months. Dry winds are common occurrences for this area. Agro climatic conditions are favorable for cultivation and growth of crops, plantations, orchards and vineyards (Consiliul Raional Singerei 2014).

Telenesti district

Telenesti district is located in the north-western edge of the central part of Moldova, 90 km to the north from Chisinau municipality. The total area of Telenesti district is 850 km^2 covered by hills, woods and slopes. District has administrative centre Telenesti town, 23 villages and 30 localities in the frame of communes. Total population in year 2017 was 71,900 residents from which 58,800 were living in rural areas (NBS 2017).

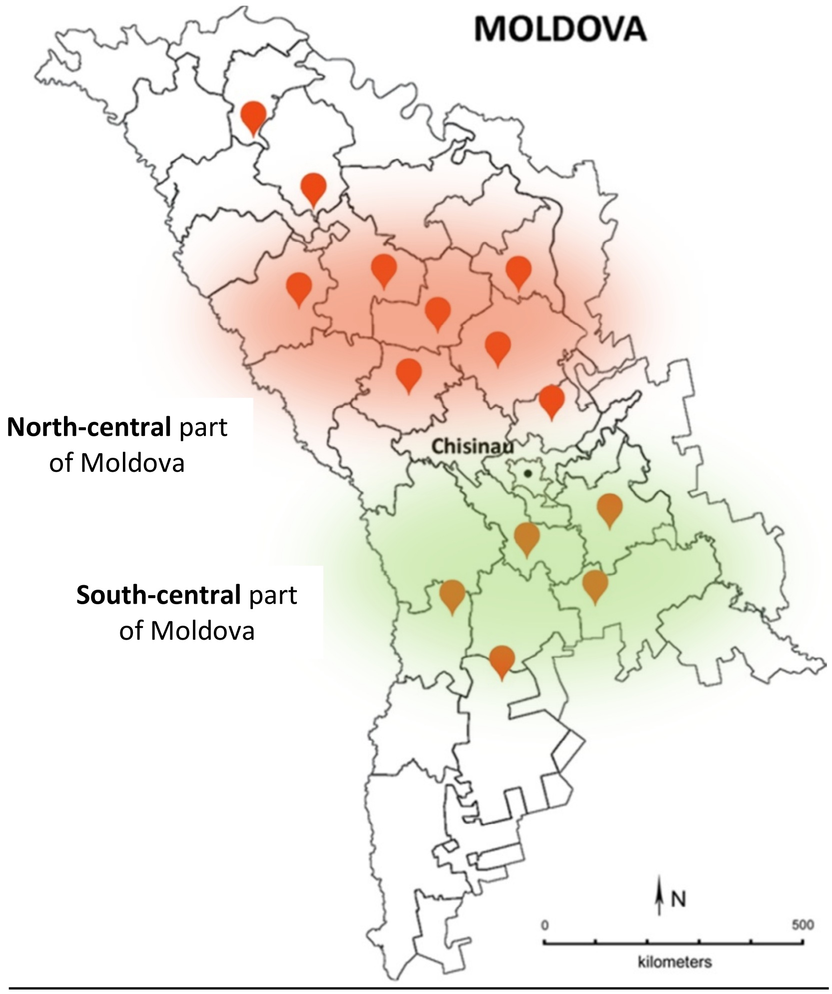
Telenestii district is characterized by a temperate continental climate with short mild winters. The key economy sector of this region is agriculture (Council District Telenesti 2017). According to National Bureau of Statistics (2016) in 2016 there were 16,840 hectares of sawn area: 5,765 hectares for industrial crops, 637 hectares for forage crops and 240 hectares for potatoes, vegetables and water melons. The hydrographic network is comprised of the Raut River (35 km) and the Ciuluc River (19 km). District includes 99 water basins with the total area of 1351 hectares. Water basins fulfill functions of irrigation and recreation for local households (Council District Telenesti 2017).

Anenii Noi district

Anenii Noi district consists of 5 municipalities, 25 villages and 14 localities in the frame of communes. The district administrative center is Anenii Noi town. The total population of district is 83,419 residents from which 89.4 % (74,578 residents) are living in rural area (NBS 2016).

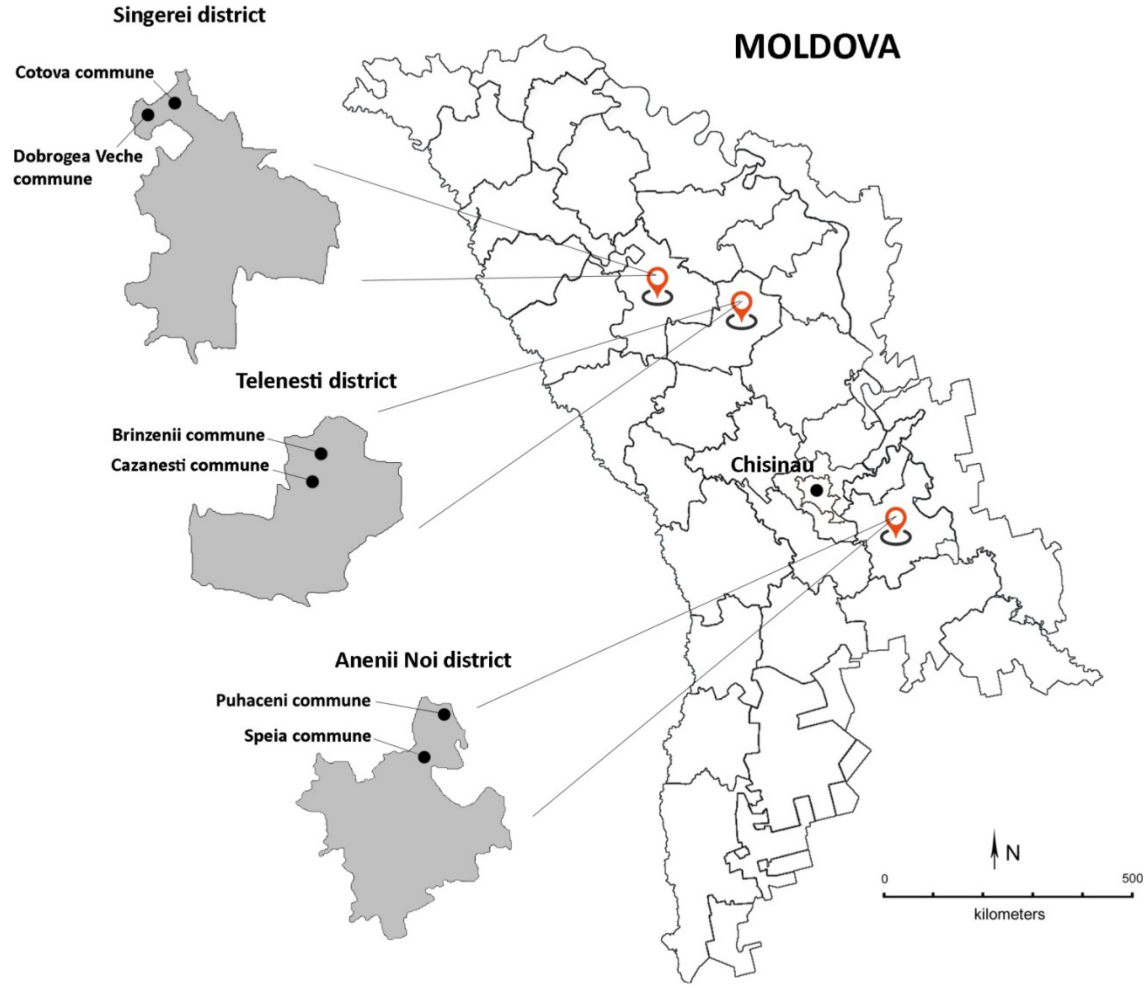
Anenii Noi district has a total area of 888 km^2 with the landscape of highly rugged valleys, hills and ravines with steep slopes. Erosion and landslide processes led to the formation of the cavities between the hills. Many rural settlements are located in these landforms. The eastern part of the district located in the floodplain of the river Nistru and has a less fragmented flat terrain. The district territory is crossed by dozens of rivers and streams. Some of them dry up in the warm time of year. Croplands occupy 55 % of the total area, perennial plants of 10.4 %, pasture land of 8.8 %, forest vegetation of 13.7 % and other unproductive land of 12.1 % (Anenii Noi district Official Website 2016).

Figure 6. Location of target group of WFS SMS-subscribers



Source: Author 2018

Figure 7. Selected communes in Singerei district, Telenesti district and Anenii Noi district



Source: Author 2018

3.3. Target groups

Online survey was conducted with target group of respondents subscribed for WFS through SMS notifications. In total 46 SMS-users of WFS were emailed with request for participation in online survey and response from 34 respondents was received. Contact information about this particular target group was obtained from internal database of ACSA NGO.

SMS-subscribers were selected based on the following criteria:

(i) To have Moldovan citizenship.

(ii) To be agricultural producer and grow crops (vegetables, fruits, cereals etc.) mainly in the open space.

(iii) To live in rural district.

(iv) To speak Romanian or Russian language.

My second target group of respondents subscribed for WFS through Email notification was selected based on *purposeful non-random sampling*. This sampling method focuses on particular characteristics of a population that are of interest (Laerd dissertation 2012). In case of this research on respondents who utilize WFS through Email messages. Contact information about this target group was also obtained from internal database of ACSA NGO and respondents were visited with participation of local ACSA consultants. In total 49 Email-users were interviewed: 16 respondents in Dobrogea Veche commune, 13 respondents in Cazanesti commune and 20 respondents in Puhaceni commune.

The third target group was respondents Non-utilized WFS. *Non-random convenience method* was applied for data collection. This specific type of non-probability sampling method relies on data collection from population members who are conveniently available to participate in study (Saunders et al. 2012). In total 48 Non-users were interviewed: 14 respondents from Cotova commune, 14 respondents in Brinzenii commune and 20 respondents in Speia commune.

Email-subscribers and Non-subscribers were selected based on the following criteria:

(i) To have Moldovan citizenship.

(ii) To be agricultural producer and grow crops (vegetables, fruits, cereals etc.) mainly in the open space.

(iii) To reside within 3 selected rural areas.

(iv) To speak Romanian or Russian language.

The total number of interviewed participants was 131. Descriptive statistics of target groups divided by source of WFS notification is represented in the Appendix 1.

3.4. Timeframe

Total time for the whole research writing (from intensive reading for literature review till final thesis submission) lasted from March 2017 to April 2018. Duration of the main phases of this thesis is shown in Table 2. The first phase was the theoretical preparation phase when the objectives and methods of the research were determined. The second phase was the data collection process completed primarily by getting feedback from online survey and then directly data collection in the target area of the Republic of Moldova. The third phase included data processing and coding, data analysis in econometric Software Stata 15 and data interpretation.

Table 2. Diploma thesis timeframe

	March 2017-June 2017	July 2017-September 2017	October 2017-January 2018	February 2018 – April 2018
Analysis of secondary data				
Formulation of objectives				
Formulation of methods				
Questionnaire design				
Online survey				
Pilot testing				
Data collection in Moldova				
Data processing and coding				
Data analysis				
Data interpretation				

Source: Author 2018

3.5. Data analysis

The primary data was subjected to three types of analyses. For the first specific objective of my study, farmers' decision to utilize Weather Forecast Services (WFS) was modelled as a binary choice (farmers could either to subscribe to ACSA Weather Forecast Services or otherwise). As a consequence, I estimated a Binary probit model. The motivation and derivation to use the Binary probit model was expounded in several econometric textbooks (Long & Freese 2014; Greene 2012; Cameron & Trivedi 2010). For the second specific objective, to assess the usefulness and constraints of Weather Forecast Information Module utilization, the Pearson's Chi-square two sample test was applied (Mamahlodi 2013). In addition, the T-test was used to determine whether the differences between SMS-subscribers and Email-subscribers of Weather Forecast Services were statistically significant. To achieve the third specific objective, I used descriptive statistics to analyse the existing sources of agricultural information and their usage preferences by local farmers.

3.5.1. Chi-square test and T-test

A two sample Chi-square test was used to compare the differences in perceptions of the farmers based on their source of getting Weather Forecasting information: through SMS or Email-based notifications. The perception about level of usefulness of WFIS was measured on a 4-point Likert scale: not useful at all, not useful, useful, and very useful. The Pearson Chi-square test was a suitable method for Likert scale social data. The main constraints to the use of WFS from farmers' perspectives depended on the fallacy of alerts, complex text messages, high service price (Etwire 2017) and lack of information on the adoption of protective measures. Additionally, to compare mean differences between SMS-users and Email-users of WFS was applyed a T-test for the continuous variables and Chi-square test for binary or ordered variables.

3.5.2. Binary probit model

The probit model is a statistical probability model with two categories in the dependent variable (Liao 1994). Probit analysis is based on the standard normal probability distribution. The binary dependent variable, takes on the values of zero and one (Aldrich & Nelson 1984). The probit analysis provides statistically significant findings of which performance increase or decrease the probability of adoption (Uzunoz & Akcay 2012).

Binary probit model was used by this study to analyze the factors that influence farmers' decision to subscribe for Weather Forecasting alerts provided by ACSA. Farmers' subscription was captured as a dummy variable with the value 1 assigned to a farmers who utilized Weather Forecast Services, while farmers non-utilized this services was taken as 0.

According to Greene (2003), the binary probit for the two choice models can be written as:

$$Y_i^* = \begin{cases} 1 if Y_i^* > 0 \\ 0 if Y_i^* \leq 0 \end{cases}$$

Assuming a normal distribution of errors and following from Greene (2003), the probability of a farmers' subscription to weather alerts was given by the following equation:

$$\Pr(Y = 1) = \int_{-\infty}^{\beta' x} \oint (t) dt = \Phi(\beta x)$$

Where $\oint$ is a standard normal distribution, (Y = 1) implies that a farmer was subscribed for Weather Forecast Services and x represented the exogenous variables likely to have an influence on farmers services' utilization. In addition to estimation of probabilities, this study also estimated the marginal effects which were actually used for the discussion of the results. Marginal effects tell us how will the outcome variable change when an explanatory variable changes. The marginal effects were more informative and easy to understand and explain. Following from Nyaupane and Gillespie (2011), the marginal effects for dummy variables was estimated using following equation:

$$\Pr[Y = 1|\bar{x}., d = 1] - \Pr[Y = 1|\bar{x}., d = 0]$$

Where $\bar{x}.$ represented the mean values of all continuous variables. Empirically, the model for estimating the determinants of farmers' decision to utilize WFS was specified as:

$$Y = \beta_0 + \sum_{i=1}^{9} \beta_i x_i$$

Where β_0 was the constant term or intercept and β_i represented the parameters to be estimated. The marginal effects provided insights into how the explanatory variables shift the probability of frequency of WFS utilization. Using the econometric software STATA 15, marginal effects were calculated for each exogenous variable while holding other variables constant at their sample mean values (Uzunoz & Akcay 2012).

3.5.2.1. Description of Explanatory Variables

Exogenous variables expected to influence farmers' decision to utilize WFS provided by ACSA were presented in Table 3. These variables included farm and socio-economic characteristics of respondents, in particular: gender and age of farmers, educational level, farm land size, income from farming and experienced hail in the last three years. Each variable was briefly described below. It included the theoretical justification for its inclusion in the model.

Age: It is a continuous variable defined as the age of the farm household head at the time of data collection measured in years. According to Mittal and Mehar (2015) older farmers are less reliant on information, and therefore do not get in touch with communication innovations as early as their younger colleagues. Therefore, in this study it was assumed that young farmers are more likely to subscribe for WFS than elders.

Gender: It is a dummy variable taking the value of 1 for male-headed household and 0 if otherwise. Gender of the farmer was included to differentiate between male and female farmers in their participation in making a choice to subscribe for WFS. Gender has an effect on access to information from different sources. It influences the information seeking behaviour and ability to make decisions (Zendera 2011).

Education: Higher educational grounding of the household head and any other member of the household with the highest education increase the knowledge base about climate change and related adaptation (Komba & Muchapondwa 2012). Zendera (2011) has also reported that level of aducation has an influence on the interpretation and understanding of climatic data and application of this information in decision-making.

Land size: It is a continuous variable measured as the number of hectare (ha) of land of the farm. Farm size was a proxy for farmers' economic status and was positively associated with the probability of using modern techniques and multiple sources of new information (Mittal & Mehar 2015).

Income: The study results of Oyekale (2015) showed that farmers with production surpluses that brought some income for their households had higher probabilities of accessing forecasts on weather changes and incidence of diseases and pests. This was expected since farming was among the occupations that were most vulnerable to vagaries of weather (Hess 2002).

Hail: It is a dummy variable taking the value of 1 for farmers, experienced natural event in the form of hail during the period of 2015-2017 and 0 if otherwise. Researches from Nigeria Iheke & Agodike (2016) stated that it has been noted worldwide that farmers have already experienced an increase in the frequency and severity of floods, droughts, and other extreme weather events, and they have shown that adoption of technological forecasting can reduce losses from these extreme events (particularly short duration events such as flash flooding).

Table 3. Variables included in the Binary probit model estimation

Variables	Definition	Type of variable
	Dependent variable	
Weather Forecasts Services	Decision of farmers to utilize Weather Forecast Services	Binary variable (1 = yes; 0 = no)
	Independent variables	
Gender of farmer	Gender of respondent	Binary variable (1 = male; 0 = female)
Age of farmer	Age of respondent	Continuous variable
Education	Level of finished educational attainment	Binary variable (1 = university; 0 = secondary)
Income	Average monthly income from farming household in MDL	Continuous variable
Land size	Number of cultivated area in hectares	Continuous variable
Hail	Experienced hail in last three years (2015-2017)	Binary variable (yes = 1; 0 = no)

Source: Author 2018

4. Results

4.1. Descriptive statistics results

Demographic indicators

The results on the demographic characteristics of farmers in the study area were presented in Table 4. They showed that a total of 64.1 % of the respondents were males, whereas 35.9 % were females. Majority (57.2 %) of the farmers were in the age range between 40 and 59 years old while 28.3 % were between the ages of 20 – 39 years. Only 14.5 % of the Moldovan farmers were above 60 years old. The mean age of the farmers was 47.4 years and the maximum age was 69 years old. Majority (81.7 %) of the farmers were married, whereas 11.5 % were single, 4.5 % were widowed and only 2.3 % of respondents were divorced. 64.2 % of the farmers had secondary education and higher (university) education (35.8 %).

Table 4. Demographic characteristics of farmers

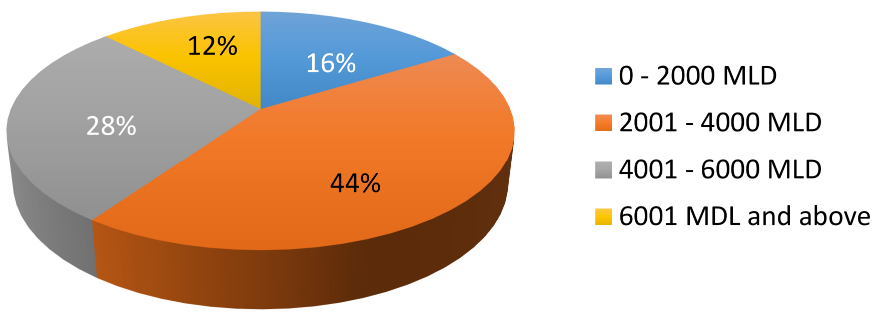
Variable	Description	Percentage (%)
Gender	Male	64.1
	Female	35.9
Age	20-29	7.6
	30-39	20.7
	40-49	26.7
		30.5
	Above 60	14.5
Marital status	Married	81.7
	Single	11.5
Educational level	Secondary	64.2
	Higher education (university)	35.8
Number of HH members	1-3	48.1
	4-6	49.6
	Above 7	2.3

As was shown in Table 4 about 49.6 % of the farmers had from 4 to 6 household members, from 1 to 3 cohabitants in a house had 48.1 % of the farmers and only 2.3 % of the respondents had 7 and more members of household.

Agricultural indicators

Average monthly income from farming household was 3991 MLD (= approx. 242.6 USD). 60 % of farmers' households earned monthly till 4000 MLD while 28 % of farmers claimed to have from 4001 to 6000 MLD. The lowest rate (12 %) of the income from farming had the farmers who earned more than 6001 MLD (see Figure 8). In regard to allocation of farming income among Email and SMS-subscribers of WFS, the average monthly income of SMS-users reached 8760 MDL while Email-users earned 3441 MLD per month. Average monthly income of non-users of WFS was only 3578 MLD (see Appendix 1).

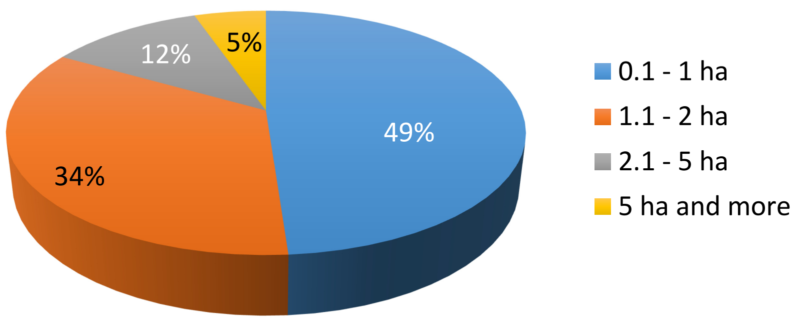
Figure 2. Average monthly income from farming households



The results on the farmers' cultivated area of land varied between 0.1 hectare and 15 hectares with a mean farm size of 1.7 hectares. Farm households owning from 0.1 to 1 hectare represented the majority (48.9 %) of the respondents. 34.4 % of the farmers cultivated farm area between 1.1 and 2 hectares.

The largest plots of cultivated land (from 2.1 hectares and more) had 16.7 % of the interviewed farmers (see Figure 9). Cultivation of land was mostly done with application of agricultural equipment (tractors, combines), as reported by 76.3 % of the farmers. For irrigation systems, about 40.5 % of the farmers watered their crops manually, while those only using sprinkler or drip irrigation accounted for 26.7 % and 43.5 %, respectively.

Figure 9. The size of cultivated land area per farm household

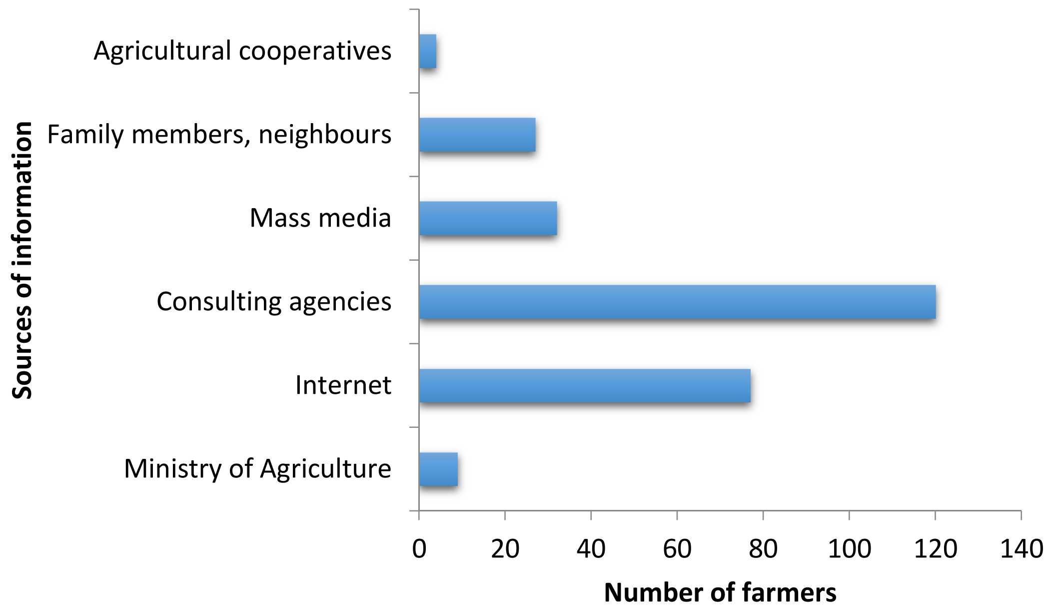


As questionnaire results showed, during 2015 – 2017 years Moldovan farmers in the study area were frequently exposed to the uncertainties of weather as drought, hail, flood and frost. It was found that about 95.8 % of farmers have experienced drought in the past three years. In division of answers regarding utilization of WFS, the highest vulnerability to deal with drought and its impact had non-subscribers of WFS (98 %). Their agricultural-crop loss due to natural disasters in general amounted to 40 % of the harvest. The result findings also indicated that Email-users and SMS-users of WFS had a smaller reduction of their yield due to natural phenomenon (37 % and 22 %, respectively) (see Appendix 1).

Sources of farmers' information needs

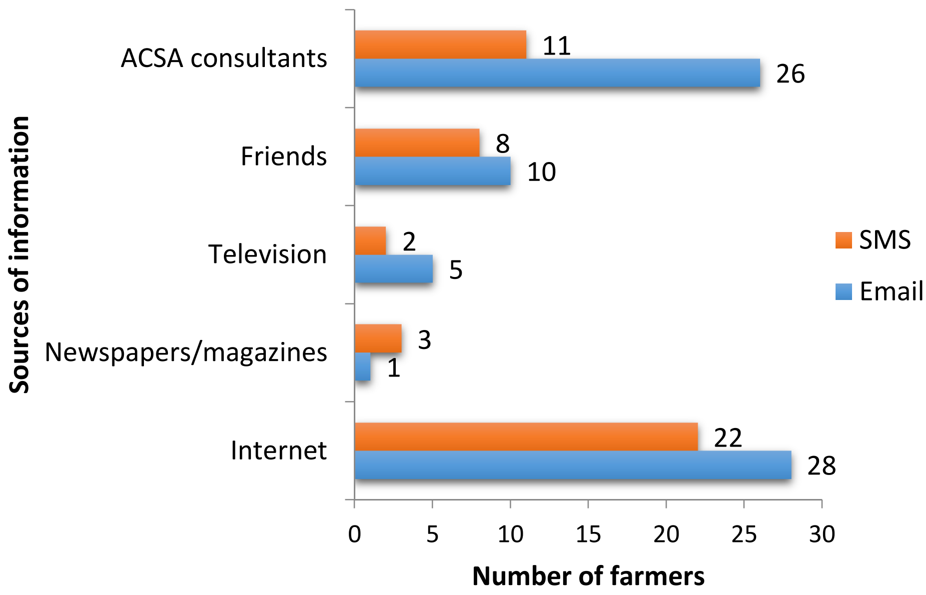
According to questionnaire survey results, farmers obtained many of their needed information from consulting agencies providing information services. Particularly, from local and regional consultants who worked for information agency ACSA. Figure 10 reflected the tendency of used sources of information among the surveyed respondents. Farmers, replying on the question regarding sources of agricultural information, could choose several options of answer simultaneously. The result of the data analysis showed that a large proportion (91.6 %) of the respondents indicated that Consultancy Agency (mainly extension services provided by ACSA consultants via direct communication or over the phone) was their basic source of extensive information. 58.8 % of the respondents answered that they get the needed agricultural information through the Internet usage. From the study it could be also inferred that 24.4 % of farmers approach the use of mass media (radio, television and printed media) in agricultural information seeking. In addition, analysed data revealed that family members/friends/neighbours/relatives were common (20.6 %) sources of information for farmers. This indicated that farmers rely on their friends or relatives to get farming information. Among other used sources of agricultural information were the Ministry of Agriculture of the Republic of Moldova and agricultural cooperatives. They presented 6.7 % and 3.1 %, respectively.

Figure 10. Most common sources of agricultural information for respondents



The study results regarding sources of information through which subscribers learned about WFS of the AMIS was shown in Figure 11. Selected one or more answer choices demonstrated that majority of the farmers (both Email and SMS-subscribers) became aware of WFS through the Internet (64.7 % and 57.1 %, respectively).

Figure 11. Sources of information through which subscribers learned about WFS

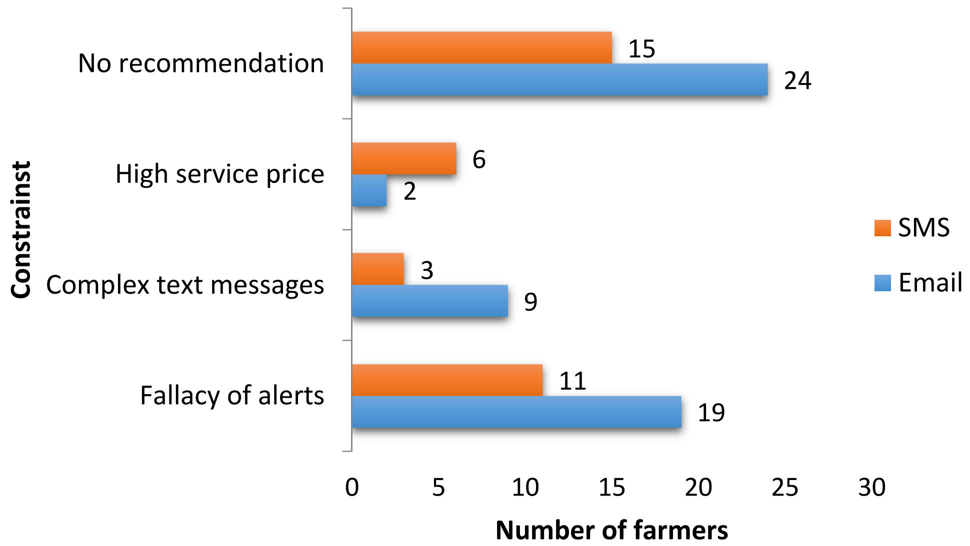


Contact with ACSA consultants had the second most influential role (53.0 % and 32.4 %, respectively) in providing information wherefrom subscribers learned of existence of WFS.

WFS usefulness and constraints

The study findings showed farmers' rating of the level of usefulness of WIS provided by ACSA information system disaggregated by source of information: Email and SMS notifications. It was found that majority of the farmers rated the information received from ACSA as useful and very useful. Only 2 SMS-subscribers out of 34 evaluated weather alerts as "not useful". The option "not useful at all" was not selected by any of respondents. Figure 12 showed the results for various constraints to the use of WFIS faced by the interviewed Email and SMS-subscribers in the study area. Lack of information on the adoption of protective measures was the commonest constraint encountered by most of the weather alerts subscribers.

Figure 12. Distribution of Email and SMS-subscribers according to constraints on WFIS



Chi-square test was used to evaluate differences in the assessment of usefulness and main constraints to the use of WFS between Email and SMS-subscribers. Table 5 showed the results of Pearson's Chi-squared test analysis which revealed that statistically significant difference existed between Email and SMS-users of WFS at 5 % level of significance in the perception of pricing strategy for services. In comparison to Email-subscribers, SMS-subscribers of WFS more often selected "high service price" as the main obstacle to the WFS utilization. This result indicated that farmers' preferences and willingness-to-pay for WFS differed based on the source of weather notifications and its implementation costs. Farmers' services evaluation regarding to level of effectiveness and such constraints as: fallacy of alerts, complex text messages and lack of information on the adoption of protective measures, did not differ significantly between the two groups of subscribers.

Table 5. Results of chi^2-squared test

Variable	**E-mail users**	**SMS-users**	Difference
Effectiveness	3.57	3.65	-0.08
	Constraints		
Fallacy alerts	0.41	0.35	0.06
Complex text messages	0.18	0.09	0.09
High service price	**0.04**	**0.18**	**-0.14****
No recommendation	0.49	0.44	0.05
Sample (n = 83)	49	34	

Note: Significances of the differences in means are based on the results of Pearson's chi^2-squared test

* Significant at 10% level ** Significant at 5% level *** Significant at 1% level

Source: Author 2018

Results of tests of significant difference (T-test and Pearson Chi-square) between the two groups of WFS subscribers were reported in Table 6. The findings of this analysis indicated that farmers subscribed for Email notifications significantly differed from farmers subscribed for SMS-based notifications with respect to all characteristics shown in above mentioned table. A comparison between mean numbers of assessed variables indicated that SMS-users were characterized by a higher level of education and higher number of adults within household, for example. Such variables as number of household members, size of cultivated area and average monthly income from farming also followed the tendency of higher mean numbers of SMS-users. The results on mean frequency of weather forecasting messages indicated that SMS-users received notifications more often, in comparison to Email-users, what probably led to less crop losses of SMS-subscribers due to natural disasters as drought and flood. It was also found that Email-users had crop losses more than 30 % from the whole yield more frequently than SMS-users. In addition, farmers, who watered their crops manually, were found more frequently among Email-users.

Table 6. Mean differences between SMS-users and Email-users of Weather Forecast Services

Variable	**E-mail users**	**SMS-users**	Difference
University education[2]	0.24	0.79	-0.55***
Number of adults[1]	2.35	3.15	-0.8***
Number of HH members[1]	3.31	4.18	-0.87***
Land size[1]	1.19	3.25	-2.06***
Income[1]	3471	6523	-3052***
Messages several times per week[2]	0.02	0.79	-0.77***
High service price[2]	0.04	0.18	-0.14**
Drought[2]	1.00	0.85	0.15***
Frost[2]	0.88	0.62	0.26**
Experience crop loss[2]	1.00	0.85	0.15***
Crop loss more than 30%[2]	0.57	0.12	0.45***
Manual watering[2]	0.45	0.18	0.27***
Sample (n = 83)	49	34	

Note: Significances of the differences in means are based on the results of a *t-test* (1) for the continuous variables and on Pearson's chi^2-squared test (2) for binary or ordered variables.

* Significant at 10% level ** Significant at 5% level *** Significant at 1% level

Source: Author 2018

4.2. Analytical results of Binary probit model

This section represented the estimated results on the factors affected the WFS utilization decision by interviewed Moldovan farmers. The regression results and marginal effects from Binary probit model were presented in Table 7. These results suggested that gender of farmer, level of education and experienced hail in the last three years played an important role in farmers' decision of WFS adoption. The coefficient of gender of farmer was negative and suggested that female farmers were less likely to subscribe for WFS utilization. This coefficient was statistically significant at the 5 % level. The results of the marginal effect demonstrated that an increase in the number of female farmers in the sample, decrease in the probability of females to utilize weather alerts notifications by 18 percentage points. Another statistically significant coefficient of educational level was positive and indicated that farmers with higher education attainment tended to be more willing to adopt for WFS. Founded result was significant at 1 % level. Besides, marginal effect at the mean showed that university education significantly increased the likelihood of utilization of WFS by about 25 percentage points. The result also demonstrated the important role played by experienced hail in the last three years as natural phenomenon that influenced adoption of WFS. These result findings were significant at 1 % level. Based on the marginal effect, I can conclude that an experienced hail by farmers in the period from 2015 to 2017 years significantly increased the likelihood of utilization of WFS by 24 percentage points. My results also suggested that farming income, age of farmer and size of cultivated area had no statistically significant impact on farmers' decision to patronize WFS in our sample. In addition, continuous explanatory variables of farming income and farmers' age had minus sign before coefficients. Its meaning was that the probability of using WFS decreased with age and with growing income from farming. However, increasing size of farm land had a positive trend in the use of WFS but effect on the endogenous variable also was not statistically significant.

Table 7. Results of Binary probit model and Marginal effects at the mean

	Coefficient	Standard Error	p-value	95% Confidence Interval		Marginal effect
Income	-0.00005	0.00009	0.55	-0.0002	0.0001	-0.00002
Gender of farmer	**-0.60**	**0.26**	**0.02**	**-1.09**	**-0.08**	**-0.18**
Age	-0.01	0.01	0.38	-0.03	0.01	-0.003
Education	**0.81**	**0.29**	**0.005**	**0.24**	**1.36**	**0.25**
Land size	0.24	0.22	0.27	-0.19	0.67	0.07
Hail	**0.78**	**0.31**	**0.01**	**0.18**	**1.39**	**0.24**
Constant	0.54	0.67	0.42	-0.77	1.86	
Number of observation	131					
LR chi^2	29.50					
Prob > chi^2	0.0000					
Pseudo R^2	0.1714					

Source: Author 2018

5. Discussion

The results from the study in India (Babu et al. 2012) showed that farmers' access information from a range of sources, but this in turn depends on their information search behaviours. According to my questionnaire survey results, farmers in the study area of the Republic of Moldova obtain many of their needed information from consulting agencies providing information services. Agricultural extension and advisory services are also pluralistic in India (Babu SC et al. 2012), Tanzania (Elly T & Silayo EE 2013), and Ethiopia (Tadesse 2008).

A matter of gender in adoption of agricultural technologies has been explored for a long time and most studies have described mixed findings regarding the different importance men and women have in technology implementation (BonabanaWabbi 2002). Based on the result of my study, gender of farmer had significant impact on the farmers' willingness to subscribe for WFS. Particularly, my findings indicated that female farmers were less likely to use extension services of weather forecast as compared with male farmers. That outcome was also found in several African countries as Kenya (Zendera 2011), South Africa (Nxumalo & Oladele 2013), Burkina Faso (Ouédraogo et al. 2018) and Nigeria (Omonona et al. 2005). This result should be explained that gender has an impact on technology adoption since the household head is the primary decision maker and males have more access to and control over resources than females due to social and cultural norms and values. However, there was also opposite point of view from Etwire et al. (2013) that female farmers are often more socially networked and have higher likelihood to be linked with agricultural extension services.

According to Sri Lanka researches Namara et al. (2013), education of agricultural producers has been supposed to have a positive impact on farmers' willingness to adopt new technologies. Educational level of a farmer improves his ability to obtain process and utilize information which is relevant to adoption of new technologies.

The use of ICTs is one approach to link smallholder farmers to markets and provide them with relevant and timely marketing information. Based on the information, farmers can perform informed decision-making during selling and when farming. The aim is to increase farmers' income and improve their productivity (Mawazo 2015). The obvious benefit is also that agricultural producers can avoid crop losses by utilizing the early forecast systems (Magesa et al. 2014).

In addition, findings of researchers from Burkina Faso (Zongo et al. 2016) confirmed significant influence of farmers' education on the demand for weather information. This may be due to the fact that education increases the ability of farmers to understand the need for weather information to decide in terms of farming production in regard to weather changes. The impact of education on the adoption of weather information was in line with attained results in Kenya and Ethiopia (Lybbert et al. 2007).

Also, farmers who faced natural phenomenon as hail of severe intensity were more likely to take measures against their vulnerability to hail before it happened by adopting risk reducing services of weather alerts. This result is in agreement with the obtained data of Pakistan authors (Ullah et al. 2015) who indicated that experienced natural events such as floods and heavy rains led farmers to adopt WFS as a risk mitigation strategy. Risk resistance ability encourages farmers to take steps and secure themselves from yield losses caused by natural disasters. The case study finding in Australia also suggested that farmers' risk exposure and risk perception should be accounted for main factors when deciding on risk mitigation strategies in the agricultural field (Nguyen et al. 2007).

The obtained results also indicated that continuous explanatory variables of farming income and farmers' age were not significant and had minus sign before coefficients. Its meaning was that the probability of using WFS decreased with age and with growing income from farming. However, my results were in opposite to results obtained by Nigerian researchers Iheke and Agodike (2016). In their case above mentioned variables significantly and positively related to adoption of climate change mitigation services. That implied that adoption was increased with increase in farming income and farmers' age. This situation can be explained that lack of fund prohibits farmers from assuming risks of financial dependence associated with utilization of new technologies.

Based on my result regarding WFS constraints, SMS-subscribers of early warning system considered high cost of provided services as the main obstacle to the WFS utilization. Such a claim was also made by Anjum (2015) who stated that cost was a big issue to consider in mobile phone ICTs. Agricultural producers in rural areas in developing countries have very low income so they are not able to afford themselves to purchase the required services. Similar findings were observed by the projects of International Development Research Centre. The study results of Rashid and Elder (2009) showed that cost of the technology is very high, and ICTs connectivity is very weak. According to Mawazo (2015) lack of information and financial constraints of rural people may bring significant challenges to services adoption. This may lead to breakdown to meet communication costs. Besides, services providers need to ensure that the marketing information provided is trusted by ensuring subscribers do not compromise the information. The study of Zoltner and Steffen (2015) proposed that the cost of information necessary for farmers should be low in order to promote and encourage AMISs adoption. Among other challenges of ICTs sustainability is that most rural farmers in developing countries are illiterate and thus may not recognise the relevance of risk prevention information (Mawazo 2015).

5.1. Limitations of the study

In spite of all efforts and willingness to achieve the best results, there were several limitations that may have an impact on course of the research and they have to be mentioned.

(i) During face-to-face interviews, the most popular limitation is the language barrier which can be the reason of misunderstanding between interviewer and respondent. Data collection was carried out in Russian language and not all farmers were willing to respond.

(ii) In my case, research was partially influenced by the high season of harvest. Farmers were busy and sometimes did not have much time and willingness to fill in questionnaire.

(iii) Limiting time during data collection could be another constraining factor to interview even greater number of respondents.

(iv) Online survey limitations were related to:

- Limited availability of respondents. Some farmers were less likely to respond to online questionnaires (received 34 answers out of 46 requests);
- No personal communication with respondents and inability to clarify answers.

(iv) Unequal number of sample size between target groups could be considered as another limitation factor.

6. Conclusions

Gender of farmer, level of education and experienced hail in the last three years played a significant role in farmers' decision of WFS adoption. It was suggested that female farmers were less likely to subscribe for WFS utilization, whereas farmers with more high education attainment and experienced hail in years 2015-2017, they were more likely to adopt WFS of the Moldovan AMIS. My results also suggested that farming income, age of farmer and size of cultivated area had no statistically significant impact on farmers' decision to utilize WFS in our sample.

Majority of farmers evaluated the information received from ACSA as useful and very useful. The main constraint to the use of WFS depended on high service price, particularly from SMS-subscribers' perspectives. In comparison to Email-subscribers, SMS-subscribers of WFS more often selected "high service price" as the main obstacle to the WFS utilization. This result indicated that farmers' preferences and willingness-to-pay for WFS differed based on the source of weather notifications and its implementation costs.

For carrying out various activities by farmers in rural areas, among other things, information support is also vital. Farmers in the study area searched agricultural information from a range of sources. The results indicated extension services (consulting agencies), the Internet and mass media (radio, television and printed media) as the most used information sources. Farmers became aware of WFS mainly through the Internet and contact with ACSA-NGO consultants.

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Appendix 1: Descriptive statistic results divided by source of WFS notification

	Total	Non-subscribers	Email-subscribers	SMS-subscribers
Social and economic indicators				
Share of respondents (%)	100	37	37	26
Male (%)	64.1	50	65.3	82.3
Mean age in years	47.4	46.9	48.7	46.3
Higher education (yes) (%)	35.8	18.8	24.5	76.5
Mean number of HH members	3.5	3.0	3.0	4.2
Mean number of cultivated area (ha)	1.7	1.0	1.2	3.2
Average monthly income from farming (MLD)	3991	3578	3441	8760
Extension services (yes) (%)	91.1	93.8	89.8	91.2
Drought (%)	95.8	98.0	82.3	94.7
Hail (yes) (%)	27.5	12.5	32.7	41.2
Flood (yes) (%)	6.1	12.5	4.1	0
Frost (yes) (%)	77.9	81.3	85.7	61.8
Mean crop loss (%)	34	40	37	22

Appendix 2: Questionnaire for agricultural producers in English language

Czech University of Life Sciences Prague, Faculty of Tropical AgriSciences

1. **Personal Information**

Gender	male		female
Age			
Family status			
Level of completed education	primary education	secondary education	higher education (university)
Your region			
City / Village Name			

2. **Household composition (number of family members)**

	male	female
Number of adults		
Number of children under 15 years of age		
Number of older persons more than 60 years old		
Head of the family		

3 **What is your total area of cultivated land (hectares or hundred parts)**

4 **What is your average monthly income from farming households (MDL)?**

5 **Do you have access to information about the state of the market of agricultural products?**

☐ Yes ☐ No

6 **Where do you get the information you need most of all?**

☐ Ministry of Agriculture of the Republic of Moldova

☐ Internet

☐ Extension services (consulting agencies)

☐ Mass media

☐ Family members, neighbours

☐ Agricultural cooperatives

☐ Other ……………………….

7 Do you use Weather Forecasting Services of the Agricultural Marketing Information System?

☐ Yes

☐ No

If you do not use this service - please go to the question # 14

8 How did you learn about the existence of Weather Forecasting Services of the Agricultural Marketing Information System?

☐ From the internet

☐ From newspapers / magazines

☐ From TV

☐ From friends

☐ Other (please explain) __________________

9 Since when did you start using the weather alert service?

☐ 20___ year (write year)

10 How often do you receive notifications (messages)?

☐ Once a week

☐ Several times a week

☐ Once a month

☐ Several times a month

☐ Once a year

11 What source for Weather Forecasting (notifications) do you use?

☐ Mobile phone

☐ E-mail

☐ Other (please explain) __________________

12 How would you rate the effectiveness of Weather Forecasting Services?

☐ Very effective

☐ Effective

☐ Not effective

☐ Not effective at all

13 In your opinion, what are the main obstacles to the use of Weather Forecasting Services?

☐ Fallacy of alerts
☐ Complex text messages
☐ High service price
☐ Lack of information on the adoption of protective measures
☐ Other (please explain)__________________

14 Have you ever experienced any natural disasters in the last three years (2015-2017)?

☐ Yes ☐ No

If so, which ones?

☐ Drought

☐ Hail
☐ Flood
☐ Frosts
☐ Other__________

15 Have you been subjected to crop loss (or part of it) in connection with this natural phenomenon?

☐ Yes ☐ No

If so, how would you rate the percentage (%) of loss of your crop on this scale?

10 20 30 40 50 60 70 80 90 100%
(all harvest)

16 What kind of irrigation do you use?

☐ Drip irrigation
☐ Sprinkler irrigation device
☐ Other (please explain)_________________

17 Do you use fertilizers?

☐ Yes ☐ No

If yes, which and in what quantities (kilogram)?

Fertilizer	Kg
____________________	___________
____________________	___________
____________________	___________
____________________	___________

18 Do you use agricultural equipment (tractors, combines)?

☐ Yes ☐ No

19 Do you have access to a loan?

☐ Yes ☐ No

20 What kind of crops do you grow?

Crop	Kg	Cultivated area	Price per kg (MDL)
____________________	___________________	___________________	____________________
____________________	___________________	___________________	____________________
____________________	___________________	___________________	____________________
____________________	___________________	___________________	____________________
____________________	___________________	___________________	____________________

Appendix 3: Questionnaire for agricultural producers in Russian language

Уважаемые фермеры, я бы хотела Вас заранее поблагодарить за заполнение данной анкеты. Этот опросный лист поможет мне проанализировать эффективность услуги погодного прогнозирования Маркетинговой Информационной Системы (МИС) и ее влияние на сельскохозяйственную продуктивность в Республике Молдова. Участие в опросе - добровольное, ответы на вопросы анкеты - анонимные. Большое Вам спасибо за Ваше время и помощь!

Чешский университет естественных наук, город Прага

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1 Личные данные

Ваш пол	мужской	женский	
Возраст			
Семейное положение			
Уровень оконченного образования	начальное	среднее	высшее (университет)
Ваш регион			
Название города/села			

2 Состав домохозяйства (количество членов семьи)

	мужчина	женщина
Количество взрослых		
Количество детей младше 15 лет		
Количество лиц старшего возраста старше 60 лет		
Глава семьи		

3 Какая у Вас общая площадь обрабатываемой земли (в гектарах или сотках)?

4 Какой у Вас средний ежемесячный доход от ведения фермерского домашнего хозяйства (лей)?

5 Имеете ли Вы доступ к информации о состоянии рынка сельскохозяйственной продукции?

☐ Да ☐ Нет

6 Откуда в основном Вы получаете интересующую Вас информацию?

☐ Министерство Сельского хозяйства ☐ Интернет

☐ Консультационные агентства ☐ Средства массовой информации

☐ Члены семьи, соседи ☐ Другое ……………………….

☐ Фермерские кооперативы

7 Используете ли Вы услуги погодного прогнозирования Маркетинговой Информационной Системы?

☐ Да ☐Нет

Если данную услугу Вы не используете – переходите, пожалуйста, к вопросу №14

8 Откуда Вы узнали о существовании услуг погодного прогнозирования Маркетинговой Информационной Системы?

☐ Из интернета ☐ Из газет/журналов

☐ По телевидению ☐ От друзей

☐ Другое (пожалуйста поясните) ___________________

9 С какого года Вы начали использовать услугу погодного оповещения?

☐ 20___ год (напишите год)

10 Как часто Вы получаете уведомления (сообщения)?

☐ Один раз в неделю ☐ Несколько раз в неделю

☐ Один раз в месяц ☐ Несколько раз в месяц

☐ Один раз в год

11 Какой источник погодного прогнозирования (уведомления) Вы используете?

☐ Мобильный телефон

☐ Е-маил

☐ Другое (пожалуйста поясните) __________________

12 Как бы вы оценили эффективность данной услуги?

☐ Очень эффективна

☐ Эффективна

☐Нейтральна

☐Не эффективна

☐ Совсем не эффективна

13 По Вашему мнению, какие существуют основные препятствия к использованию погодных оповещений?

☐Ошибочность оповещений ☐ Сложные текстовые сообщения

☐ Высокая цена услуги ☐ Слабый доступ к информации

☐ Другое (пожалуйста поясните) ___________________

14 Пришлось ли Вам испытать какие-либо природные катаклизмы за последние три года (2015-2017)?

☐ Да ☐ Нет

Если да, то какие?

☐ Засуха ☐ Град ☐ Наводнение ☐ Заморозки

Другое (пожалуйста поясните)____________________

15 Подверглись ли Вы потере урожая (или его части) в связи с данным природным явлением?

☐ Да ☐ Нет

Если да, то как бы Вы оценили процент (%) потери Вашего урожая по данной шкале?

10 20 30 40 50 60 70 80 90 100%

(весь урожай)

16 Какой вид полива сельхоз культур Вы используете?

☐ Капельное орошение ☐ Дождевальное устройство полива

☐ Другое (пожалуйста, поясните) ___________________

17 Используете ли Вы удобрения?

☐ Да ☐ Нет

Если да, то какое и в каких количествах (килограмм)?

Удобрение	Кг
_____________________	____________
_____________________	____________
_____________________	____________
_____________________	____________

18 Используете ли Вы с/х. технику (тракторы, комбайны)?

☐ Да ☐ Нет

19 Есть ли у Вас доступ к получению кредита?

☐ Да ☐ Нет

20 Какие сельскохозяйственные культуры Вы выращиваете?

Продукт (культура)	Кг	Посевная площадь	Цена за кг (лей)
______________________	__________	___________________	_______________
______________________	__________	___________________	_______________
______________________	__________	___________________	_______________

Appendix 4: Photo documentation - questionnaire survey