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Dissertation thesis

The effect of international migration on agricultural production patterns: evidence from the Republic of Moldova

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Declaration

I hereby declare that I have written and presented this dissertation thesis with the title "The effect of international migration on agricultural production patterns: evidence from the Republic of Moldova" by myself with including the literature listed in the references section of this thesis.

Prague, 10 May 2019

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Abstract

Despite that remittances represent an important financial resource for rural farmers with the potential to relieve credit constraints, the empirical evidence regarding the effect of remittances on the investments in farm productive assets and adoption of sustainable agricultural practices is limited in the Republic of Moldova. The thesis examines the effect of remittances on the utilization of farm inputs including chemical inputs, farm machinery, irrigation facilities and adoption of sustainable agricultural practices among 234 small-scale farmers living in the Orhei, Soroca and Cantemir districts. The empirical approach reflects the potential endogeneity of the treatment variable by the adoption of the extended probit regression model. The results demonstrated that remittances did not lead to an increased likelihood of utilization of farm assets (except irrigation facilities) and did not increase likelihood of the adoption of sustainable agricultural practices. Even though money sent by members working abroad allows farmers covering their basic needs, lack of investments in time - saving technology requires further investigation**.**

Keywords

binary probit model, Eastern Europe, farm assets, labor migration, sustainable agricultural practices

Content

List of abbreviations

2SLS	Two-stages least squares
3SLS	Three-stage least squares
ACSA	National Agency for Rural Development
ANOVA	Analysis of variance
CIS	Commonwealth Independent State
EU	European Union
FAO	The Food and Agriculture Organization
HH	Household
IOM	International Organization for Migration
IMF	International Monetary Fund
IV	Instrumental variable
MVP	Multivariate probit model
NBS	National Bureau of Statistics of the Republic of Moldova
NPK	Nitrogen, phosphorus and potassium
NTFP	Non-timber forest product
SAPs	Sustainable agricultural practices
SAUM	State Agrarian University of Moldova
TLU	Tropical livestock unit
UN	United Nations
USSR	Union of Soviet Socialist Republics
VIF	Variance inflation factors

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1. Introduction

Labor migration has become an important livelihood strategy for many Moldovan citizens especially for those living in rural area. Due to the extent of the migration phenomenon, the Republic of Moldova is a country with one of the highest dependence on remittances (The World Bank 2019) which constitute a considerable source of income for rural households dependent on agricultural production. Remittances facilitate to poor farmers to overcome credit constraints (Waidler et al. 2017) and enable them to invest in the education of their children, medicament and construction (Pilarova & Kandakov 2017; Lücke et al. 2007). However, the empirical evidence regarding the impact of remittances on utilization and investment in farm productive assets as well as the adoption of sustainable agricultural practices (SAPs) is rather limited (see for example Piras et al. 2018 and Bolganschi 2011 among others).

Migration may affect agricultural production through several channels. Nevertheless, the overall effect of remittances and labor migration on agricultural production and rural environment depends mostly on farmer´s attitude toward farming and willingness of member(s) in sending households to invest remittances in productive assets enabling them to deal with labor force loss caused by the migration. Firstly, when farmers are not motivated to stay in agriculture or they do not have enough financial capital to invest in labor-saving strategies, they may tend to lease their farmland and abandon farming (Khanal 2018; Ji et al. 2018; Xu et al. 2017; Sunam & McCarthy 2016; Qian et al. 2016; Yan et al. 2016b; Jaquet et al. 2015). Farmers, who decide to continue with farming may adopt less labour-intensive practices, reduce the scope of their production (Qian et al. 2016; Shi et al. 2011; Damon 2010; Miluka et al. 2010) and increase time spent on farm work by household members left-behind who have to replace activities performed by migrants (Vadean et al. 2019; Wang 2018; Dávalos et al. 2017; Gartaula et al. 2017; Yan et al. 2016a; Bhattarai et al. 2015; Jaquet et al. 2015). In case, when there is enough surplus labor and members left-behind have enough motivation to be involved in farming activities, remittances may allow them to purchase farm assets (Baird et al. 2019; Caulfield et al. 2019; Radel et al. 2018; Kpadonou et al. 2017; Qian et al. 2016; Yang et al. 2016; Böhme 2015; Sauer et al. 2015; Manivong et al. 2014; Wang et al. 2014) and invest in SAPs (Kpadonou et al. 2017; Wouterse 2017).

Even though several studies investigated the impact of remittances on agricultural patterns in the Republic of Moldova, they did not concentrate on the effect of remittances on investments in chemical inputs, irrigation facilities and adoption of SAPs. To close this gap, the thesis investigates the effect of remittances and other factors on the utilization of farm assets and the adoption of SAPs among smallholder farms. The study compares the use of productive assets and the adoption of SAPs in households receiving money from members working abroad and in households without remittances.

2. Literature review

A conceptual framework presented in Figure 1 and Figure 2 provides an overall picture of the mechanisms through which international migration affects investment in farm intensification practices and adoption of innovation and at the same time illustrates the structure of a literature review.

Large-scale migration of young individuals from rural areas caused by lack of well-paid job possibilities, poverty and lack of financial capital is linked to a shortage of agricultural labor and adoption of a range of livelihood strategies by migrant households to deal with the situation after the migration of household member(s). Due to the adoption of labor – saving strategies and reduction of the scope of the production, the investment in agricultural production are lower. The lower investment lead consequently to lower adoption of SAPs that make small scale-farmers unprotected against extreme climate events and exposed to low soil quality.

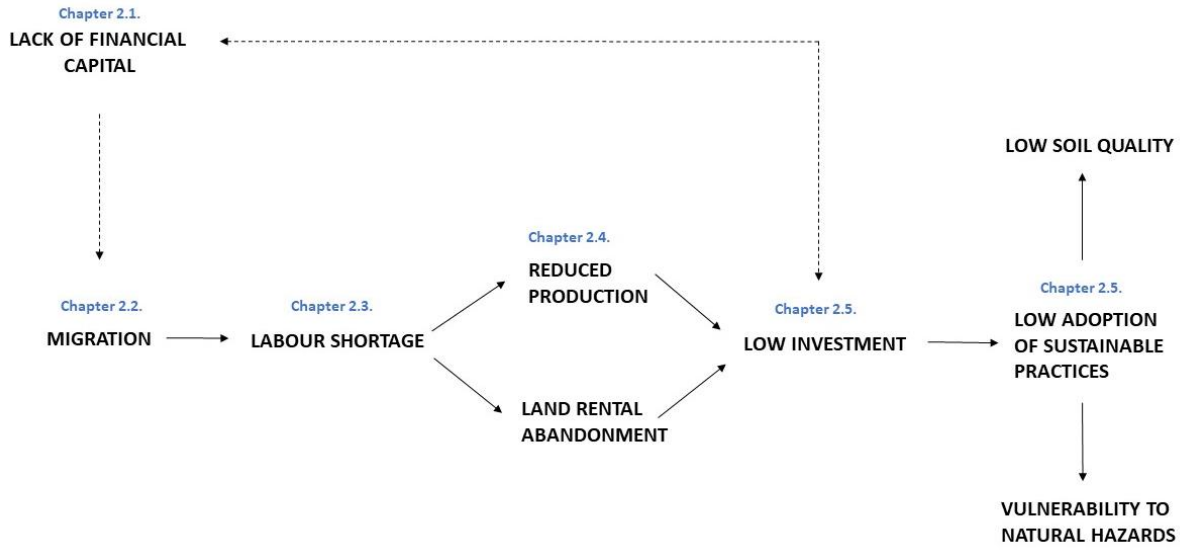


Figure 1 Conceptual framework – the effect of migration and financial capital

Remittances sent by household members working abroad may help to small-scale farmers relax credit constraints and facilitate investment in productive assets and adoption of SAPs, however sometimes the amount of remittances is too low or household members are not motivated enough to invest in agriculture, which consequently leads to transition out of agriculture and investment only in direct consumption.

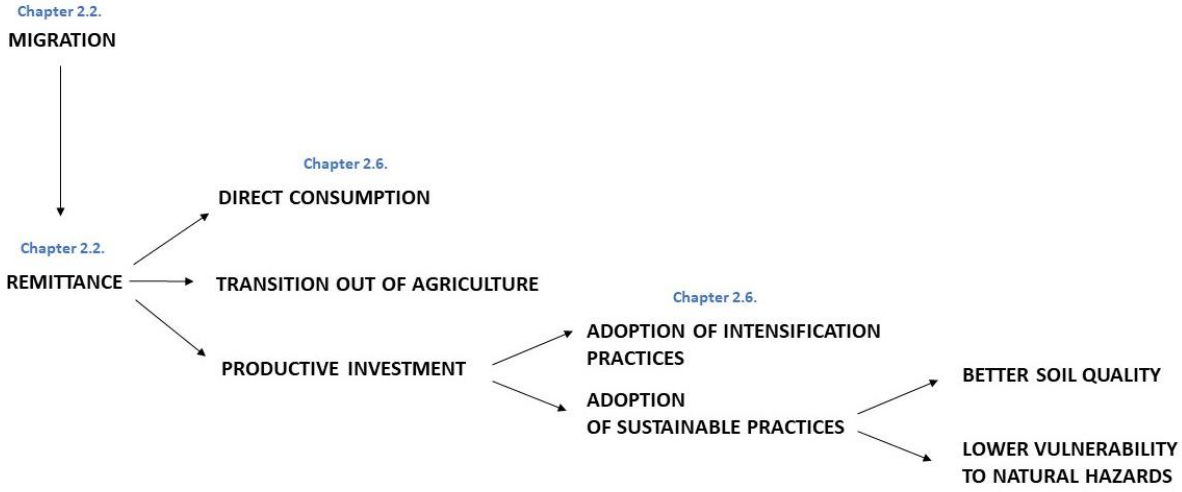


Figure 2 Conceptual framework – the effect of remittances

The first chapter of the literature review (chapter 2.1.) introduces the economic situation of the country. Widespread poverty and low wages in the agricultural sector have led many rural citizens to migrate abroad. Therefore, the first chapter focus on poverty incidence among rural households (2.1.1.), the significance of farm income and remittances in the household budget (2.1.2.) as well as on the availability of financial capital and credit (2.1.3.).

The second chapter of literature review (chapter 2.2.) describes the migration patterns in the Republic of Moldova, beginning with the most important causes and waves of the departure of Moldovan citizens abroad (subchapter 2.2.1.). Due to the intensity of the migration phenomenon and the domestic economic situation, the Republic of Moldova is one of the world leading countries with a very high dependence on remittances. Remittances flow in last decade is discussed in subchapter (2.2.2.). As a migration and remittances are determined by several individual and household characteristics including age, gender, educational level, household size, legality of the stay, migration monetary costs, migration networks and by economic and political situation in home as well as host countries, we suppose that migration patterns and

remittances flow differ between the Commonwealth Independent States and the European Union. The comparison of these two areas is included in subchapter (2.2.3.).

The share of labor employed in the agricultural sector significantly dropped over time due to extensive migration and availability of off-farm jobs in urban areas. The chapter (2.3.) includes the description of employment in agriculture and labor shortage over the last two decades (subchapter 2.3.1). When a surplus of labor on the market is limited, migration may increase labor workload for members left-behind (2.3.2.).

The chapter (2.4.) describe the range of livelihood strategies which are applied by migrant households to deal with the vulnerability of their livelihoods. When farmers do not have enough labor and financial capital to invest in labor-saving strategies, they may tend to adopt less labor-intensive practices (subchapter 2.4.1.), reduce the scope of their production (subchapter 2.4.2), lease their farmland or abandon farming (subchapter 2.4.3).

Due to labor loss effect caused by a large-scale migration of young individuals abroad, credit-constraints, the inability of small-scale farmers to purchase farm assets, reduction of the scope of production and due to weak development of the local market the investment in farm assets and inputs are low which is discussed in the chapter (2.5.). The low investments are connected with the low profitability and low adoption of practices affecting the soil quality. Therefore, the investment of small-scale farmers in farm machinery, chemical inputs, irrigation is discussed in subchapter (2.5.1.), adoption of SAPs in subchapter (2.5.2.) and its impact on soil quality and vulnerability to climate hazards in subchapter (2.5.3.) and subchapter (2.5.4), respectively.

In case, when there is enough surplus labor and members left-behind have enough motivation to be involved in farming activities, remittances may allow them to purchase farm inputs and machinery, pay for wage labor and invest in SAPs (2.6.1.). However, sometimes farmers do not have enough motivation to continue with farming (2.6.2.) or the amount of remittances is too low and they invest only in direct consumption (2.6.3).

2.1. Economic situation

2.1.1. Poverty incidence

The Republic of Moldova is the poorest country in Europe (UNDP 2019). The highest level of poverty (monetary as well as multidimensional[1]) is registered in rural areas of a country. Although poverty rates decreased in recent years, the gap between urban and rural areas persists (Dávalos et al. 2016). The poorest region in Moldova is the Southern region, being followed by the Central region, the Northern region and municipality of Chisinau (Ministry of Economy of the Republic of Moldova 2012, Dávalos et al. 2016; Bolbocean 2008).

Poverty in rural areas is associated with a low level of modernization and economic life dominated by agriculture (IMF 2011) and continue to affect the traditionally vulnerable segments of rural population such as families depending on agricultural activities, elderly people, people with low level of education and limited professional skills as well as families with more children (Ministry of Economy of the Republic of Moldova 2012; The World Bank & World Food Programme 2015). In 2018, the average monthly salary of an employee in agricultural sector was 3,105 Leu (173 USD), which is less than in other sectors (NBS 2019). Widespread poverty, low wages in agricultural sector and better job opportunities in surrounding countries have led many rural citizens to migrate abroad which contributed to an aging and shrinking of rural population (ILL, NBS 2010).

2.1.2. Households income

Progress in poverty reduction was driven largely by remittances and pensions which has become a significant source in the household income (Dávalos et al. 2016). In 2018, on average, the remittances accounted for 20 percent of household budget. Although the remittances contributed to the improvement of well-being of the rural population, households became dependent on money received from overseas. At the same time, remittances contribute to the increase of inequalities between the households with members working abroad and households without (UNDP 2017).

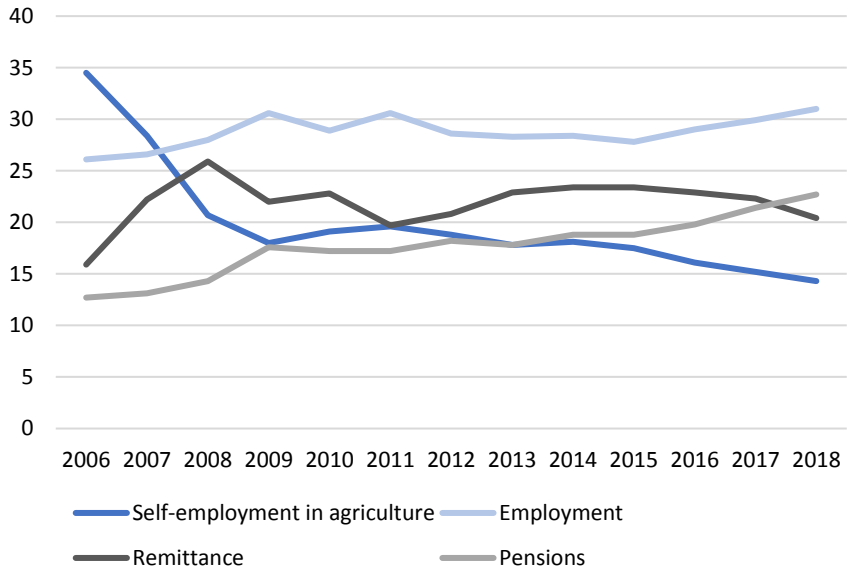
The increase of social benefits share in disposable income is determined mostly by the acceptance of Law on "*Social Assistance*" in 2008. Even though this measure

[1] Multidimensional poverty index includes four main dimensions: health, education, employment and housing

facilitated a poverty reduction in rural areas as well, analogously as in the case of remittances, it has deepened dependency of rural citizens on unproductive income. Since the social benefits are at the same size as a salary, it discouraged many individuals to work (UNDP 2017).

Considering that rural households rely on additional income sources, the importance of farm income declined in recent years from 28 percent in 2007 to 20 percent in 2017 as shown in Graph 1 (Möllers et al. 2016; NBS 2019). The share of income derived from non-farm employment in the total disposable income is lower in the rural areas compared to urban areas. Together with a higher prevalence of income derived from agriculture in rural areas, the considerable inequalities persist between urban and rural population.

Graph 1 Disposable incomes average monthly per capita, rural areas



Source: NBS 2019

2.1.3. Lack of financial capital and credit availability

Moldovan small-scale farms are mostly caught in a poverty trap. Due to low income, they lack financial capital and credit to make an agricultural investment which resulted in use of low-yield intensification technologies and at the same time they have to deal with low productivity and low income as a result of low investments. Moreover, small-scale farmers are not able to cover incurred financial losses from previous years, indeed, low farm income derived in the past few years is linked with the decrease of farmland (Piras & Botnarenco 2015).

Access to credit and high interest rate pose challenge for small farmers as formal credits are barely accessible to them and therefore, they have to rely on informal credits provided by the larger farmers from the same village (Piras & Botnarenco 2015). According to Moroz et al. (2015) and Möllers et al. (2016), small-scale farmers have to face to limited access to credit due to several reasons. First, they have to deal with insufficient collateral options. Second, the supply of loans is limited almost exclusively to short-term loans as a result of limited collateral. Third, high interest rates amounting to 15-20 % annually lead to a low demand for bank loans.

Due to absence of collaterals, small-scale farmers often rely on credits provided by local agencies. Farmers may apply for small credits (up to 25,000 Leu/1389 USD) at the beginning of the season and return it after the harvest period in case of favorable weather conditions (Piras & Botnarenco 2015). Apart from the formal loans, provision of private loans is also common among farmers. This source of income seems to play an important role in the financing of small farmers, as there are no administrative burdens and there is a lower or no interest rate compared to formal loans. Local large-scale farmers usually lend money to smallholders at the beginning of the agricultural season (Piras & Botnarenco 2015).

2.1.4. Labour migration and remittances in Moldova

Migration has become an important livelihood strategy for many Moldovan citizens enabling them to deal with widespread poverty, lack of adequate employment opportunities and low salaries (de Zwager & Sintov 2014; IOM 2012). The historical overview provides characteristics of migration since independence in 1991 and the collapse of the regime of communism in the Republic of Moldova. Due to the intensity of the migration phenomenon and poverty, the Republic of Moldova is one of the world leading countries with a very high dependence on remittances. The short description of remittance flow is discussed in the subsequent subchapter. The last subchapter is devoted to differences in migration patterns in two main migration areas – Commonwealth Independent States and the European Union.

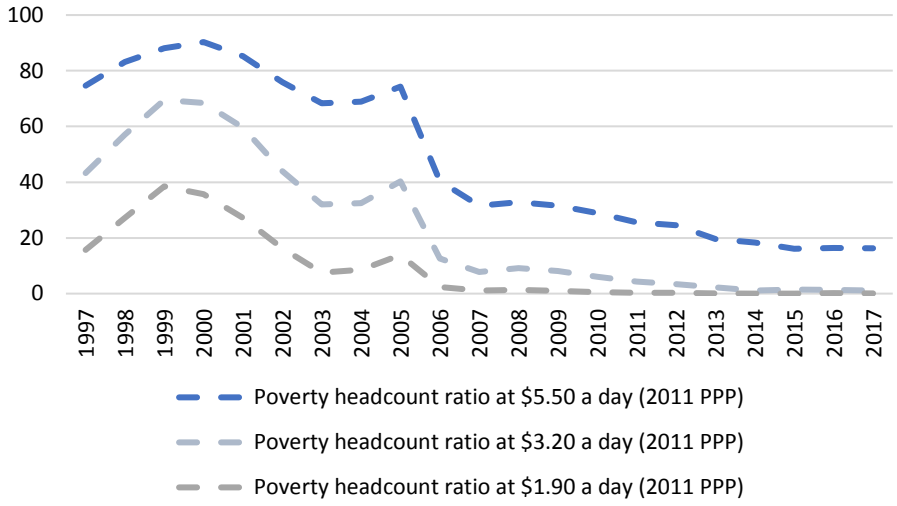
2.1.5. Migration waves and its patterns

Three main migration waves with specific patterns can be recognized (Vanore & Siegel 2015). The first period of migration started after the gain of independence in 1991 and is characterized by the movement of individuals with ethnical or business motivation

(Borodak & Tichit 2014). At least 300,000 individuals were involved in business migration to Turkey, Poland, Russia, Romania, and Germany (Mosneaga 2017). However, the introduction of the visa regime together with the complicated checks and balancing prices in the post-communist countries, business migration has become less advantageous for individual migrants. As a result, business migration (focused on the trade of the products) was replaced by the wave of labor migration. Together with economically oriented migration, ethnic and religion groups such as Jews, Germans and Gagaouzes migrated abroad. Jews migrated mainly to Israel and the USA, Germans to Germany and Gagaouzes to Turkey (Borodak & Tichit 2014). Ethnic migration is characterized by migration of whole families who left the country with the intention to stay abroad permanently (Vanore & Siegel 2015). Beside international migration, internal migration of the individuals living in the Transnistrian region was present as a consequence of the military conflict in 1992 (IOM 2012).

The financial and economic crisis of the Russian Federation in 1998 launched a mass migration from Moldova – large spikes in emigration rates occur during this period (Vanore & Siegel 2015). The Russian economic crisis deeply affected Moldova's economy, since more than half of its exports were aimed to and Russia represented the main commercial partner (IOM 2012). The currency collapse and inflation started to grow, and poverty affected the majority of the population. It is estimated that 69.5 percent of Moldovan citizens lived on less than $3.20 a day (2011 PPP) and 38.5 percent on less than $1.90 a day in 1999 as shown in Graph 2 (The World Bank 2019). Moldovan citizens migrated not only to Russia and Ukraine but also to countries of the European Union, Turkey, Israel, the USA (Mosneaga 2017).

Graph 2 Poverty headcount ratio



Source: The World Bank 2019

The third wave of migration was influenced mainly by the cancellation of visa requirements for Romanian citizens in 2002 as well as by accession of Romania in the European Union and was motivated mainly by opportunities in the external labor market (Eskola 2007). Based on the recent statistics, there were approximately 859,400 Moldovan citizens living abroad in 2013, which is equivalent to 24.2 percent of the population (Ratha et al. 2016).[2] The majority of Moldovan citizens came from rural areas (IOM 2016). The highest rate of emigration is registered in the South region, the poorest region (ILO 2017; Dávalos et al. 2016). Nowadays, Moldovan citizens migrate mostly to Russia, Italy, Romania, Ukraine, Germany, Portugal, Spain, Israel and the United States (Pilarova & Kandakov 2017; Ratha et al. 2016; de Zwager & Sintov 2014). Almost 39 percent of Moldovan households have at least one person involved in international or internal migration and more than 29 percent of household have experience with seasonal or permanent migration (Drbohlav et al. 2017).

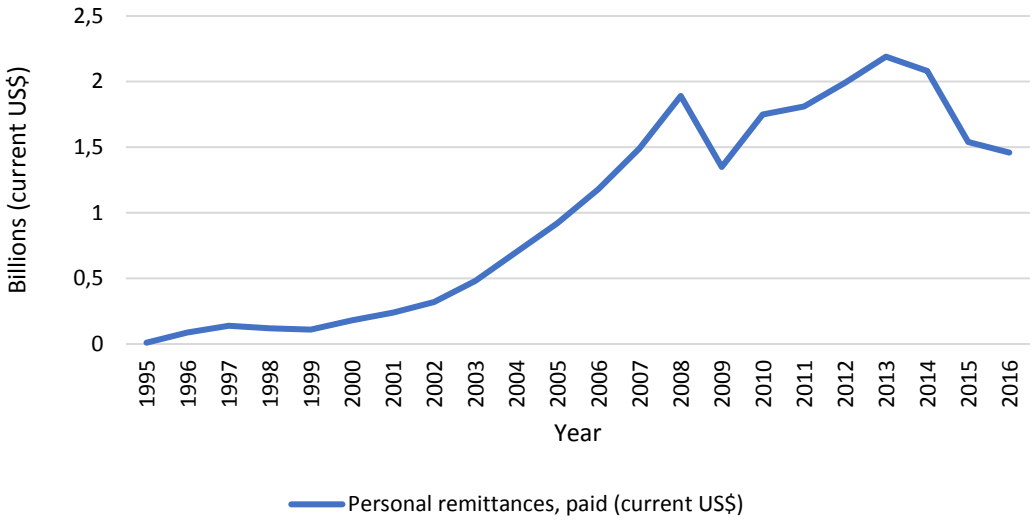
2.1.6. Remittances

Due to the intensity of the migration phenomenon and the domestic economic situation, the Republic of Moldova is one of the world leading countries with a very high dependence on remittances. Based on the data of The World Bank (2019) shown

[2] Remarkable number of Moldovan citizens applied for Romanian citizenship since 1991 and therefore when crossing borders to other countries of the European Union, their move is not recorded as Moldovan citizens, but as Romanian citizens. Consequently, the number of Moldovan citizens living abroad is likely to be underestimated (UNECE 2014).

in Graph 3, the amount of remittances sent by members working abroad increased significantly since 1995. A higher share of households receiving remittances was registered in rural areas compared to urban areas (IOM 2016). According to Pilarova and Kandakov (2017), Salah (2008) and Lücke et al. (2007) the largest share of migrant's remittances is used for household expenses such as food and clothes and also for passive investments, especially house or apartment procurement, the purchase of cars or used for savings.

Graph 3 Remittance flows in the Republic of Moldova



Source: The World Bank 2019

2.1.7. Differences between CIS and EU patterns

Moldovan citizens migrate mainly in two regions with cultural, historical and linguistic similarities: the European Union (Italy, Portugal) and the Commonwealth of Independent States (the Russian Federation, Ukraine) (The World Bank 2010b; IOM 2017). Moldovans who emigrated to European Union countries originate from a central part of Moldova when Moldovans from the northern, eastern and southern part of country migrate mostly to Russia (Drbohlav et al. 2017).

Individual characteristics such as age, gender, educational level of potential migrant (Piracha & Saraogi 2017; Vanore & Siegel 2015; de Zwager & Sintov 2014; Borodak & Piracha 2010; Pinger 2010) play important role in the selection of the region and host country. Likewise, migration is determined by household characteristics including household size, area of residence, legality of the stay, migration monetary costs,

migration networks and by economic and political situation in home as well as host country (de Zwager & Sintov 2014; Bara et al. 2013; Cheianu-Andrei et al. 2013; Borodak & Piracha 2010; Pinger 2010).

The labor migration to the CIS countries (mainly to Russia) is facilitated by cultural and religious proximity, by shared historical past and by a good knowledge of the Russian language (Cheianu-Andrei 2013; de Zwager & Sintov 2014). Russia has a large labor market and offers its employees higher salaries than in the Republic of Moldova. A migration in Russia was facilitated by a visa-free regime within the CIS (since 1992), reduced migration costs and by the possibility of illegal employment at the labor market (Cheianu-Andrei 2013; de Zwager & Sintov 2014). Migrants oriented toward the Commonwealth Independent States are more typically younger men from rural areas engaged primarily in construction and repair sectors, transportation, industry, and agriculture (Dávalos et al. 2016; de Zwager & Sintov 2014; Lücke et al. 2008; The World Bank 2010b).

The labor migration to EU countries (especially Italy and other southern European states such as Spain and Portugal) is facilitated by knowledge of Romanian language (de Zwager & Sintov 2014; The World Bank 2010b). The migration in this region is characterized by a higher prevalence of females from urban area engaged in the service sector, housekeeping, trade and home-care (de Zwager & Sintov 2014; The World Bank 2010b). Migrants tend to be slightly older and more educated than those in the CIS region which is consistent with labor market demand (de Zwager & Sintov 2014). They earn more and send larger amounts of money home than those who work in the CIS (Lücke et al. 2007) as Moldovan migration to the EU tends to be more permanent (de Zwager & Sintov 2014; Bara et al. 2013).

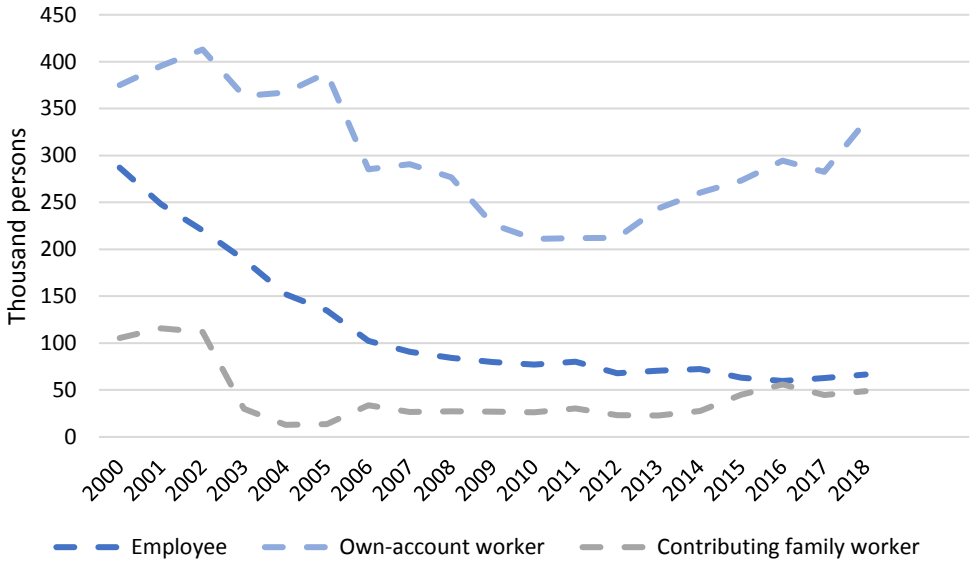
2.2. Labour shortage

2.2.1. Labour shortage and employment in agriculture

Extensive migration leads to labor-force shortages in Moldovan migrants' communities (Cheianu-Andrei 2013). The share of labor employed in the agricultural sector significantly dropped over time due to extensive migration and availability of off-farm jobs in urban areas (The World Bank 2016b; The World Bank & World Food Programme 2015). Every year, rural areas lose a significant share of their labor force, as rural youth leave their homes and migrate to a larger city or abroad in search of a better

future. Around 24 percent of rural youth 15–24 years old is working abroad, compared with only 16 percent employed in the domestic economy, which points to a lack of well-paid job opportunities among young people in rural areas (Dávalos et al. 2016). This tendency has stabilized since the year 2009, due to more favorable conditions for the farming and return of migrant workers from the host countries caused by the economic crisis as shown on Graph 4 (UN Moldova 2012). About 36 percent of male and 29 percent of female in economic active age were employed in agriculture in 2017 (The World Bank 2019).

Graph 4 Employment in agricultural sector



Source: NBS 2019

In contrast, the share of people involved in subsistence farming (less than 20 hours per week) has been rising steadily, from 13 percent to 24 percent. This type of agricultural work performed mostly by elderly people or by individuals with lower education is not officially considered as employment (Dávalos et al. 2016; The World Bank 2016b).

2.2.2. The increased workload for household members

Migration of household member(s) may increase labor work load for members left-behind as was found in Moldova (Salah 2008) as well as in many countries worldwide such as Albania, China, Kyrgyzstan, Nepal and others (Wang 2018; Dávalos et al. 2017; Gartaula et al. 2017; Yan et al. 2016a; Bhattarai et al. 2015; Jaquet et al. 2015; Mendola & Carletto 2012; Chang et al. 2011; Mu & Van de Walle 2011; Schoch et al. 2010). To handle labor-intensive and time-demanding task, families sometimes recruit extra labor

among relatives or friends who are not paid for the work, but it is based on mutual help as was found in Kyrgyzstan (Thieme 2014; Schoch et al. 2010).

Study of Mu and Van de Walle (2011) conducted in China demonstrated that members left-behind (especially women) do not appear work longer or to reduce leisure time because of household members migration, but they are doing more strenuous work during those working hours. However, a study conducted in Moldova by Böhme et al. (2015) found that migration allows elderly people to spend more time on leisure activities instead of engagement in subsistence farming.

The timing of migration plays an important role (Jacobson et al. 2019; Koster et al. 2013). Study of Koster et al. (2013) found that men from Nicaragua migrate in non-peak agricultural season and therefore substitution of farm labor by household members is not necessary. However, men from communities in Peru in Puna Ayllu have to engage in gold mining activities which lead to their absence during the peak agricultural season and therefore women and youth have greater responsibility for many farming tasks (especially for harvesting). Study of Jacobson et al. (2019) mentioned that male migrants from Lvea Krang from Cambodia are available at home to prepare soils for rice planting and consequently reduce some labor costs, but migrants from Popok are away at the time of peak rice planting and fail to reduce food insecurity.

2.3. Livelihood strategies

The chapter describes the range of livelihood strategies which are applied by migrant households to deal with the vulnerability of their livelihoods caused by a labor shortage. When farmers do not have enough labor and financial capital to invest in labor-saving strategies, they may tend to adopt less labor-intensive practices, reduce the scope of their production, lease their farmland or abandon farming as described in subsequent chapters.

2.3.1. Abandonment of crop production

When farmers have to deal with the scarcity of farm resources and farm labor, unfavorable environmental conditions together with the thin and incomplete labor market, all these factors may lead to the modification of farmers land arrangement behavior and to the insufficient land management. As a result, farmers may rent their land to somebody else, abandon cropland and keep their landholding fallow as was found in Moldova (Leah 2016) as well as worldwide (Khanal 2018; Ji et al. 2018; Xu et al. 2017; Qian et al. 2016;

Sunam & McCarthy 2016; Yan et al. 2016b; Craven 2015; Craven & Gartaula 2015; Jaquet et al. 2015; Li et al. 2012; Robson & Nayak 2010; Sikor et al. 2009).

Based on the statistics of General Agricultural Census performed in The Republic of Moldova in 2011, about 11 percent of the total utilized agricultural area or 20 percent of arable land remain uncultivated (abandoned) as a consequence of migration of rural population, old age of the owners and inability to invest in agricultural production (Leah 2016).

Study of Robson et al. (2018), Robson and Berkes (2011), Qin (2010) and Möllers et al. (2016) revealed that the absence of key household laborers can lead to increasing abandonment of previously cultivated distant landholding in China and southern Mexico as well as in Moldova. The abandoned plots in The Republic of Moldova are rather small, difficult to reach and poor quality (Möllers et al. 2016).

Some households choose to move away from the agriculture because its members are more attracted by off-farm jobs and consider agriculture less attractive activity (López-Feldman & Chávez 2017; López-Feldman & Escalona 2017; Craven & Gartaula 2015; Quisumbing & McNiven 2010; McCarthy et al. 2009). In this regard, the study of Li et al. (2012) conducted in Qinling mountain area in China found that remaining members in the household have lower incentive to invest in productive assets and they rather choose to abandon their farmland and forest land. Study of Hu and Rahman (2015) realized in Sichuan Province in southwest China found that especially rural households with elderly family members or those with a young wife are generally more willing to rent out land when men migrate abroad compared to households with a different composition. Research of Sunam and McCarthy (2016) and Jaquet et al. (2015) revealed, that small-scale farmers from Sunsari and Kaski district of Nepal practice sharecropping called “adhiya” when the households rent the land to somebody else and receive half of the production. However, some household who were involved in sharecropping before the departure of household member abroad abandon this practice and they are not interested to continue in sharecropping or farming even after the return of their household members from abroad. The main reason is, that farmers are not capable to continue with sharecropping due to lack of labor required for plowing and other farm activities (Sunam & McCarthy 2016). Study of Qian et al. (2016) conducted in Jiangxi Province in China demonstrated that farmers rather leave the farmland abandoned than rent it out to

somebody else due to the absence of land transfer markets and the imperfect land property rights institutional system.

The specifics of the migration (such as the type of migration, seasonality or host country), landform conditions, wealth status, or farmer´s experience, skills and education play important role in farmers behavior as was found in Kyrgyzstan, China and Thailand (Pan et al. 2018; Xie & Jiang 2016; Garip 2014; Atamanov & Van den Berg 2012). Study of Atamanov and Van den Berg (2012) from Kyrgyzstan revealed, that permanent migration has a large negative effect on crop production and income when seasonal migration does not have any effect. Seasonal migrants may return home during the peak period and help other household members with intensive farm activities. Moreover, migrant workers with farming experience prior to migration have closer ties to the farmland and agricultural production in general and are significantly less likely to abandon land compared to others. The study of Zhu et al. (2019) conducted in Zhejiang Province in China demonstrated that the size of land holdings plays an important role in the decision to invest remittances in productive assets.

2.3.2. Adoption of labor-saving strategies

When household members are not able to sufficiently replace missing family labor by productive inputs (including fertilizers, irrigation, etc.), but they are able to continue with farming despite the migration of their relatives, they may tend to adopt labor-saving strategies and shift from growing of labor-intensive crops into the less labor-intensive ones. As an example, as was found in several countries worldwide, farmers opt for shifting from cash crop production into the subsistence crop production (Qian et al. 2016; Shi et al. 2011; Damon 2010; Miluka et al. 2010), shifting from traditional plants to high-value and low labour crops (DiCarlo et al. 2018), from multiple cropping system to the single cropping system (Yan et al. 2016b), from traditional multi-species systems toward monocultures (Robson & Berkes 2011) or from production of two season rice in one season rice production (Shi et al. 2011). The preference of subsistence production instead of commercial production may be caused due to the motive of members left-behind to ensure their food security (Damon 2010). However, the study of Aguilar-Støen et al. (2016) conducted in Guatemala demonstrated that migrant household receiving remittances tend to cultivate corn to a lesser extent than others and focus more on the planting of perennial cash crops such as coffee.

2.3.3. Reduction of inputs and land dedicated to agricultural activities

In general, as was found by many studies worldwide as well as in The Republic of Moldova[3], migration of household member may result in disintensification of agricultural production (e.g., the use of fewer inputs per unit area) (Gray & Bilsborrow 2014; Shi et al. 2011; Qin 2010), in lower productivity and profitability (Maharjan et al. 2013) and in reduced technical efficiency especially in households with absent men and young adults (Sauer et al. 2015). Migration may lead to decrease of the scale and intensity of agricultural activities and land use (Yan et al. 2016a; Hu & Rahman 2015; Shi et al. 2011; Qin 2010), to decline in the livestock, grain and cash crop production value (Qian et al. 2016), to reduction of cultivated area and amount of food crops (Zhunusova & Herrmann 2018; Craven 2015; Bolganschi et al. 2015), allocation of crops that require minimum resources (Bolganschi et al. 2015), to decrease of the number or area of gardens (Craven 2015) and to lower crop diversity (Craven 2015; Hu & Rahman 2015; Robson & Berkes 2011; Robson & Nayak 2010; McCarthy et al. 2009). Study of Oldekop et al. (2018) found that migrant households with land with lower slopes deal with lost agricultural labor by reducing of the amount of land dedicated to agriculture, by spending less time on agricultural activities, by increasing investment in labor-saving technologies and by maintaining their agricultural production by farming smaller areas more intensively.

2.4. Investment

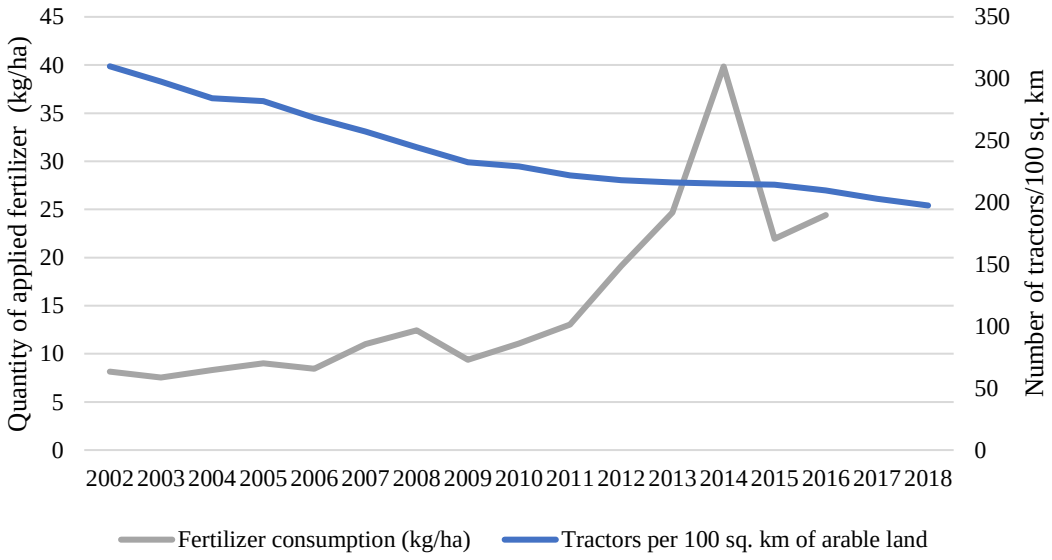
2.4.1. Investment in farm assets

The use of inorganic fertilizers, pesticides and irrigation declined in the Republic of Moldova during the period of transition. First, before the independence of Moldova, chemical fertilizer and heavy machinery were used extensively benefiting from direct and indirect subsidies from USSR. The utilization of both farm assets dropped dramatically over the period which was caused by credit-constraint, inability to purchase farm assets and by weak development of the local market (Spoor & Izman 2006). Despite the increase in recent years, which is shown in the Graph 5, the level of fertilization of agricultural land remains to be much lower in comparison to other European countries (FAOSTAT 2019; Moroz & Ignat 2015). Fertilizers, pesticides, and fuel are largely imported to the country due to the absence of local production of these inputs and small-scale farmers are

[3] Bolganschi et al. (2015)

often exposed to input volatility (Moroz et al. 2015; Spoor & Izman 2006; UNEP undated).

Graph 5 Utilization of inorganic fertilizers and tractors



Source: The World Bank 2019

Second, irrigation infrastructure is almost inexistent among small-scale farmers (The World Bank 2010a). Irrigated land has reduced dramatically compared to the Soviet period which is caused mainly by aging and deterioration of the infrastructure and no replacement by new parts. Moreover, farm reforms and the overall collapse of the agriculture sector since the 1990s contributed to the diminished use of irrigation facilities (The World Bank, CIAT 2016; Spoor & Izman 2006). Small-scale farmers are not able to invest in high-value agriculture. Based on the recent statistics, only nine percent of agricultural land is irrigated (FAOSTAT 2019).

2.4.2. Adoption of sustainable agricultural practices

The adoption of SAPs such as conservation agriculture, establishment of farmland protection forest belts, implementation of phyto-technical measures such as cultivation of alternative crops in strips, grassing the space between rows in plantations and growing green manure, which has the potential to prevent soil degradation, improve soil quality and enable to small-scale farmers to adapt to climate change (Boincean et al. 2016; Boincean & Lal 2014; Wiesmeier 2018; Cerbari & Leah 2016; Moroz et al. 2015; Leah 2012a; Leah 2012b), is relatively low. Based on the statistics from year 2015/2016,

conservation agriculture was adopted on 60,000 hectares of land that is about 20,000 hectares more than in 2014/2015 (Kassam et al. 2019; Kassam et al. 2015).

Another measure facilitating combating of soil compaction should include the application of organic fertilizers such as plant residues, manure, compost, green manure, sludge from livestock and household waste. Application of organic matter leads to the accumulation of humus in the soil layer and lead to the improvement of soil fertility (Leah 2015). However, the reduction of specialized livestock complexes led to the lowering of the volume of applied organic fertilizer to the soil (Spoor & Izman 2006). Many farms have to deal with a lack of financial resources which limits their adaptive capacity (Sutton et al. 2013).

2.4.3. Soil degradation

Intensive soil tillage and utilization of heavy farm machinery together with the intensive application of chemical inputs including pesticides, herbicides, and inorganic fertilizers have resulted in severe degradation of Chernozem soils and decline of soil fertility and reduction of humus layer during the period between 1960 and 1990 (Leah 2015). However, low adoption of SAPs, use of inappropriate soil cultivation technologies and non-sustainable farming activities, failure in crop rotation, lack of financial capital and funding at all levels, inappropriate land management and inefficiencies in land-use planning affect soil quality and lead to further deterioration of the soil structure (IFAD 2018; Krupenikov et al. 2011; The World Bank 2010a). As a consequence, Chernozem soil lost approximately 40 % of the initial amount of soil organic matter which led to the significant decline of soil fertility and productivity (Krupenikov et al. 2011) and soil degradation lead to 3.1 billion of MDL losses every year (IFAD 2018). Moreover, inappropriate storage and use of chemicals an organic fertilizer (such as manure) together with inadequate nutrient management practices have contributed to the pollution of surface and groundwater resources (The World Bank 2013).

2.4.4. Vulnerability to climate hazards

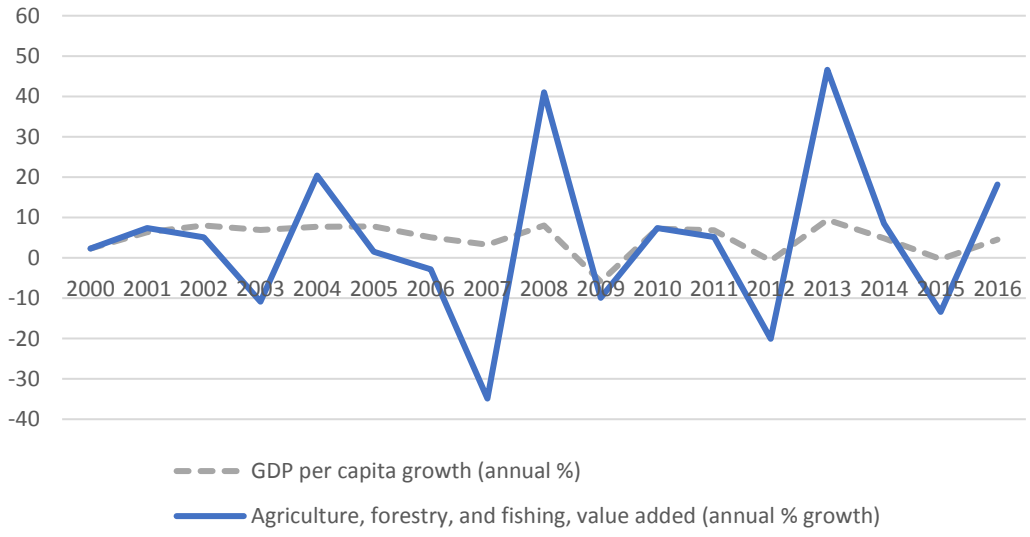
Despite that agricultural production is very vulnerable to natural hazards, the majority of small-holders (typically with an area of land less than ten hectares) lacking the access to financial capital to improve crop productivity and resilience (The World Bank 2016b). Consequently, inadequate use of protective measures (including mulch and distribution of timely meteorological information to farmers) together with low adoption´

rate of SAPs make small scale-farmers unprotected against extreme climate events. As a majority of crop production is rain-fed, crop yields are frequently affected by the incidence of natural hazards including drought, erosion or hail representing one of the main limiting factors affecting crop production in the Republic of Moldova (Potopova et. al. 2016; Leah 2012c; Potop 2011; UNDP 2009; The World Bank, CIAT 2016). For the period spanning from the independence of Moldova to 2018, the Republic of Moldova has already experienced several years of extreme droughts.

Small-scale farmers with land holding up to 1.5 hectares as well as farmers situated in the central hot semi-humid and south hot-arid zones are the most vulnerable segment of rural population to a climate change (UNDP 2009; Leah 2012b; UN Moldova 2012). Climate change can decrease productivity through the losses in yields, which affect especially those farmers who rely on self-production for subsistence purposes, but at the same time it leads to higher food prices, which affect consumers (The World Bank 2016b). Wheat and maize production is frequently affected by a drought occurrence (The World Bank 2016b; Potopova et al. 2016; UNDP 2009). Therefore, climate change can seriously undermine food security of small-scale farmers, as shown in 2007 when severe drought occurred and affected availability and quality of food (The World Bank 2016a).

The Graph 6 illustrates recent trends in gross agricultural production and GDP/capita growth showing high fluctuations during years of severe drought in several years (especially in years 2003, 2007, 2009, 2012 and 2015).

Graph 6 Added value in agriculture and GDP per capita growth



Source: The World Bank (2019)

Apart from drought, in some localities, households have to deal with lower crop yields affected by extreme hail events. For instance, the occurrence of hail caused yields losses amounted to 70 – 100 percent of the production in the Stefan Voda district in the year 2016 (The World Bank, CIAT 2016). Wind, soil erosion and flood are other hazards causing significant damages to agricultural production in Moldova. Approximately 43 percent of the cropland is somehow eroded and more than six percent of agricultural lands are considered to be highly eroded (Leah 2012a).

2.5. Remittances

Remittances sent by household members working abroad may help to small-scale farmer overcome credit constraints and facilitate investment in productive assets and adoption of SAPs, however sometimes the amount of remittances is too low or household members are not motivated enough to invest in agriculture, which consequently leads to transition out of agriculture and investment only in direct consumption.

2.5.1. Adoption of capital-intensive activities

Remittances sent by members working abroad allow poor rural small-scale farmers to relax credit constraints (Chiodi et al. 2012; Bredl 2011) and enable them to invest in farm assets and technology as was found by the qualitative results of Piras et al. (2018) in Moldova and many studies worldwide (Baird et al. 2019; Qian et al. 2016; Yang et al. 2016; Böhme 2015; Sauer et al. 2015; Ducrot 2017; Caulfield et al. 2019; Radel et al. 2018; Kpadonou et al. 2017; Sauer et al. 2015; Manivong et al. 2014; Wang et al. 2014; Atamanov & Van den Berg 2012; Gray 2009). The study of Piras et al (2018) demonstrated that investments in greenhouses, rototillers or walnut orchards were done thanks to remittances. The percentage of household investing in farms is the highest in the northern region of the country (Hristev et al. 2009). Frequently, migrants from the same community invest in the similar type of businesses including investment in mills, vegetable greenhouses, which consequently contributes to higher competition in the local market and lead to low profitability of the businesses (The World Bank 2010b). When taking into account destination of migrant, Moldovan migrants in Italy and Portugal invest more in farm land and equipment in Moldova compared to migrants in Germany, United Kingdom, Israel and Russia (Cheianu-Andrei 2013).

All these investments allow farmers to overcome labor loses caused by migration, enable families to continue cultivating crops for household consumption (Isakson 2009)

and boost crop yields and raise land productivity (Taylor & Lopez-Feldman 2010). Study of Baird et al. (2019) conducted in Vietnam found that lower labor availability caused by migration of villagers to Laos contributed to the higher interest in mechanization, which has become more available and cheaper in the area.

Villagers living in the plain rural areas are more likely to invest remittances and purchase farm assets when the residents of mountainous areas rather tend to abandon their land and agricultural activities (Pan et al. 2018). Study of Garip (2014) conducted in Nana Rong in Thailand demonstrated that rich household are more likely to lose productive assets including small tractors called "*itans*", larger tractors and number of cows, buffalos and pigs, because they are not able to deal with the labor shortage, but poor households gain productive assets as remittances enable them to overcome credit constraints.

The studies conducted in Kenya and West African countries found that remittances facilitate the adaption to climate change (Ng'ang'a et al. 2016) and adoption of modern or SAPs improving soil condition such as zaï pits (Kpadonou et al. 2017; Wouterse 2017), fallowing, mulching and composting especially in case of poor or land-constrained households (Kpadonou et al. 2017). Study of Ng'ang'a et al. (2016) suggested that households with at least one member who migrated abroad purchase agricultural innovations. However, the study of Caulfield et al. (2019) conducted in the rural Andes demonstrated that migration decreases the use of soil and water conservation techniques and at the same time, remittances were associated with an increased application of pesticides and chemical fertilizers and mechanized tillage.

2.5.2. Pay of temporary wage day laborers

Remittances can be used also to pay temporary wage day laborers to compensate for the lost labor caused by migration and to reduce the left behind children and women's time allocation for agriculture as was found in Nepal, Kyrgyzstan and Guatemala (Maharjan et al. 2013; Xu 2017; Thieme 2014; Schoch et al. 2010; Isakson 2009). In this regard, the study of Isakson (2009) from Guatemala found that among households receiving remittances, one-third of them hire workers called "mozos" who complete all agricultural tasks. However, the labor shortage in villages caused that mostly male teenagers in their final years at school or young villagers who have not yet migrated are hired (Schoch et al. 2010). The hiring of agricultural workers is sometimes difficult

because only a few people remain in the village and therefore households are largely dependent on family labor despite they have money to hire labor (Robson & Berkes 2011).

2.5.3. Transition out of agriculture

Even if the household receives remittances, members may decide to reduce the work effort because they are not motivated to farm, and the migration can be seen a part of a strategy to move out of agricultural production as was found in Moldova as well as Albania (Bolganschi 2011; Miluka et al. 2010). In Moldova, generally, there is an ongoing decline in investment interest in agricultural production and real estate (de Zwager & Sintov 2014). Migrants' households invest even less in farm machinery and maintenance of equipment than non–migrants' households. Smallholders with members working abroad prefer to use their remittances to abandon agriculture rather than to invest in modern farming technology (Bolganschi 2011). Recent research from Moldova conducted by Piras et al. (2018) showed that households receiving remittances are not more likely to sell or purchase farm assets and that non-recipient households do not significantly differ from those who receive remittances.

As was found by studies worldwide, remittances may represent a source of supplementary income which can consequently lead to pulling out of subsistence crop production (Maharjan et al. 2013) since members-left behind changed attitudes and perception towards food security and towards the role of subsistence farming as the primary source of food and they prefer to purchase imported food (Wang et al. 2017; Craven 2015; Craven & Gartaula 2015). In this regard, the study of Wang et al. (2017) revealed, that farmers are discouraged to use the winter wheat-summer maize double cropping system and they prefer to purchase wheat products from the market using non-farm income. Study of Robson and Nyak (2010) and Robson and Berkes (2011) conducted in southern Mexico found that decline in cultivated area of corn, beans, and other staple crops caused that households purchase approximately 2/3 of staple food product from the local food store and markets and only a few households produce enough crops to meet their consumption needs throughout the whole year. Study of Gray & Bilsborrow (2014) focusing on agricultural production and rural environment in Ecuador suggests that remittances are substituting for agricultural production, allowing a decrease in the agricultural effort. Consequently, the whole subsistence agricultural production

system becomes more vulnerable, unproductive, less sustainable and less secure against changing weather patterns (Craven 2015) and migrant households become completely dependent on imported and bought food (Craven 2015; Craven & Gartaula 2015).

2.5.4. Investment in direct consumption

In Moldova, remittances are mainly used to cover basic daily needs including (food, clothing, etc.) of the family, and then for improving the living conditions (such as buying new furniture and home appliances etc.), as well as to expand a house (de Zwager & Sintov 2014; Cheianu-Andrei 2013). Based on the study of Cheianu-Andrei (2013), a small amount of remittances is spent on production and investments in land or agricultural equipment. However, the study of Hristev et al. (2009) confirmed the findings of Ochieng et al. (2017) that households receiving a limited amount of remittances spent money for consumption purposes, but a higher amount of transfers allow farmers to invest in agriculture. Moreover, Hristev et al. (2009) point out to regional differences. Those households located in central and southern regions spend a much higher share of remittances for covering basic needs and purchasing of durable goods.

3. Research objectives

3.1. The main objective and specific objectives

Main objective

The main objective of the thesis is to analyze differences between non-migrant households and households with member(s) working in CIS and EU countries regarding the land use, utilization of productive assets and adoption of SAPs to take into account different migration patterns in two main migration areas and to determine the impact of remittances on the agricultural production patterns.

Specific objectives

The main objective of the thesis will be accomplished through specific objectives:

a) Determination of differences between non-migrant households and households with relatives working in European Union country and Commonwealth Independent State in the land use, utilization of farm assets and adoption of SAPs
b) Estimation of the effect of remittances on the utilization of farm assets
c) Estimation of the impact of remittances on the adoption of SAPs
d) Determination of main factors affecting utilization of farm assets and adoption of SAPs

3.2. Research questions and hypothesis

Remittances sent by members working abroad may allow poor rural farmers to relax credit constraints (Chiodi et al. 2012; Bredl 2011) and enable them to invest in productive assets (Baird et al. 2019; Caulfield et al. 2019; Radel et al. 2018; Ducrot 2017; Kpadonou et al. 2017; Qian et al. 2016; Yang et al. 2016; Böhme 2015) as well as SAPs (Kpadonou et al. 2017; Wouterse 2017). However, the empirical evidence regarding the impact of migration and remittances on agricultural production in the Republic of Moldova is limited.

Therefore, the research questions and hypothesis included in Table 1 will be used to determine the impact of remittances on the utilization of productive assets and the adoption of SAPs in rural areas of the Republic of Moldova.

Table 1 Research questions and hypothesis

Res. question	Hypothesis	Method of verification	Test of models
RQ1: Do international remittances encourage the use of farm assets?	1) H_0: There are no differences between migrant and non-migrant households regarding the use of productive assets	One-way ANOVA / Kruskal-Wallis test (Kruskal and Wallis 1952) Chi-square test (Pearson 1900) / Fisher exact test (Fisher 1922)	Normality: Shapiro - Wilk test (Shapiro and Wilk 1965) Homogeneity of variance: Bartlett's test for equal variances (Bartlett 1937)
	2) H_0: Remittances do not have any effect on the utilization of chemical inputs 3) H_0: Remittances do not have any effect on the use of farm machinery 4) H_0: Remittances do not have any effect on use drip and sprinkler irrigation	Binary probit model, a multivariate probit model	Multicollinearity: variance inflation factor (VIF). If VIF >10 - problem with multicollinearity (Kleinbaumet al. 2013) Heteroscedasticity: test proposed by Wooldridge (2014) Endogeneity: extended probit regression model (Stata 2017) Instrumental variables: bank account ownership and presence of HH member(s) in the EU
RQ2: Do remittances facilitate the adoption of SAPs?	5) H_0: There are no differences between migrant and non-migrant households regarding the adoption of SAPs	One-way ANOVA / Kruskal-Wallis test (Kruskal and Wallis 1952) Chi-square test (Pearson 1900) / Fisher exact test (Fisher 1922)	Same as RQ1 H: 1
	6) H_0: Remittances do not have any effect on the adoption of SAPs	Binary probit model, a multivariate probit model	Same as RQ1 H: 2,3,4
RQ3: What factors influence the adoption of SAPs	-	Binary probit model, a multivariate probit model	Same as RQ1 H: 2,3,4

4. Methodology

4.1. Target area

A multistage sampling technique was adopted to select the target areas for the empirical study. The first stage involved the purposive selection of districts (the Orhei district, the Soroca district and the Cantemir district) to include districts with various agricultural potentials. In each district, two or three communes were selected as shown in Figure 3.

Figure 3 The Republic of Moldova with study districts and selected communes

4.1.1. Agricultural production and migration patterns in surveyed regions

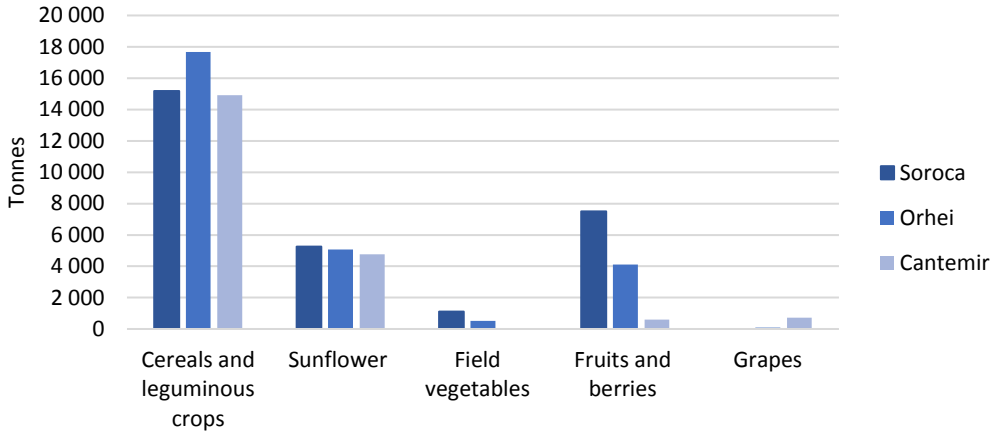
Agricultural production

The Republic of Moldova is divided into three agro-ecological zones. The North region is the most developed area regarding the animal and crop production benefiting from the favorable climatic conditions and fertile soils. This region along the Dniester River (a forest-steppe) is characterized by high productivity rates for pastures and livestock but is also suitable for growing of crops such as maize, wheat, sunflower, soybean, barley, sugar beet, potatoes and apples (Möllers et al. 2016; The World Bank, CIAT 2016).

Soroca, which is located in the North region is, therefore, the most suitable region for field vegetable and fruit production out of the three surveyed districts which are presented in Graph 5. However, the district is more sensitive and vulnerable to climate changes relative to Orhei district (Corobov et al. 2013; Cantemir district was not assessed). The Central region (a hilly and forested area) is suitable for growing of perennial crops (vineyards and orchards).

Farms in the Orhei region profit from the presence of large markets located in the district and in the capital city Chisinau (Möllers et al. 2016; The World Bank, CIAT 2016). In Orhei, small-scale farmers are mostly involved in cereal and leguminous and sunflower production (NBS 2019). The Southern region (a mix of hills and plains) is exposed to a dry climate condition affecting crop production and due to higher temperatures and low rainfall, South region is less suitable for agricultural production compared to other regions. Consequently, in Cantemir district located in South agro-ecological zone the production of field vegetable, fruit and berries is lower compared to other regions (Möllers et al. 2016; The World Bank, CIAT 2016).

Graph 7 Gross harvest of agricultural crops in surveyed districts in 2016



Source: NBS 2019

Migration patterns

Soroca and Orhei districts are characterized by the higher level of migration to the Russian Federation. The proportion of migrant to Italy and Russia is more equable in Cantemir district (NBS 2019). Poor rural households are often not able to finance the transition to EU countries and instead send migrants in Russia and the CIS, because migration to these countries is less costly due to geographic proximity and visa-free travel (de Zwager & Sintov 2014).

4.2. Data collection and target group

Small-scale farmer quantitative questionnaire survey, a local expert online questionnaire survey and face-to-face qualitative interviews with local extension providers were used to compare qualitative and quantitative results and identify areas of overlap.

Table 2 Data collection

	Small-scale farmers questionnaire survey	Local expert online questionnaire survey	Face-to-face qualitative interviews
Target area	Orhei, Soroca and Cantemir districts	Whole country	Orhei district
Target group	Small- scale farmers with an area of landholding less than ten hectares	Extension services providers Governmental organization NGOs Farmer association University staff	local extension providers from ACSA
Time	July and September 2016	August and October 2016	July 2016
Sample	234*	64	5
Sampling	Purposive selection of target areas A systematic random** sampling of respondents	Purposive sampling to cover various fields of expertise	Purposive sampling

Note: * In total, 282 questionnaires were collected, 48 questionnaires were excluded due to farm size larger than 10 hectares

** the sample size was calculated as following: at least 30 respondents/village with confidence interval 90 %, margin of error 15 %

First, the *small-scale farmer quantitative questionnaire survey* was conducted between July and September 2016. Prior to the survey, the questionnaire was tested with a pilot group of five respondents in Orhei district and a questionnaire was subsequently adjusted. The survey was supported by the local extension providers from the National Agency for Rural Development (ACSA) and by the staff of the State Agrarian University of Moldova (SAUM). The final sample includes in total 234 small-scale landholdings located in the Orhei district, the Soroca district and the Cantemir district.

Agriculture is characterized by the existence of many small fragmented family farms and only low number of corporate holding such as limited liabilities companies and agricultural cooperatives as a consequence of land reforms (Cimpoies & Semionova 2018; Hartvigsen 2014; Hartvigsen et al. 2012). Following a definition of small-scale farming in the Republic of Moldova, only those farmers with an area of the farmland smaller than ten hectares are included in the final sample (NBS 2015). Majority of small-scale farmers is orientated towards the production of potatoes, maize and vegetables, fruits and table grapes (Möllers et al. 2016; The World Bank, CIAT 2016) for consumption purposes and the rest of production is sold mainly on the local market (Cimpoies & Semionova 2018; Möllers et al. 2016; Moroz et al. 2015). Most of the

livestock (cattle, swine, sheep, goats, horses, and poultry) is breed by small-scale farmers (Ignat & Moroz 2013).

Systematic random sampling was used to select respondents. In each household, only one member was included in the survey. In the majority of cases, the household head was interviewed, whenever he/she was absent due to involvement in an off-farm job in another part of the country or due to labor migration abroad, the household member responsible for the farming activities was included.

The questionnaire (included in Annex 7) contains the following information about smallholder characteristics and farm livelihood activities in the survey year 2016:

a) Farmer/household head characteristics (age, gender, education, income, citizenship, the area of residence)
b) Household composition (number of members including children (younger than 15 years), adults (between 15 and 60 years old) and elderly people (older than 60 years)), wage and family farm labor
c) Information about crop and animal production such including a quantity of the product consumed and sold on the market, market channels, quantity of breed animals, number of pieces used for the milk, meat or draft
d) Land use (land size, number of plots, a distance of plots to the house, rental of land)
e) Utilization of productive assets (farm machinery, chemical inputs, irrigation), adoption of SAPs
f) Migration and remittance patterns (host country, presence in a host country, past responsibilities, investment of remittances)
g) Utilization of extension services
h) Ownership of household assets (electricity, indoor toilet, car, etc.)
i) Barriers of agricultural production (drought, erosion, pest infestation, credit constraints, market instability and more)

Second, to understand the migration issue in the Republic of Moldova more thoroughly, an *online structured questionnaire survey* was made available to local experts on SurveyGizmo platform between August and October 2016. Participants were selected by purposeful sampling to cover various fields of expertise. The questionnaire was distributed to 64 local experts in fields shown in Table 3.

Table 3 Distribution of respondents based on their profession, qualitative survey

Representatives of	Central region	North region	South region
Extension services providers	7	8	0
National Agency for Rural Development (ACSA)	12	16	8
Governmental organisation	4	0	0
Non-governmental organisation	6	7	0
Farmer association	3	1	0
University staff	11	2	1
Total	43	34	9

Note: The total number of respondents is 64 – several respondents occupy more positions

The questionnaire (shown in Annex 8) includes information about local experts and their perception of the following topics:

a) Specialization and location of the respondent (organization)
b) Differences between migrant and non-migrant households in land use and investment in productive assets
c) Impact of migration and remittances on land use
d) Factors affecting agricultural production
e) Impact of climate change on the likelihood of migration

Third, *face-to-face qualitative interviews* were conducted with five local extension providers from ACSA in Orhei district in July 2016.

4.3. Quantitative data analysis

The empirical approach included two main parts. First, descriptive and inferential statistic were performed to analyze differences between households with a migrant in European Union country, CIS country, and non-migrant households. One-way analysis of variance (ANOVA), Kruskal-Wallis test, Chi-square test, and Fisher exact test were used. Second, simple binary probit and multivariate probit model was adopted to determine factors influencing utilization of several farming practices including application of chemical inputs, use of farm machinery and irrigation facilities, adoption of SAPs. Several tests were performed to check for multicollinearity, heteroskedasticity, and endogeneity of variables included in the models.

4.3.1. Descriptive statistic

To determine if there is a difference in means between two or more independent groups, the one-way ANOVA was planned to be used. However, there are several assumptions which should be fulfilled.

Assumptions:

1. The dependent variable is measured at the continuous level
2. Independent variable consists of two or more categorical, independent groups
3. No relationship between the observations in each group or between the groups themselves
4. The data does not include significant outliers
5. The dependent variable is normally distributed for each category of the independent variable
6. Homogeneity of variances

Source: Laerd Statistics 2018

The assumption of normality was tested by Shapiro-Wilk (Shapiro and Wilk 1965) test and assumption of homogeneity of variance was verified by Bartlett's test for equal variances (Bartlett 1937) (Williams, undated). Despite that the assumption of homogeneity of variances was fulfilled, the assumption of normality was not achieved. Therefore, the Kruskal - Wallis test (Kruskal and Wallis 1952) was used instead of one-aay ANOVA. The test of normality of residues, results of one-way ANOVA and Barlett´s test for equal variances of residues are available upon request.

The χ^2 test (Pearson 1900) and Fisher exact (Fisher 1922) test were applied for binary or categorical dependent variables. The χ^2 test of independence was used to determine whether variables are independent of each other or whether there is a pattern of dependence between them. Fisher exact test was used when the expected frequency was lower than five.

4.3.2. The binary and multivariate probit model

Binary probit model

Simple binary probit was run to determine characteristics influencing the adoption of farming practices including utilization of owned machinery, application of chemical inputs, utilization of irrigation infrastructure and adoption of SAPs. Each farming practice

was a dependent variable equal to one if a small-scale farmer used this practice in 2016 and zero if otherwise. The detail description of dependent variables (as well as independent variables) is included in chapter 4.3.5. Marginal effects are presented in the results part.

The binary probit model in the following form was used:

$$Y_{ik} = \beta_1 X_i + \varepsilon_i \quad (1)$$

where Xi represents a set of all explanatory variables presented in Table 4, $\beta 1$ is a vector of estimated parameters and εi is an error term. Yik is a dependent variable where k denotes if a farmer used farm machinery, chemical inputs, SAPS and irrigation facility.

The system of equations describing binary choices of small-scale farmers is given as follows:

$$Yik = \{1 if Yik > 0$$

$$0 \quad otherwise \quad (2)$$

Multivariate probit model

The univariate probit (or logit) models could be inefficient when farm practices are interrelated and can lead to biased estimates (Khanna 2001; Dorfman et al. 1996) since univariate models ignore the correlation in the error terms of several equations. Moreover, small-scale farmers might consider a combination of several farming practices as complementary and others as a substitution (Belderbos et al. 2004; Khanna 2001; Dorfman et al. 1996). Farmers might be more likely to adopt a mix of several practices than just a single practice to improve their production and boost up crop yields. Therefore, the multivariate probit (MVP) model was applied. The MVP recognizes the correlation in the error terms of utilization equations and estimates a set of binary probit models (in our case five probit models) simultaneously.

4.3.3. Multicollinearity, heteroscedasticity, endogeneity

Multicollinearity

The regression model was tested for the presence of multicollinearity using a variance inflation factor (VIF). Since the empirical model includes a large number of independent explanatory variables, multicollinearity is a potential issue. Despite that collinearity does not bias parameter estimates, it can influence the standard errors.

Moreover, the model becomes sensitive to changes in the sample size or in the model structure (Greene 2003).

Various recommendations regarding the value of VIF and level of tolerance have been proposed. Most commonly, the value of ten as the maximum level of VIF and a value of 0.10 has been recommended as the minimum level of tolerance (Kleinbaumet al. 2013). However, a suggested maximum VIF value of five (Schuenemeyer & Drew 2011) or four (Hair et al. 2010; Pan & Jackson 2008) and minimum value of tolerance 0.20 (Hair et al. 2010) or 0.25 can be found in the literature (Huber & Stephens 1993). When the multicollinearity among variables cannot be rejected, exclusion of independent variable from the model, application of ridge regression, weighted least squares can be used (Stata undated).

VIF was estimated using the formula stated below:

$$VIF_k = \frac{1}{1 - R_k^2}$$

where R_k^2 is the R^2-value obtained by regressing the k^{th} predictor on the other specified explanatory variables. Variance inflation factor is calculated for each of the k predictors included in a multiple regression model.

Heteroscedasticity

The test of heteroscedasticity was adopted for the binary probit model. Heteroscedasticity, in particular, can cause problems such as incorrect standard errors or biased and inconsistent parameters.

The test of heteroscedasticity for binary probit model proposed by Wooldridge in Stata Forum (2014) was applied as follows (the syntax in the parentheses):

1. Estimation of our model by binary probit model (probit y x1 x2 ... xK where y is an outcome variable and x1 x2 ... xK are independent variables)

2. Obtaining the fitted linear indices x(i)*bhat (predict xbhat, the index where x is independent variable)

3. Estimation of the augmented model by probit model. Syntax includes the original independent variables x(i) and then [x(i)*bhat]*x1(i), (probit y x1 x2 ... xK c.xbhat#c.x1 c.xbhat#c.x2 ... c.xbhat#c.xK where y is dependent variable, x1 x2 ... xK are independent variables, x1(i) is the subset of x(i) in the heteroskedastic function)

4. Testing of the joint significance of the interactions by the adoption of the standard Wald test for exclusion restrictions (test c.xbhat#c.x1 c.xbhat#c.x2 ... c.xbhat#c.xK)

Endogeneity

Furthermore, the model was tested for endogeneity. Empirical model specifications may suffer from an endogeneity due to the presence of omitted variables, sample selection bias, measurement error and reverse causation (Carter Hill et al. 2008; Greene 2003; Wooldridge 2002). Since estimation with endogenous variables can lead to biased and inconsistent results (bias in the coefficient estimates of the explanatory variables) (Wooldridge 2016), an instrumental variable (IV) method was applied to adequately address endogeneity.

Previous studies focusing on the impact of labor migration and remittances on land use, farm production, farm labor and rural environment addressed the potential endogeneity issue by using of instrumental variable approach such as 2SLS (Tshikala et al. 2018; Zhu et al. 2019; Ng'ang'a et al. 2016; Yin et al. 2016; Böhme 2015; Maharjan et al. 2013; Atamanov & Van den Berg 2012; Zhu et al. 2012; Wouterse & Taylor 2008), 3SLS (Vadean et al. 2019; Tshikala et al. 2018; Yin et al. 2018; Li et al. 2012), IV probit model (López-Feldman & Chávez 2017; Feng et al. 2010), IV Tobit model (Dávalos et al. 2017; Chang et al. 2011; Miluka et al. 2010; Pfeiffer et al. 2009), IV fixed effect (Damon 2010).

In our research, extended probit regression model(eprobit) introduced in Stata 15 in 2017 was applied. The eprobit fits all models including any combination of endogenous covariates and allows to use continuous as well as binary explanatory variables in the model (StataCorp 2017).

The following syntax was used: eprobit y x1…xk, endogenous (w = z1 z2)

Where eprobit is the command, y is a binary dependent variable denoting utilization of farm machinery, chemical inputs, SAPs and use of irrigation facility, x stands for set of covariates (farmer, household and farm characteristics included in the model), w (remittances) is an endogenous covariate and z1 and z2 are instrumental variables which should be correlated with the endogenous explanatory variable (but should not be directly related to the outcome variable or correlated with the unobserved error) (StataCorp 2017).

Instrumental variables

Following several previous studies such as Piracha and Saraogi (2017) and Matano and Ramos (2013), bank account ownership and presence member(s) migrating to the European Union country in the household were used to instrument the remittances in our models. Despite Moldovan household are not highly banked, remittance receivers are more likely to use them compared to non-migrant households (de Zwager & Sintov 2014). Furthermore, as Piracha and Saraogi (2017) mentioned, the share of remittances sent via formal channels is increasing in recent years in the Republic of Moldova. Study of Matano and Ramos (2013) referred that the ownership of a bank account may encourage members working abroad to transfer remittances to their relatives living in Moldova. It was found, that migrants working in the EU countries remit more than those who work in the Commonwealth of Independent States (Lücke et al. 2007) as Moldovan migration to the EU (including especially Italy, Spain, France, and Germany) tends to be more permanent and includes a higher proportion of women who are employed in home care (de Zwager & Sintov 2014; Bara et al. 2013).

4.3.4. Variables included in the model

Treatment variable

Remittances

The impact of remittances on adoption and investment in productive assets such as chemical inputs, farm machinery, and irrigation facility was discussed in several previous studies from Central Africa (Ochieng et al. 2017), Central America (Davis & Lopez-Carr 2014), Nepal (Maharjan et al. 2013), Ecuador (Vasco 2011; Gray 2009), Albania (Miluka et al. 2010) and others. However, the results of these studies are inconsistent. Remittances sent by members working abroad allow poor rural small-scale farmers to relax credit constraints (Chiodi et al. 2012; Bredl 2011) and enable them to invest in farm assets and technology (Yan et al. 2016b) such as high-quality seeds (Tshikala et al. 2018; Sauer et al. 2015), chemical inputs (Caulfield et al. 2019; Radel et al. 2018; Kpadonou et al. 2017; Sauer et al. 2015; Manivong et al. 2014; Wang et al. 2014; Atamanov & Van den Berg 2012; Gray 2009), but several other studies did not find any effect of remittances such as Asfaw et al. (2018) for mulching, chemical inputs, and irrigation or Damon (2010) for chemical inputs and livestock ownership.

Control variables

The factors influencing investment and adoption of chemical inputs, farm machinery and irrigation facilities by small-scale farmers have been intensively investigated in countries such as Ethiopia (Miheretu & Yimer 2017; Nigussie et al. 2017; Wakeyo & Gardebroek 2013; Adimassu et al. 2012), Tanzania (Kassie et al. 2015; Kassie et al. 2013), Ghana (Donkor et al. 2016), Kenya (Ndiritu et al. 2014; Waithaka et al. 2007) as well as in China (Pan et al. 2018; Zhang et al. 2017; Jia et al. 2013; Zhou et al. 2010) and other countries in recent years; however there is just limited evidence on smallholder farms use of remittances for investment in agricultural production from the Commonwealth of Independent States including Moldova.

Table 4 Definitions and description of variables used in the model

	Description (0 = no/ 1= yes)	**Mean Std.**	**Std. Dev.**
Chemical input utilization	Household used at least one of these assets: mineral fertilizers, herbicides or pesticides in the year 2015 (0/1)	0.38	0.49
Farm machinery utilization	Household used at least one of these assets: tractor, plow, planting equipment, seedler, combine in the year 2015 (0/1)	0.38	0.49
Irrigation	Household used a sprinkler or drip irrigation (0/1)	0.15	0.36
SAPs	Household adopted at least one practice out of: crop rotation, a combination of different crops, intercropping, planting trees on the edge of farmland, chisel plow, no-tillage, alternative plants in strips, planting legumes and green manure, residues left on the field, residues plough in the soil, residues used as mulch/ straw or as compost in year 2015 (0/1)	0.42	0.49
Treatment variables			
Remittances	Household received remittances last year (0/1)	0.39	0.49
Household head (farmer) characteristics			
Gender	Male = 0, Female = 1	0.24	0.42
Age	Age (years)	36.37	15.34
Tertiary education	Completed tertiary education (0/1)	0.41	0.49
Secondary education	Completed secondary education (0/1)	0.51	0.50
Primary education	Completed primary education (0/1)	0.08	0.27
Agriculture - main income	Agriculture represents the main source of income (0/1)	0.30	0.46
Household characteristics			
HH size	Number of members living in HH	4.01	1.88
No. of agr. workers	Number of HH members involved in agriculture	2.40	1.16
No. of hired workers	Number of hired day laborers	0.24	0.81
Farm characteristics			
Number of owned plots	Total number of plots owned by a household	2.06	1.85
Land size	Prior to estimating the empirical models, the positive values of the outcomes was transformed by ln (y + 1) to reduce skewness and heteroscedasticity.	2.03	0.12
North region	HH is located in North development region (0/1)	0.36	0.48
Central region	HH is located in Central development region (0/1)	0.37	0.48
South region	HH is located in South development region (0/1)	0.27	0.27
Extension service	Farmer used extension service last year (0/1)	0.16	0.37
Lack of credit and capital	Perception of lack of credit and capital resources (0-5	1.82	1.72
Low fertility and productivity of land	scale; where 0 is no effect and 5 is the very high effect on crop production)	1.75	1.75
Diversity	Number of planted crops on the farm (out of several types of a crop)	2.07	1.29

Note: * In the majority of cases, the household head was interviewed, whenever he/she was absent, the household member responsible for the farming activities was included.

Farmer characteristics

Empirical models include farmer characteristics as control variables to depict the differences in human capital. The effect of variables including household head´s gender, farmer's age, and education are tested in several studies conducted in countries such as Albania (Miluka et al. 2010), Ecuador (Vasco 2011; Gray 2009), China (Pan et al. 2018; Jia et al. 2013) as well as in various African countries (Miheretu & Yimer 2017; Nigussie et al. 2017; Ochieng et al. 2017; Donkor et al. 2016).

Gender

The gender of household head is an important determinant of agricultural assets utilization whereby male farmers have a higher likelihood of using of chemical inputs (Kpadonou et al. 2017, Nigussie et al. 2017; Fosso & Nanfosso 2016 – for pesticides; Damon 2010) and irrigation facilities (Yin et al. 2018) and they own more livestock (Damon 2010) compared to females. Female farmers have to deal with lower access to credit, inputs, extension services, and information, which may limit the adoption of farm practices and utilization of productive assets. However, several studies did not find any gender differences in adoption of farm practices and utilization of productive assets (Fosso & Nanfosso 2016; Van Hulst & Posthumus 2016; Fosso & Nanfosso 2016; Miluka et al. 2010) or higher likelihood of use of manure for female (Nigussie et al. 2017). Female farmers often lack the resources to buy farm inputs such as inorganic fertilizers, so they apply manure on their fields (Nigussie et al. 2017).

Age

Older farmers may be more risk-averse and resistant to adopt new technology as they are more comfortable with the utilization of traditional practices (Nigussie et al. 2017; Donkor et al. 2016; Kassie et al. 2015; Ndiritu et al. 2014). On one hand, they gained more experience and skills in agriculture during the years when they were farming compared to younger counterparts, on the other hand, elderly people usually have to deal with loss of energy and strength needed to manage a farmland and short-term planning (Ndiritu et al. 2014; Kassie et al. 2013). Moreover, older farmers, often lack the financial means to purchase farm assets (Nigussie et al. 2017). Younger farmers are more progressive and flexible in the adoption of new farm technologies and have longer planning horizon compared to older counterparts (Miheretu & Yimer 2017; Nigussie et al. 2017), but at the same time, they may be more interested in non-farm jobs

opportunities than by agriculture. Moreover, they are usually physically fitter or stronger compared to older farmers (Nigussie et al. 2017). Several studies found, that age of a farmer play important role in utilization and investment in chemical inputs (Feng et al. 2010; Miluka et al. 2010; Gray 2009) or compost (Kpadonou et al. 2017), however majority empirical evidence did not find a significant effect of age on chemical inputs use and expenditures (Asfaw et al. 2018; Kpadonou et al. 2017; Van Hulst & Posthumus 2016; Davis & Lopez-Carr 2014; Maharjan et al. 2013; Damon 2010), farm machinery (Davis & Lopez-Carr 2014), irrigation facilities (Asfaw et al. 2018), manure (Kpadonou et al. 2017; Feng et al. 2010), mulching (Asfaw et al. 2018; Kpadonou et al. 2017), conservation agriculture (Van Hulst & Posthumus 2016). A study of Gray (2009) found that younger farmers have higher expenditures in chemical inputs and several other studies did not find any effect of age on utilization of chemical inputs (Asfaw et al. 2018; Kpadonou et al. 2017; Damon 2010; Feng et al. 2010; Miluka et al. 2010), irrigation and mulching (Asfaw et al. 2018).

Education

The educational level of farmers was found to be an important determinant of the utilization of productive assets and adoption of farm practices in previous studies (Kpadonou et al. 2017; Abdulai 2016; Fosso & Nanfosso 2016; Feng et al. 2010). On one hand, small-scale farmers with higher educational level have better awareness of the benefits and negatives of applied technology/practice, they are more aware of the economic and environmental implications of farm management practices, they have deeper knowledge of specific timing of application (including chemical inputs, modern farm machinery, etc.) and better level of planning as well as they have better ability to understand and adapt to climate change (Miheretu & Yimer 2017; Waithaka et al. 2007). On the other hand, they have a higher opportunity cost of labor and are able to earn higher returns in alternative economic activities than agriculture (Sinyolo et al. 2016). Several studies found, that farmers who achieved higher educational level are more likely to use chemical inputs (Fosso & Nanfosso 2016), manure (Feng et al. 2010), compost (Kpadonou et al. 2017) and conservation agriculture practices (Abdulai 2016).

Farm income

Smallholders, for whom agriculture represent the main source of income, have a higher likelihood of investing in farm assets due to their higher priority to improve land

productivity and crop yields (Migheli 2017). Off-farm employment leads to a decrease in investment in farm inputs and at the same time as it reduces the availability of labor and farmers' efforts to be involved in farm activities (Kassie et al. 2015; Kassie et al. 2013). However, the study of Van Hulst and Posthumus (2016) did not find any effect on adoption of herbicides and conservation agriculture practices.

Household characteristics

The effect of household characteristics including household size and labor involved in farm activities is tested in empirical models investigating the use of productive assets and farm practices in several previous studies (Zhang et al. 2017; Kassie et al. 2015; Ndiritu et al. 2014; Waithaka et al. 2007). As the study by Kassie et al. (2015) shows, household characteristics affect the adoption of SAPs and chemical inputs especially in countries where the market and institutions do not work well.

Household size and farm labor

On the one hand, the households with many members tend to be more motivated to invest in agricultural inputs and improve their crop yields since they have to meet the consumption needs of the family (Ochieng et al. 2017). On the other hand, large families may consume all their production and consequently, they do not have enough financial sources to invest in agricultural inputs (Wakeyo & Gardebroek 2013). This occurs especially in the case of larger households with a high dependency ratio (Shikuku et al. 2017). Families are an important source of labor which can be allocated in farm management practices, but at the same time, they can substitute for other agricultural inputs such as chemicals (Wakeyo & Gardebroek 2013). Moreover, larger families may adopt more labor-intensive land management practices (Miheretu & Yimer 2017). Several studies found that larger families are less likely to use (or invest in) chemical inputs (Asfaw et al. 2018; Feng et al. 2010; Miluka et al. 2010) when the other did not find any impact of household size on the utilization of chemical inputs (Damon 2010), irrigation (Asfaw et al. 2018), manure (Feng et al. 2010) or conservation agriculture practices (Asfaw et al. 2018).

Farm characteristics

The effect of smallholder farm characteristics including farm size, the number of plots of land and location on chemical input utilization was tested in number of previous studies (Nigussie et al. 2017; Ochieng et al. 2017; Donkor et al. 2016; Ndiritu et al. 2014;

Thuo et al. 2014; Wakeyo & Gardebroek 2013; Vasco 2011; Miluka et al. 2010; Zhou et al. 2010).

Number of plots

Ownership of a higher number of plots of land was found to positively influence investment in fertilizers in Senegal, Albania, and Ecuador (Thuo et al. 2014; Vasco 2011; Miluka et al. 2010). Households that possess more than one plot may apply modern technologies to diverse crops (Perz 2003). However, the study of Feng et al. (2010) did not find a significant effect on manure.

Land size

Farmers with larger landholdings were found to have a higher likelihood to apply chemical inputs in comparison with smaller farms in Ghana (Donkor et al. 2016) and Ethiopia (Wakeyo & Gardebroek 2013), since farmers with large farms tend to have more capital and thus can afford to buy farm inputs such as chemical fertilizers (Wakeyo & Gardebroek 2013; Adimassu et al. 2012). The study by Sinyolo et al. (2016) from South Africa demonstrates that despite households with larger landholding are not more likely to use mineral fertilizers, they apply larger amounts of them. Farmers with larger farms are more likely to use or invest in chemical inputs (Maharjan et al. 2013). However, the study of Asfaw et al (2018) did not find any effect of land size on chemical inputs, irrigation or mulching.

Region

According to previous studies, regional differences play an important role in crop production and influence farmers´ technology adoption due to various environmental conditions, market access and infrastructure which influence the profitability of the use farm assets such as chemical inputs (Sinyolo et al. 2016; Thuo et al. 2014; Feng et al. 2010). For example, Feng et al. (2010) found that households located in remote villages utilize mineral fertilizer less than households in villages with good market access. In this regard, the study of Zhou et al. (2010) demonstrated that the amount of applied fertilizer decreases with increasing distance to the market. To depict the different climatic conditions and agricultural potential of the different regions of Moldova, our empirical model includes characteristics denoting in which development region (North, Central or South) a household is situated.

Extension services

The use of extension services can facilitate the adoption of farm practices. Agricultural extension agents remain the main source of information regarding the adoption of new technology for farmers in many countries (Sinyolo et al. 2016; Teklewold & Köhlin 2011). Consequently, the utilization of extension services increases awareness of the benefits of new technology, enhances farmers´ technical capability and increases the likelihood of the adoption of land management practices including chemical input application (Miheretu & Yimer 2017; Asfaw et al. 2018) or irrigation and mulching (Asfaw et al. 2018).

Access to credit and soil fertility

Poor soil fertility is expected to increase adoption of maize-legume rotation and residue retention (Manda 2015) as well as the adoption of other SAPs (Tesfaye 2014; Amsalu & de Graaff 2007).

Access to credit was found to positively influence the adoption of farm assets (Miheretu & Yimer 2017). A study of Sinyolo et al. (2016) shows that access to credit alleviates the credit constraints that affect farmers, especially during the planting period.

Diversity

Specialization in agricultural production and diversity (measured in terms of the number of crops grown) may influence the adoption of SAPs (Kpadonou et al. 2017 for a number of cash crops) and overall farm efficiency (Sauer et al. 2015). It is hypothesized that with greater the diversity, the adoption of chemical inputs increases with the aim to provide nutrients for numerous crops grown by a household (Chianu 2004).

5. Results and discussion

The following section presents the results and discussion regarding:

a) the difference in migration patterns in two regions (CIS and EU)
b) differences between non-migrant households and migrant households regarding land use, investment in productive assets and adoption of SAPs
c) factors influencing the use of productive assets
d) factors influencing the adoption of SAPs

5.1. Migration patterns

About half of households had experience with international migration when one or more household members were abroad. Migrants were mostly men in the productive age. The main destinations of the migrants were Russia, Italy, Romania, and Ukraine which is consistent with the previous studies (Pilarova & Kandakov 2017; Ratha et al. 2016; de Zwager & Sintov 2014).

Based on the local expert: *"More and more young families find a permanent place of residence in another countries. Many of them do not see the future in Moldova anymore"* (university staff, Cahul).

Households were typically composed of four members. Non-migrant household appears to be larger compared to the migrant household which is consistent with previous findings reported by Miluka et al. (2007). As expected, a household with migrant(s) working in European Union seems to be more often male-headed as a higher prevalence of females migrates in EU countries (de Zwager & Sintov 2014; The World Bank 2010b). However, results of the Chi-square test and Fisher exact test (Table 5) revealed that there are no significant differences between migrant and non-migrant households regarding household composition.

Table 5 Differences between non-migrant HHs and migrant HHs in HHs composition

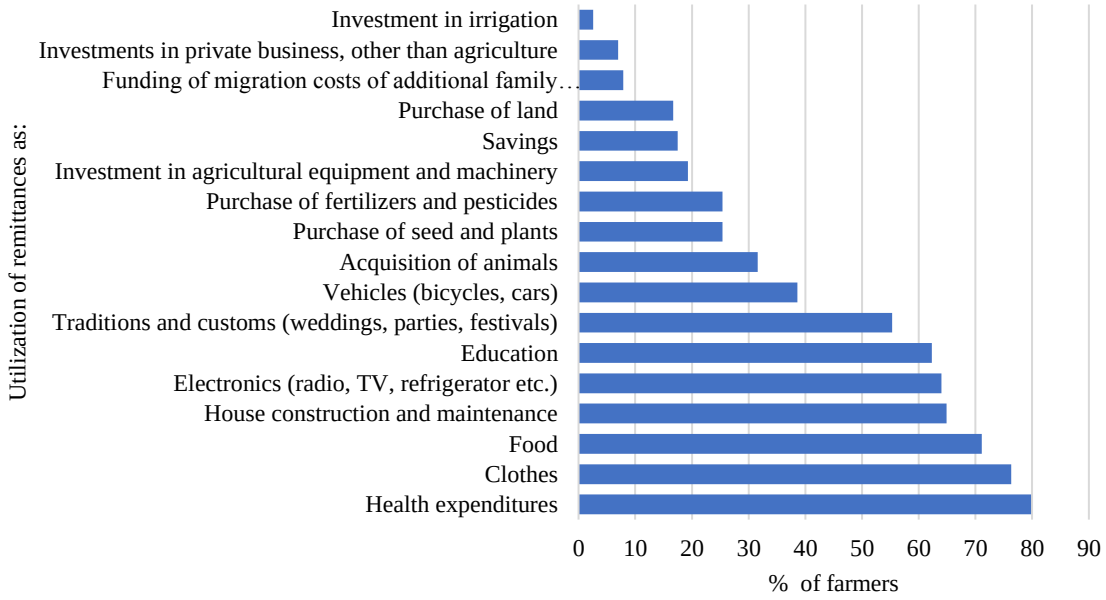
	Non-migrant	CIS	EU	Total	Coefficient (p-value)
HH size (members)	4.14	3.64	3.88	4.01	2.36 (0.307) [1]
No. of children	0.73	0.67	0.51	0.67	2.77 (0.251) [1]
No. of elderly people	0.52	0.38	0.43	0.47	0.76 (0.685) [1]
HH head gender	0.23	0.25	0.18	0.24	1.09 (0.579) [2]
	125	55	51	234	

Note: 1- Kruskal-Wallis test, 2- Fisher exact test; variable HH head is in binary form (1= woman, 0= man)

Remittances were spent mostly on the payment of health and education expenses, buying clothes, food, and electronics and on household construction and maintenance, costumes, and vehicles as shown in Graph 9. Investing remittances in material goods such as a house or car is a visible sign that a household member has migrated successfully.

Based on previous findings, remittances were spent by households rather for current agricultural expenditures, e.g. buying seeds, or paying for services related to mechanization than as investments in equipment and machinery (Möllers et al. 2016). Our study revealed that 32 percent of households bought farm animals, 25 percent purchased seed and seedlings, 25 percent invested in pesticides and mineral fertilizers, 21 percent used remittances for the purchase of farm equipment and machinery and 17 percent of households spent remittances on land purchases.

Graph 8 Utilization of remittances by small-scale farmers



Migrant workers were involved in the planting of crops (14 percent), harvesting (14 percent), and preparation of land (12 percent), weeding (11 percent), animal feed and care (10 percent) and marketing of product (9 percent) before the departure abroad. More than 21 percent were involved in other tasks such as household chores etc. Migrant women were mostly responsible for planting, weeding and harvesting whereas men were responsible for preparation of land, harvesting, planting and animal feeding. Less than six percent of household members were fully involved in agricultural tasks (more than three chores out of seven) before they migrate abroad – mostly men who migrated to Russia.

5.2. Differences between non-migrant households and migrant households

5.2.1. Land use

Farms in the Republic of Moldova are heavily fragmented as a consequence of land reforms. On average, individual farmlands are located on an area of two hectares, typically distributed in two plots which consistent with the previous studies from the Republic of Moldova (Hartvigsen 2015; Hartvigsen et al. 2012). Due to high-level fragmentation farmers have to deal with additional costs and inconvenience (Hartvigsen et al. 2012). Households with members working in the European Union appears to own larger farms and tend to be less fragmented. Results of the Kruskal-Wallis test (Table 6) revealed that there is no significant difference in land ownership and number of plots between non-migrant household and households with members working in the EU and CIS.

Table 6 Differences between non-migrant HHs and migrant HHs in land use

	Non-migrant	CIS	EU	Total	Coefficient (p-value)
Land (ha)	2.06	1.88	2.17	2.03	0.47 (0.792) [1]
Distance (km)	1.89	1.26	1.87	1.73	3.63 (0.116) [1]
Number of plots	2.06	2.17	2.00	2.06	0.84 (0.660) [1]
Rented land	0.08	0.07	0.10	0.08	0.31 (0.856) [2]

Note: 1- Kruskal-Wallis test, 2- Fisher exact test; variable "Rented land" is in binary form (1= farmer rented farm land, 0 = no)

About eight percent of small-scale farmers leased land to somebody else. Based on results of a qualitative survey, some farmland remains uncultivated. When the whole family migrates abroad, land can be also sold to economic agents abroad cheaply: "*The land is not processed, or it is sold at honey prices to overseas economic agents, who care nothing but to suck from the ground, but they will not cherish it"* (NGO representative, Orhei). The interviews with consultants from the Orhei district revealed that there is a problem with labour shortage in rural areas of Moldova due to migration. There is missing labour mainly during the land preparation and harvest period. Furthermore, the land abandoned by migrants poses a burden on neighbouring farmlands because of thread of pest infection and weed spread from abandoned areas. The land is gradually transformed into fallow area since whole families migrate abroad (or farm holders in old age remain in household and young generation is working in the cities or abroad). Therefore, there is problem also with chemical inputs application since uncultivated land absorbs the part of used dose in the neighbouring plots.

The majority of arable land is devoted to the wheat and maize cultivation, followed by table grapes, lucerne, vegetable, sunflower, legumes, and fruit which is consistent with previous studies of The World Bank, CIAT (2016) and Moroz et al. (2015). Typically, surveyed farmers used their garden located near the house for cultivation of higher value crops (e.g. vegetables, berries (mostly strawberries and raspberries) and partly for growing table grapes) or for keeping farm animals (poultry, ducks, turkey as well as livestock and goats for which they also use common grazing land). Main varieties of vegetables grown by farmers were potatoes, tomatoes, onions, cabbage, cucumbers, peppers, and carrot. A smaller share of farmers cultivates pumpkins, watermelons, and melons; and a few of them planted peas, radish, chickpeas and broad beans. Farmers concentrated mostly on growing of fruit variates such as table grapes, apples, plums, sweet and sour cherries, pears, peaches, apricots, and walnuts.

Despite that production of high-value crops such as fruit and vegetables have a potential to improve small-scale farmer´s farm income, the production is relatively low. This is consistent with the results of a qualitative survey. Based on the opinion of local experts, due to lack of workforce, agriculture land is covered by crops such as cereals and no-added value crops such as fruit and vegetable planted in open fields requiring fewer labor inputs.

Based on one respondents*:"Agricultural lands are cultivated with crops that require a small workforce: grain, technical plants and not value-added crops: open-grown and sheltered vegetables as a consequence of labour shortage"* (extension service provider, Donduseni).

The limited production of high-value crops is caused by an underdevelopment of agricultural markets for productive inputs, insufficient investments in farm assets due to high price, natural hazards and absence of climate risk mitigation measures such as irrigation facilities and conservation agriculture practices (The World Bank, CIAT 2016; FAO 2012).

Based on the results, a household with migrants working in CIS seems to plant more often fruit and vegetable compared to households with a migrant in EU. However, results of the Chi-square test and Fisher exact test (Table 7) revealed that there are no differences between migrant and non-migrant households regarding crop production.

Table 7 Differences between non-migrant HHs and migrant HHs in crop production

	Non-migrant	CIS	EU	Total	Coefficient (p-value)
Vegetable	0.14	0.26	0.14	0.17	4.20 (0.123) [1]
Fruit	0.10	0.09	0.02	0.08	3.48 (0.151) [2]
Legume	0.08	0.12	0.14	0.10	1.57 (0.457) [1]
Maize	0.74	0.74	0.71	0.73	0.21 (0.900) [1]
Table grapes	0.19	0.17	0.22	0.19	0.33 (0.849) [1]
Lucerne	0.15	0.17	0.12	0.15	0.65 (0.722) [1]
Wheat	0.32	0.22	0.41	0.32	4.44 (0.109) [1]
Sunflower	0.13	0.12	0.10	0.12	0.31 (0.929) [2]

Note: 1- Chi-square test; 2- Fisher exact test ; variables are in binary form (1= farmers grown crop in year 2015, 0 = farmers did not planted crop)

Most of the production was self-consumed in unprocessed as well processed form and surpluses of the crop products were sold on the local market, to neighbors, friends or family members outside the household, directly to a food processor, wine factory, factory, or consolidation center depending on the type and quantity of the product. In total, 36 percent of farmers sold the part of their production.

About 72 percent of the surveyed households were involved in poultry farming, which provide farmers with stable source food in the form of fresh meat and eggs and whose stock is usually renovated each year. Most of the pieces are killed in autumn, and their meat is stored in order to decrease household expenditures. Pigs represented second mostly breed animal species despite it requires higher initial investment and higher feeding costs compared to sheep/goats. However, slaughtering of the pig provides a quite high amount of meat. Livestock was breed by 24 percent of farmers and milk products such as milk, cheese or sour cream were used mostly for self-consumption. The old pieces served for the meat. The several families usually took care of cattle by turn (proportionally to the number of pieces owned by the family). Sheep and goats were acquired by less than 11 percent of farmers. Since the number of goats and sheep owned by farmers is limited, in most of the cases, kids and lambs are consumed by the family. Sheep were sometimes used for wool. Only a few farmers breed nutrias for their fur. Horses were owned by five percent of farmers and used for the draft. They are not aimed to be slaughtered unless they become old and unproductive.

Table 8 Differences between non-migrant HHs and migrant HHs in animal production

	Non-migrant	CIS	EU	Total	Coefficient (p-value)
TLU	1.26	1.03	1.06	1.16	3.80 (0.150) [1]
Sheep	0.04	0.05	0.04	0.04	0.15 (0.911) [3]
Horses	0.06	0.04	0.04	0.05	0.91 (0.729) [2]
Pigs	0.42	0.36	0.51	0.43	2.43 (0.296) [2]
Poultry	0.72	0.72	0.73	0.72	0.01 (0.997) [2]
Cattle	0.28	0.19	0.18	0.24	3.04 (0.218) [2]
Goats	0.09	0.05	0.06	0.07	0.96 (0.749) [3]
Gooses	0.10	0.09	0.10	0.10	0.14 (0.957) [3]

Note: 1- Kruskal-Wallis test, 2- Chi-square test; 3- Fisher exact test ; variables are in binary form (1= farmers breed animal in year 2015, 0 = farmers did not breed); TLU= the tropical livestock unit

Non-migrant households seem to have a higher livestock holding, which contradicts other findings reported by McCarthy et al. (2009), Vasco (2011) and Ochieng et al. (2017) as livestock production is less labor intensive than crop production. However, the results of the Chi-square test and Fisher exact test (Results in Table 8 revealed, that there are no differences in animal production between non-migrant and migrant households).

5.2.2. Use of productive assets

The level of mechanization is relatively low, only 33 percent of farmers owned a tractor, 22 percent plow and cultivator, 14 percent seedler and 7 percent combine harvester. Inasmuch as borrowing for the machinery and equipment is for small-scale farmers complicated due to the high-interest rate charged by commercial subjects, farmers, thus, did the majority of farm tasks by hand (especially weeding or harvesting, pruning) or paid for mechanization services. Therefore, smallholders relied on contractors for machinery services to purchase for unavoidable farm machinery and equipment such as modern tractor (32 percent), plow (25 percent), cultivator (30 percent), seedler (32 percent) and in lower extent combine (9 percent) and planter (6 percent). Some farmers owned farm machinery and rented it at the same time due to the bad state of the machinery.

Based on the local expert: *"There is a high share of manual labor and especially small farmers with land area of 3-4 hectares have to face to high prices for mechanized services"* (extension service provider, Causeni).

Our results indicated that a higher share of migrant households with a member working in the European Union used farm machinery and lower share of them rent farm machinery compared to non-migrant household and households with a member in CIS. However, results of the Chi-square test and Fisher exact test (Table 9) revealed that there are no significant differences between migrant and non-migrant households regarding the use of productive assets.

Based on expert opinion, migration influences investments in agricultural production in Moldova. One of the respondents mentioned that: *"Migrant households have larger investments ensuring their higher productivity and production of more competitive products"* (extension service provider, Glodeni) while another one stated: *"Some households with migrants invest remittances to bring added value to agricultural products"* (extension service provider, Straseni). To the contrary, another respondent pointed to limited investments made by migrants: "*A minimum number of migrants invest in entrepreneurial activities, especially in agriculture. Of the total number of 220-240 migrants I know from Causeni only two migrants have purchased land and one has planted multi-annual crops. The majority of the migrant households rent the farmland to limited liability companies"* (extension service provider, Causeni). In this regard, one respondent stated "*Households with migrants leased agricultural land to agricultural companies. However, smallholders for whom agriculture represents their main source of income and who obtained a loan or grant make an investment and purchase agricultural machinery such as tractors. Investment in propagation, lease land, animals and chemical inputs is made from the income obtained from annual farming activity"*(extension service provider, Causeni).

To handle high requirements of farm tasks during the labor-intensive period (i.e. harvesting or weeding), about 24 percent of households hired day laborers. However, the possibility of hiring agricultural labor is constrained as young generation prefer to find off-farm work or migrate abroad rather than perform heavy agricultural tasks.

Approximately 38 percent of farmers purchase some kind of chemical inputs (including pesticides, herbicides and mineral inputs such as potassium and ammonium nitrate, urea or peat). Fertilizer was used mostly for maize, wheat, sunflower, tomatoes, plums, and apples. Our results indicated that a higher share of non-migrant households used chemical inputs compared to migrant households. Results of the Chi-square test and

Fisher exact test (Table 9) revealed that there are no significant differences between migrant and non-migrant households regarding the use of productive assets.

Table 9 Differences between non-migrant HHs and migrant HHs in use of farm assets

	Non-migrant	CIS	EU	Total	Coefficient (p-value)
Farm machinery					
Owned machinery	0.38	0.35	0.43	0.38	0.88 (0.643) [1]
Tractor	0.32	0.31	0.37	0.33	0.58 (0.750) [1]
Plough	0.22	0.17	0.31	0.23	3.12 (0.210) [1]
Planting equip.	0.14	0.16	0.22	0.16	1.73 (0.420) [1]
Seedler	0.11	0.12	0.20	0.13	2.32 (0.313) [1]
Greenhouse	0.07	0.07	0.04	0.06	0.68 (0.774) [2]
Combine	0.07	0.07	0.06	0.07	0.10 (1.000) [2]
Rented machinery	0.45	0.43	0.41	0.44	0.20 (0.904) [1]
Chemical and organic inputs					
Chemical inputs	0.41	0.38	0.29	0.38	2.01 (0.367) [1]
Pesticide	0.34	0.35	0.24	0.32	2.18 (0.337) [1]
Herbicide	0.17	0.10	0.14	0.15	1.36 (0.506) [1]
Sprayer	0.16	0.10	0.18	0.15	1.37 (0.505) [1]
Mineral fertilizer	0.08	0.10	0.10	0.09	0.32 (0.851) [2]
Irrigation					
Irrigation	0.15	0.17	0.06	0.15	4.22 (0.110) [2]
Sprinkler irrigation	0.06	0.07	0.04	0.06	0.51 (0.872) [2]
Drip irrigation	0.09	0.10	0.02	0.09	3.15 (0.195) [2]

Note: 1- Chi-square test; 2- Fisher exact test ; variables are in binary form (1= farmers used technology in year 2015, 0 = farmers did not use)

Despite the repeated occurrence of drought, the level of irrigation is low as the irrigation infrastructures have high maintenance costs which are for the majority of farmer unaffordable which is consistent with previous findings of The World Bank, CIAT (2016) and Spoor & Izman (2006). Only 15 percent of farmers used drip or sprinkler irrigation. Rest of the farmer irrigated crops by hand. This is in line with the data of FAOSTAT (2019) which revealed that only nine percent of agricultural land is irrigated. The drip or sprinkler irrigation was used mostly for vegetable (such as tomatoes).

Based on the local expert: *"Small investments in irrigation are caused by a the lack of sustainable source of good-quality water for irrigation"* (extension service provider, Telenesti).

Households with migrant(s) in CIS countries are to more likely to use drip sprinkler irrigation compared to non-migrant households and household with members in European Union. However, results of the Chi-square test and Fisher exact test (Table 9) revealed that there are no significant differences between migrant and non-migrant households regarding the use of productive assets.

5.2.3. Adoption of sustainable agricultural practices

Drought represents the main limiting factor on the agricultural production of local smallholders followed by hail occurrence, lack of credit, the problem with irrigation facilities, pest infestation and market instability. Wind erosion and limited transportation means did not represent a barrier for farmers. The perception of barriers of agricultural production is included in Graph 9. Based on the local expert: *"Climate change leads to large losses in agricultural production and soil degradation, which consequently lead to further migration"* (extension service provider).

Based on the local experts, there are also another limiting factors of agricultural production such as:

a) Lack of factories for processing and preserving agricultural production in rural areas (university staff, Chisinau)
b) Insufficient state subsidies (extension service provider, Causeni)
c) Lack of cheap loans (extension service providers, Causeni, Criuleni)
d) Lack of programs encouraging young people in agricultural business (extension service providers, Criuleni)
e) Problem with the existence of intermediaries between producers and consumers (NGO provider, university staff, Ialoveni)
f) Very high prices of seed material, mineral fertilizers, fuel and low prices for agricultural production (extension service providers, Nisporeni)

Despite the often-reported occurrence of natural hazards threatening farmer´s agricultural production, only 42 percent of small-scale farmers applied at least one SAPs in 2016. The most widely practiced SAPs in all regions was crop rotation. Minimum or no-tillage, planting of green manure and planting trees around farmland and combination of different crops, mulching, either using grass or crop residues, intercropping were little practiced. Although the conservation agriculture practices can be applied to any size of farm (Kassam et al. 2013; Kassam et al. 2009), the results of our study revealed that no surveyed small-scale farmers adopt the three linked components of conservation agriculture simultaneously.

There were no differences between non-migrant and migrant household in the adoption of SAPs except the adoption of minimum or no-tillage. Results are included in Table 10. A household with members working in the European Union was more likely to

use minimum or no-tillage suggesting that remittances have played an important role in overcoming of the initial high cost of this practice.

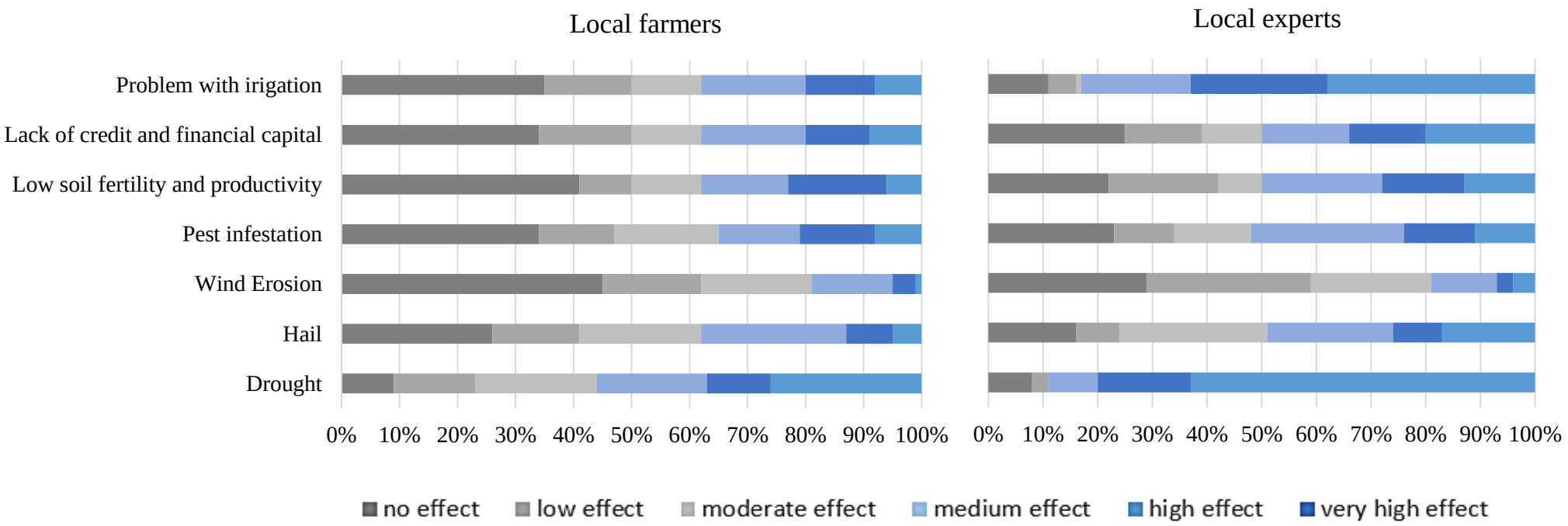
When we focus on dealing with farm residues, farmers used most often manure on their fields. Compost, plowing of residues in soil were used in a lower extent. Only three percent of farmers left straw or another organic matter on the field to mitigate the effect of drought.

Table 10 Differences between non-migrant HHs and migrant HHs s in use of SAPs

Practice	Non-migrant	CIS	EU	Total	Coefficient (p-value)
SAPs in total	0.40	0.40	0.47	0.42	0.85 (0.655) [1]
Crop rotation	0.15	0.14	0.10	0.14	0.89 (0.695) [2]
Minimum or no-tillage	0.04	0.02	0.12	0.06	6.33 (0.054) [2]
Combination of different crops	0.03	0.02	0.06	0.03	1.46 (0.482) [2]
Chisel plough utilization	0.01	0.00	0.02	0.01	1.24 (0.450) [2]
Planting legumes	0.02	0.05	0.02	0.03	1.29 (0.584) [2]
Planting trees on the edge of land	0.06	0.05	0.06	0.03	0.11 (1.000) [2]
Farm residues	0.34	0.28	0.29	0.32	1.17 (0.557) [1]
Compost	0.11	0.05	0.08	0.09	1.86 (0.440) [2]
Manure	0.19	0.16	0.18	0.18	0.44 (0.801) [1]
Cover crops	0.06	0.00	0.06	0.03	3.79 (0.175) [2]
Ploughed in soil	0.04	0.00	0.12	0.05	8.68 (0.011) [2]

Note: 1- Chi-square test 2- Fisher exact test; Intercropping, growing green manure, planting in alternative rows – only a few or no farmers adopted; variables are in binary form (1= farmers used practice in year 2015, 0 = farmers did not use)

Graph 9 Local farmers´ and experts' perceptions of the magnitude of natural and production risks affecting agricultural production



5.3. Factors influencing the adoption of productive assets and sustainable agricultural practices

Firstly, the regression model was tested for multicollinearity by use of a variance inflation factor (VIF); the results are presented in Annex 1. All tested explanatory variables have VIF values within the range of 1.07 - 1.84. Mean VIF is 1.31 which is below the threshold value of ten suggested by Kleinbaumet al. (2013). The results reveal that there is no significant multicollinearity among the explanatory and dependent variables in the model. Secondly, an extended binary probit regression model was used to address potential endogeneity. The results are included in Anexx 2. The error correlation corr (e.Remittance, e.dependent variable) is an estimate of the correlation between the errors from the main and auxilary equations. The null hypothesis states that there is no endogeneity. The estimates were not significant at a 1% level in all cases, so we cannot reject the null hypothesis. Since remittances can be treated as exogenous, the results of a simple binary probit model are presented if there is no evidence of heteroscedasticity as well. Both instrumental variables are correlated with the endogenous covariates, but they are not directly related to the outcome variable (see results in Annex 4 and Annex 5). Thirdly, the test of heteroscedasticity was performed. The results reveal that there is no significant heteroscedasticity among the explanatory variables in the models (Annex 3).

The χ^2 results of probit model show that likelihood ratio statistics are highly significant suggesting that the models have a strong explanatory power. Similarly, multivariate probit model´ χ^2 was equal to 161.21 and was significant at 1% ($p > \chi^2 = 0.000$), therefore the null hypothesis that all regression coefficients are jointly equal to zero is rejected and model has a strong explanatory power (see Table 12 and Table 13).

Several pairwise correlations between the error terms were statistically significant, which confirmed the interdependence between the adoption decisions of several farming practices, which may be due to complementarity or substitutability in farming practices, but also potentially to omit factors which affect all adoption decisions. Consequently, farmers do not decide upon a single practice to adopt; instead, the probability of adopting a practice is conditional on whether other practices have already been adopted. The correlation between farming practices is shown in Table 11.

Table 11 Conditional correlations between farming practices

	Owned machinery	SAPs	Chemical inputs	Irrigation
Owned machinery	1			
SAPs	-0.157 (0.111)	1		
Chemical inputs	0.480*** (0.103)	-0.134 (0.132)	1	
Irrigation	0.343*** (0.128)	0.261* (0.137)	0.215 (0.134)	1

Note: Standard errors in parentheses;

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

Utilization of farm machinery, chemical inputs, and irrigation were positively interdependent, which suggest that small-scale farmers usually combine several practices to enhance their production. The results revealed that the utilization of chemical inputs was complementary with irrigation and farm machinery, suggesting that farmers often combine both types of practices.

5.3.1. Factors influencing the adoption of farm assets

Treatment variable

The results revealed that *remittances* did not statistically significantly influence the use of chemical inputs (such as mineral fertilizers, herbicides, and pesticides) and farm machinery. Similarly, Asfaw et al. (2018) and Damon (2010) did not found any effect of remittances on the use of chemical inputs. Results suggest that farmers are not interested in agricultural production and remittances are rather used to meet the basic needs of the family and to cover food, medicaments than in farming. If the amount of received remittances is limited, smallholders may use them only to meet the basic needs of the family and to cover food, the payment of debts or livestock costs (Ochieng et al. 2017) instead of increasing investment in farm inputs. Since our study does not include information regarding the quantity of applied chemical inputs or the quality of used machinery, further research would be needed to test this hypothesis and to determine the effect of remittances on the quantity of chemical inputs applied and used farm machinery.

Remittances facilitate the purchase of irrigation infrastructure enabling small-scale farmers to deal with decreasing soil quality and drought. This is consistent with

findings of several studies from Mozambique, Mexico, and Laos who found, that remittances facilitate investment in water pumps and irrigation infrastructure (Ducrot 2017; Böhme 2015; Manivong et al. 2014). Results suggest that remittances enable small-scale farmers to overcome the high initial cost of irrigation facilities and the rising cost of energy supply for the pumps.

The household head´s characteristics

Gender of household head (farmer) influences the adoption of farm machinery. Women have a lower rate of use of farm machinery compared to men pointing to the existence of barriers and cultural roles affecting the utilization of farm machinery. The results correspond with the study of dTS & DAI (2011) and NBS (2014) which demonstrated that the operation and maintenance of farm machinery and equipment is largely a man's domain. Women participate mostly in vegetable and berries production and are responsible for practices including sowing seeds, planting seedlings, weeding and harvesting in greenhouses, hand spraying in small plots and animal care when men are involved in tasks such as obtaining loans, spraying pesticides on large plots, maintaining and operating farm equipment and irrigation systems, managing tractors and other forms of transport (dTS & DAI 2011).

A higher *level of education* facilitates the use of irrigation infrastructure. Result suggest that small-scale farmers with higher educational level have better awareness of the benefits and negatives of applied technology/practice and they are more aware of the economic and environmental implications of farm management practices and they have better ability to understand and adapt to climate change (Miheretu & Yimer 2017; Waithaka et al. 2007).

The *age* of household head (farmer) did not have an effect on the adoption of farm assets. This is consistent with majority of studies who found no significant effect of age on chemical inputs used and expenditures (Asfaw et al. 2018; Kpadonou et al. 2017; Van Hulst & Posthumus 2016; Davis & Lopez-Carr 2014; Maharjan et al. 2013; Damon 2010), farm machinery (Davis & Lopez-Carr 2014) and irrigation facilities (Asfaw et al. 2018).

Our results show that those farmers for whom *agriculture represents the main source of income* are more likely to use chemical inputs and farm machinery on their land than the others. These results imply that full-time farmers increase their profit and boost crop yields by the use of previously mentioned inputs. Smallholders, for whom

agriculture represent the main source of income, have a higher likelihood of investing in farm assets due to their higher priority to improve land productivity and crop yields (Migheli 2017).

Household composition

The likelihood of utilization of farm assets was not influenced by the *number of agricultural workers* involved in farm activities in our model. The larger households have a higher likelihood of farm machinery use. *Larger households* are more motivated to improve their crop yields to meet the consumption needs of the family (Ochieng et al. 2017).

Farm characteristics

Ownership of *larger landholdings* improves the utilization of farm machinery, chemical inputs, and irrigation since farmers with large farms tend to have more capital and thus can afford to purchase farm inputs. Unexpectedly, the coefficient for a *number of plots* significantly increases the likelihood of utilization of irrigation facilities. As farms are heavily fragmented as a consequence of land reforms, it was supposed that farmers have to deal with additional costs and inconvenience caused by fragmentation (Hartvigsen et al. 2012) and therefore the utilization of farm assets decrease with a higher number of owned plots. The individual farmlands are located on an area of two hectares, typically distributed in two or three plots (i.e. one or two plots of arable land, one plot of orchard/vineyard and one plot of the vegetable) which is consistent with findings of Hartvigsen (2015) and Hartvigsen et al. (2012), therefore the irrigation can be applied only on one specific plot (usually devoted to vegetable production) and the rest of plots are irrigated manually.

The *region* where the household is situated influences the probability of chemical input utilization in our model. Households situated in the South region have a higher probability of chemical input application. This finding is consistent with the research performed by Thuo et al. (2014) in Senegal, who found out that weather conditions in the agricultural zone, rainfall, and soil quality influence the decision to invest in chemical inputs. The result of our model is in line with the data from the National Bureau of Statistics of the Republic of Moldova (NBS) (2019) which demonstrates that the average amount of mineral fertilizers per one sown hectare was the highest in the Cantemir region.

According to these data, 54.56 kg/ha was applied in Soroca (North), 57.08 kg/ha in Orhei (Central) and 76.39 kg/ha in Cantemir (South) districts in 2016.

The results of our models revealed that *extension services* did not statistically significantly influence the utilization of all surveyed practices. Our questionnaire provides only limited information regarding the use of extension services, as the quality of the information provided to the farmer, skills of extension provider as well as the frequency of contact with extension agency is not included in our survey. Therefore, not only simple access to extension provider probably matters, but the quality of service does.

Unexpectedly, *credit constraints* did not have an effect on the surveyed practices (except farm machinery). One possible explanation of our result could be that credit-constrained households may use these practices, but in a lower extent in comparison to other households. Since our study does not include information regarding the quanty of applied chemical inputs, further research would be needed to test this hypothesis and to determine the effect of credit access on the quantity of chemical inputs applied. Growing of larger *spectrum of varieties* increase the likelihood of utilization of irrigation facilities. *Perception of low soil quality and productivity* play an important role in the adoption of farm machinery.

5.3.2. Factors influencing the adoption of sustainable practices

Treatment variable

The results revealed that *remittances* did not statistically significantly influence the adoption of SAPs. Contrary to our results, several studies found that remittances facilitate the adaption to climate change and adoption of modern or environment friendly practices improving soil condition such as zaï pits, fallowing, mulching and composting especially in case of poor or land-constrained households (Kpadonou et al. 2017; Wouterse 2017; Ng'ang'a et al. 2016). On the other hand, the study of Nyangena (2008) conducted in Kenya found that households receiving remittances are less likely to adopt soil conservation measures which may be caused by the little concern about the land quality as the household members are attracted by off-farm activities. Study of Caulfield et al. (2019) demonstrated that migration decreases the use of soil and water conservation techniques and at the same time, remittances were associated with an increased application of pesticides and chemical fertilizers and mechanized tillage.

The household head´s characteristics

The results indicated that there were no *gender* differences in the adoption of SAPs, which is consistent with previous findings of Fernandez (2017), Musiyiwa et al. (2017), Van Hulst & Posthumus (2016) and Tesfaye et al. (2014). The results suggest that adoption-related decisions are mostly made jointly between a man and a woman which is consistent with previous findings of dTS and DAI (2011) which demonstrated that majority of Moldovan farmers made decisions regarding land use and marketing of products jointly.

A higher *level of education* facilitates the adoption of SAPs suggesting that thus farmers are more aware of climate change and environmental degradation. Individuals who completed only primary education are less likely to use SAPs compared to tertiary-educated individuals. This is consistent with previous findings of Abdulai (2016), Fosso & Nanfosso (2016), Alam (2015), Kassie et al. (2015), Pender and Gebremedhin (2007). Results suggest that small-scale farmers with higher education have better ability to understand and adapt to climate change and at the same time they have a higher capability to seek important information and to obtain support from the government and NGOs (Miheretu & Yimer 2017; Waithaka et al. 2007; Etongo 2018).

The *age* of household head (farmer) did not have an effect on the adoption of farm practices. Majority empirical evidence did not find a significant effect of age on use of manure (Kpadonou et al. 2017; Feng et al. 2010), mulching (Asfaw et al. 2018; Kpadonou et al. 2017) and conservation agriculture (Van Hulst & Posthumus 2016).

The results suggest that rural farmers for whom *agriculture is the main source of income* did not have any higher probability of adoption of SAPs. This finding is consistent with Van Hulst & Posthumus (2016) who demonstrated that the percentage of income from agriculture did not significantly influence the adoption of SAPs.

Farm characteristics

Results of our model revealed that higher *numbers of plots* statistically significantly decrease the probability of adoption of SAPs. This is consistent with findings of Teshome et al. (2016) who mentioned that farmers who have smaller or fragmented plots are less likely to adopts SAPs. This is probably due to the increase of initial transaction cost for investments (Teshome et al. 2016). A previous study showed that a low rate of application of the crop rotation technique can be caused by several

factors such as fragmentation of land holdings caused by land reforms which complicate the application of measures dealing with erosion (Popov 2014).

Farmers living in the *South region* were more likely to adopt SAPs. The Southern region (a mix of hills and plains) is exposed to a dry climate condition affecting crop production and due to higher temperatures and low rainfall, South region is less suitable for agricultural production and most prone region to occurrence of drought compared to other regions (Möllers et al. 2016; The World Bank, CIAT 2016. Therefore, results suggest, that farmers from this region are more likely to adapt to these conditions.

It was expected a priori that access to information through *extension services* would influence the adoption of SAPs positively, but interestingly utilization of extension services did not have any effect on SAPs adoption, which is consistent with the finding of Tesfaye et al. (2014). In contrast, several previous studies such as Abdulai (2016) and Kassie et al. (2015) mentioned that the utilization of extension services is an important determinant in the adoption of SAPs. The insignificant coefficients of extension services indicate a limited role of advisory services in the adoption of SAPs adaptation planning (Abid 2019). As the quality of the information provided to the farmer, skills of extension provider, as well as frequency of contact with extension agency, is not included in our survey, further research would be needed to test this hypothesis and to determine the effect of extension services on the adoption of SAPs.

Growing of *larger spectrum of varieties* increase the likelihood of adoption of SAPs. Specialization in agricultural production and diversity (measured in terms of the number of crops grown) may influence the adoption of SAPs (Kpadonou et al. 2017).

Perception of soil quality and productivity play an important role in the adoption of SAPs. Similarly, Tesfaye et al. (2014) and Amsalu & de Graaff (2007) demonstrated that the perception of high fertility of cropland has a significant inverse relationship with the adoption of soil conservation measures. When farmers notice that own fertile farmland, they become less interested to conserve their land from possible degradation in the future (Tesfaye et al. 2014).

Table 12 Probit regression model

	Owned machinery			SAPs			Chemical inputs			Irrigation		
	Coef.	Standard err.	Marg. effect	Coef.	Standard err.	Marg. effect	Coef.	Standard err.	Marg. effect	Coef.	Standard err.	Marg. effect
Treatment variable												
Remittances	0.012	0.198	0.004	-0.146	0.197	-0.047	-0.004	0.204	-0.001	0.550**	0.240	0.107
Farmer characteristics												
Gender	-0.494**	0.198	-0.150	0.312	0.190	0.101	0.110	0.201	-0.001	0.160	0.234	0.031
Age	-0.000	0.008	-0.000	-0.008	0.007	-0.002	0.008	0.008	0.032	-0.006	0.009	-0.001
Primary educ.	-0.172	0.385	-0.052	-0.971**	0.432	-0.315	-0.358	0.408	0.002	-1.108**	0.521	-0.216
Secondary educ.	-0.095	0.210	-0.029	-0.046	0.200	-0.015	-0.158	0.208	-0.104	-0.549**	0.246	-0.107
Agriculture main income	0.615***	0.217	0.187	0.312	0.190	0.058	0.545**	0.217	-0.046	0.131	0.250	0.025
Household characteristics												
HH size	0.138*	0.076	0.042	-0.020	0.073	-0.007	0.070	0.076	0.020	0.032	0.088	0.006
No. of agr. workers	0.001	0.103	0.000	-0.173*	0.100	-0.056	-0.212	0.105	-0.062	0.072	0.119	0.014
No. of hired work.	0.149	0.121	0.045	0.138	0.112	0.045	0.018	0.116	0.005	0.070	0.132	0.014
Farm characteristics												
South region	0.331	0.235	0.101	0.387*	0.234	0.126	1.027***	0.241	0.298	-0.191	0.284	-0.037
Central region	-0.049	0.241	-0.015	0.275	0.241	0.089	-0.092	0.256	-0.027	-0.190	0.299	-0.037
No. of plots	0.092	0.075	0.028	-0.187**	0.081	-0.061	0.063	0.083	0.018	0.236***	0.087	0.046
Land size	0.620***	0.195	0.188	0.026	0.192	0.008	0.834***	0.205	0.242	0.445*	0.230	0.087
Extension service	-0.308	0.279	-0.093	0.303	0.257	0.099	-0.113	0.276	-0.033	0.272	0.299	0.053
Lack of credit /capital	-0.120*	0.057	-0.036	0.041	0.053	0.013	0.097*	0.056	0.028	0.040	0.068	0.008
Low fertility	0.102*	0.059	0.031	0.113**	0.056	0.037	-0.028	0.061	-0.008	0.011	0.071	0.002
Diversity	0.046	0.075	0.014	0.280***	0.075	0.091	-0.031	0.076	-0.009	0.162*	0.089	0.032
Constant	-1.706***	0.533		-0.315	0.514		-1.787***	0.564	0.298	-2.535***	0.644	-0.037
LR chi^2		59.56			49.39			68.42			33.81	
Prob > chi^2		0.000			0.0001			0.000			0.009	
Pseudo R^2		0.192			0.156			0.221			0.171	

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

Table 13 Multivariate probit model

	Owned machinery			SAPs			Chemical inputs			Irrigation		
	Coef.	Standard err.	p-value	Coef.	Standard err.	p-value	Coef.	Standard err.	p-value	Coef.	Standard err.	p-value
Treatment variable												
Remittances	-0.017	0.198	0.930	-0.152	0.197	0.440	-0.036	0.202	0.857	0.540	0.236	0.022
Farmer characteristics												
Gender	-0.506	0.197	0.010	0.299	0.191	0.118	0.105	0.199	0.599	0.129	0.229	0.573
Age	0.001	0.008	0.929	-0.007	0.007	0.349	0.008	0.008	0.278	-0.007	0.009	0.395
Primary educ.	-0.173	-0.173	0.671	-0.926	0.431	0.032	-0.364	0.411	0.376	-1.146	0.510	0.024
Secondary educ.	-0.095	-0.094	0.652	-0.027	0.201	0.893	-0.205	0.207	0.322	-0.593	0.242	0.014
Agriculture main income	0.598	0.217	0.006	0.197	0.215	0.358	0.525	0.215	0.015	0.095	0.249	0.704
Household characteristics												
HH size	0.118	0.075	0.119	-0.016	0.073	0.829	0.071	0.076	0.348	0.051	0.086	0.559
No. of agr. workers	0.018	0.103	0.859	-0.174	0.100	0.081	-0.209	0.105	0.047	0.050	0.119	0.677
No. of hired work.	0.144	0.119	0.227	0.130	0.109	0.235	0.008	0.116	0.946	0.069	0.133	0.605
Farm characteristics												
South region	0.341	0.231	0.141	0.386	0.237	0.102	1.032	0.237	0.000	-0.149	0.281	0.596
Central region	-0.090	0.242	0.711	0.265	0.241	0.272	-0.101	0.254	0.691	-0.100	0.295	0.735
No. of plots	0.086	0.074	0.246	-0.195	0.083	0.018	0.065	0.079	0.410	0.242	0.085	0.004
Land size	0.596	0.195	0.002	0.020	0.193	0.916	0.763	0.204	0.000	0.337	0.230	0.144
Extension service	-0.352	0.281	0.211	0.283	0.257	0.271	-0.072	0.277	0.794	0.286	0.296	0.335
Lack of credit /capital	-0.123	0.057	0.030	0.049	0.054	0.365	0.082	0.055	0.138	0.047	0.068	0.491
Low fertility	0.097	0.059	0.097	0.108	0.056	0.054	-0.030	0.060	0.620	0.007	0.069	0.915
Diversity	0.051	0.756	0.504	0.280	0.075	0.000	-0.041	0.076	0.587	0.142	0.090	0.116
Constant	-1.636	0.528	-3.10	-0.343	0.523	0.512	-1.664	0.546	0.002	-2.366	0.629	0.000
LR chi^2	161.21											
Prob > chi^2	0.000											

5.4. Summary of results

Res. question	Hypothesis	Specific objective	Result
RQ1: Do international remittances encourage the use of farm assets?	1) H_0: There are no differences between migrant and non-migrant households regarding the use of productive assets	1) Determination of differences between non-migrant households and households with relatives(s) working in European Union country and Commonwealth Independent State in the land use, utilization of farm assets	There were no significant differences between non-migrant households and households with relatives(s) working in European Union country and Commonwealth Independent State in the land use, utilization of farm assets
	2) H_0: Remittances do not have any effect on the utilization of chemical inputs 3) H_0: Remittances do not have any effect on the use of farm machinery 4) H_0: Remittances do not have any effect on use drip and sprinkler irrigation	2) Estimation of the effect of remittances on the utilization of farm assets	Remittances did not statistically significantly influence the use of chemical inputs and farm machinery Remittances facilitate the purchase of irrigation infrastructure
RQ2: Do remittances facilitate adoption of SAPs?	5) H_0: There are no differences between migrant and non-migrant households regarding the adoption of SAPs	1) Determination of differences between non-migrant households and households with relatives(s) working in European Union country and Commonwealth Independent State in the land use, utilization of farm assets and adoption of SAPs	There were no differences between non-migrant and migrant household in the adoption of SAPs except the adoption of minimum or no-tillage. A household with members working in the European Union was more likely to use minimum or no-tillage.
	6) H_0: Remittances do not have any effect on the adoption of SAPs	3) Estimation of the effect of remittances on the adoption of SAPs	Remittances did not statistically significantly influence the adoption of SAPs

RQ3: What factors influence the utilization of farm asstest and adoption of SAPs	4) Determination of main factors affecting utilization of farm assets and adoption of SAPs	a. Gender – females are less likely to use farm machinery b. Age – no effect c. Education – higher education facilitates the adoption of SAPs and irrigation d. Agriculture as main income- facilitates adoption farm machinery and chemical inputs e. HH size – influences the adoption of farm machinery f. A number of agr. workers – higher number decreases adoption of SAPs g. Number of hired workers – no effect h. Region – in South region are farmers more likely to use SAPs and chemical inputs i. Number of plots– decreases the likelihood of adoption of SAPs, increases likelihood of irrigation´ use j. Land size – higher land size facilitates the use of irrigation, farm machinery, and chemical inputs k. Access to credit – the perception of credit availability influences the use of farm machinery and chemical inputs l. Low fertility – the perception of soil fertility influences use of farm machinery and adoption of SAPs m. Diversity – diversity influences adoption of SAPs and irrigation

6. Conclusion and recommendations

Remittances play an important role in the livelihood of many households in the Republic of Moldova. In particular, money sent by household members working abroad can support poor farmers investing in agricultural assets in remote rural areas. Despite the potential benefits of remittances, only a few studies have studied the influence of remittances on farm input use among small-scale farmers in the Republic of Moldova. The present study contributes to a better understanding of the impact of remittances on chemical input utilization.

Despite the potential of remittances to facilitate investments in farm inputs due to the reduction of a household's liquidity constraints and additional off-farm income, the results of our study suggest that remittances do not support the utilization of chemical inputs, farm machinery and adoption of SAPs in the selected areas in the Republic of Moldova. One explanation for this result is that members left-behind use remittances to meet their basic needs including expenses on food, clothes, health, and education rather than to invest in farm inputs. Furthermore, as the qualitative expert interviews indicate, some smallholder farmers receiving remittances tend to exit agricultural production and rent the land to larger agricultural producers. Other migrant families just leave the land abandoned with all negative consequences such as pests and weeds spreading to cultivated plots. In other words, the results show that if some smallholder farms have the chance to exit agricultural production through the off-farm income they tend to use the chance.

Instead of the effect of remittances, the results of the quantitative survey suggest that smallholders for whom agriculture represents their main source of income and who cultivate larger sizes of landholdings and are located in more favorable climatic areas tend to be more likely to adopt chemical inputs and farm machinery to increase productivity than the others. Our results indicate that the process of structural change is ongoing in Moldova and that the structural change can be hastened by migration and the received remittances as the migrant-related families tend to rent their land to larger agricultural enterprises. The process of structural change towards larger production units has the potential to contribute to an increase in productivity and the profitability of Moldovan agriculture in the future and to a decrease in the need for labor. As migration seems to

increase the problem with the abandonment of land, policy needs to focus on the problem and introduce measures to mitigate its possible negative consequences.

Despite the often-reported occurrence of natural hazards threatening farmer´s agricultural production, less than half of small-scale farmers applied any SAPs. Consequently, inadequate use of protective measures makes small-scale farmers unprotected against extreme climate events. Therefore, adaptation plays a key role in enhancing the resilience and adaptive capacity at the farm level. To increase current productivity and mitigate the impact of climate change, at the national and regional level, the government should invest in the development of drought-resistant varieties, irrigation systems and drainage infrastructure and soil conservation practice as well as crop insurance schemes. At the local level, effective information dissemination could facilitate adoption of SAPs. At the same time, the government should create a suitable investment environment. One possible option how to support small scale farmers is to provide them smart input subsidies or facilitate the access to credit to make farming attractive to the rural population.

7. Limitations

When interpreting the results, we need to have in mind the limitations of this study. Especially, the questionnaire used in our study does not include information about the quantity of use of chemical inputs per hectare and the amounts of transfers which members of households working abroad send to their relatives. To study these effects, further studies are required as are studies on the effects of migration on structural change in agriculture and on land abandonment. Questionnaire survey is limited by a low respons rate (between 25-35 percent of individuals were not present during the survey due to off-farm work in the another village/city or employment abroad).

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9. Annex

Annex 1 Variance inflation factor

Variable	VIF	1/VIF
HH size	1.84	0.542
Agr. Workers	1.65	0.605
Central region	1.62	0.617
Age	1.54	0.650
South region	1.37	0.729
Land size	1.35	0.739
Secondary education	1.29	0.774
Primary education	1.25	0.799
Low fertility	1.25	0.802
No. of plots	1.20	0.833
Income	1.18	0.845
Extension service	1.16	0.865
Remittances	1.15	0.868
Gender	1.14	0.876
Diversity	1.12	0.896
Access to credit	1.09	0.917
Hired workers	1.07	0.938

Annex 2 Test of endogeneity

	Owned machinery			SAPs			Chemical inputs			Irrigation		
	coefficient	standard error	p-value	coefficient	standard error	p-value	coefficient	standard error	p-value	coefficient	standard error	p-value
Treatment variable												
Remittances	-0.143	0.559	0.798	0.094	0.739	0.481	-0.357	0.622	0.565	0.241	0.800	0.763
Farmer characteristics												
Gender	-0.492	0.198	0.013	0.313	0.189	0.098	0.108	0.198	0.585	0.153	0.232	0.509
Age	-0.000	0.008	0.961	-0.007	0.007	0.301	0.008	0.007	0.307	-0.006	0.009	0.466
Primary educ.	-0.174	0.384	0.652	-0.966	0.432	0.025	-0.349	0.403	0.386	-1.095	0.520	0.035
Secondary educ.	-0.097	0.210	0.644	-0.040	0.199	0.839	-0.164	0.205	0.422	-0.549	0.244	0.024
Agriculture main income	0.611	0.217	0.005	0.176	0.212	0.407	0.540	0.215	0.012			
Household characteristics												
HH size	0.137	0.076	0.072	-0.020	0.073	0.787	0.067	0.075	0.374	0.028	0.087	0.747
No. of agr. workers	0.003	0.103	0.979	-0.172	0.099	0.083	-0.203	0.106	0.055	0.079	0.119	0.507
No. of hired workers	0.152	0.120	0.207	0.133	0.112	0.237	0.029	0.115	0.803	0.077	0.132	0.563
Farm characteristics												
South region	0.326	0.235	0.165	0.385	0.233	0.098	1.009	0.244	0.000	-0.190	0.280	0.498
Central region	-0.046	0.240	0.847	0.269	0.240	0.263	-0.085	0.253	0.738	-0.194	0.295	0.510
No. of plots	0.092	0.075	0.216	-0.183	0.081	0.023	0.061	0.082	0.455	0.234	0.088	0.008
Land size	0.618	0.195	0.001	0.023	0.191	0.904	0.825	0.206	0.000	0.438	0.230	0.057
Extension service	-0.309	0.278	0.266	0.307	0.255	0.230	-0.115	0.271	0.671	0.263	0.297	0.377
Lack of credit /capital	-0.122	0.058	0.033	0.044	0.053	0.406	0.088	0.058	0.124	0.036	0.068	0.595
Low fertility	0.100	0.059	0.088	0.115	0.056	0.040	-0.029	0.060	0.626	0.008	0.070	0.907
Diversity	0.046	0.075	0.537	0.278	0.076	0.000	-0.028	0.075	0.713	0.161	0.088	0.068
Constant	-1.634	0.592	0.006	-0.419	0.594	0.481	-1.617	0.647	0.012	-2.369	0.798	0.003

Intrumental variables												
EU	0.669	0.186	0.000	0.684	0.191	0.000	0.679	0.184	0.000	0.683	0.189	0.000
Bank account	0.513	0.173	0.003	0.493	0.191	0.010	0.499	0.177	0.005	0.496	0.184	0.007
Constant	-0.709	0.129	0.000	-0.707	0.130	0.000	-0.706	0.130	0.000	-0.704	0.130	0.000
Correlation	0.104	0.352	0.768	-0.158	0.467	0.735	0.238	0.398	0.549	0.204	0.497	0.411
Wald chi^2		48.26			40.12			57.79			26.52	
Prob > chi^2		0.0001			0.001			0.000			0.066	

Annex 3 Test of heteroscedasticity

	Owned machinery			SAPs			Chemical inputs			Irrigation		
	coefficient	Standard error	p-value	coefficient	Standard error	p-value	coefficient	Standard error	p-value	coefficient	Standard error	p-value
Treatment variable												
Remittances	0.130	0.242	0.592	-0.068	0.274	0.805	-0.117	0.244	0.630	1.523	0.924	0.099
Farmer characteristics												
Gender	-0.337	0.571	0.554	0.425	0.385	0.269	0.283	0.268	0.290	1.110	0.658	0.091
Age	0.002	0.010	0.869	-0.010	0.013	0.427	0.012	0.011	0.294	0.010	0.035	0.771
Primary educ.	-0.200	0.582	0.731	-1.110	1.356	0.413	0.553	1.057	0.601	-8.195	3.677	0.026
Secondary educ.	-0.166	0.281	0.555	-0.081	0.226	0.720	-0.201	0.311	0.517	-2.648	1.367	0.053
Agriculture main income	0.880	0.633	0.164	0.229	0.305	0.452	0.446	0.631	0.480	-1.248	0.676	0.065
Household characteristics												
HH size	0.197	0.159	0.216	-0.029	0.084	0.731	0.045	0.114	0.692	-0.821	0.266	0.002
No. of agr. workers	-0.042	0.129	0.745	-0.195	0.209	0.351	-0.212	0.275	0.440	1.432	0.418	0.001
No. of hired workers	0.184	0.200	0.354	0.152	0.173	0.380	0.029	0.127	0.819	1.353	0.497	0.006
Farm characteristics												
South region	0.114	0.423	0.788	0.400	0.445	0.369	0.841	1.068	0.431	-0.639	0.974	0.512
Central region	-0.436	0.327	0.182	0.209	0.380	0.582	-0.263	0.392	0.502	-2.887	1.024	0.005
No. of plots	0.135	0.125	0.279	-0.266	0.220	0.227	0.110	0.120	0.356	0.745	0.451	0.098
Land size	0.710	0.636	0.265	0.093	0.220	0.673	0.840	0.888	0.344	0.491	0.924	0.595
Extension service	-0.374	0.418	0.371	0.438	0.441	0.320	-0.133	0.372	0.720	1.941	1.060	0.067
Lack of credit /capital	-0.156	0.145	0.283	0.055	0.071	0.445	0.080	0.104	0.442	0.136	0.192	0.480
Low fertility	0.183	0.116	0.113	0.125	0.124	0.313	0.005	0.076	0.953	-0.112	0.212	0.598
Diversity	0.041	0.092	0.653	0.320	0.285	0.262	0.011	0.106	0.917	1.157	0.418	0.006
c.xbhat#c.Remittance	0.011	0.377	0.976	0.538	0.403	0.182	-0.336	0.377	0.373	-0.883	0.709	0.213
c.xbhat#c.Gender	0.708	0.455	0.119	0.184	0.401	0.646	0.982	0.448	0.029	0.463	0.542	0.393
c.xbhat#c.Age	0.015	0.015	0.366	-0.007	0.015	0.665	0.009	0.015	0.566	0.037	0.027	0.167
c.xbhat#c.Primary education	-0.473	0.780	0.544	0.049	1.034	0.962	1.703	1.507	0.259	-2.333	1.424	0.101

c.xbhat#c.Secondary education education	-0.401	0.391	0.306	-0.117	0.399	0.770	0.156	0.395	0.692	-0.384	0.628	0.541
c.xbhat#c.sourceofincome	0.744	0.543	0.171	-0.242	0.397	0.541	-0.464	0.377	0.219	-1.630	0.637	0.010
c.xbhat#c.members	0.227	0.144	0.114	-0.006	0.137	0.967	-0.023	0.141	0.868	-0.845	0.245	0.001
c.xbhat#c.agrwork	-0.120	0.218	0.581	0.109	0.188	0.561	0.013	0.196	0.949	1.174	0.362	0.001
c.xbhat#c.hiredworkers	-0.132	0.262	0.616	-0.021	0.222	0.924	-0.024	0.170	0.888	1.414	0.728	0.052
c.xbhat#c.South	-1.621	0.520	0.002	-0.357	0.459	0.437	0.134	0.547	0.807	-0.380	0.768	0.621
c.xbhat#c.Central	-1.353	0.564	0.016	-0.338	0.490	0.490	-0.528	0.477	0.269	-2.225	0.823	0.007
c.xbhat#c.numberplots	0.141	0.178	0.429	-0.071	0.159	0.655	0.038	0.146	0.796	-0.185	0.206	0.370
c.xbhat#c.land	-0.671	0.425	0.114	0.141	0.350	0.687	-0.496	0.384	0.197	-1.773	0.769	0.021
c.xbhat#c.Extensionservice	0.110	0.512	0.830	0.675	0.592	0.255	0.359	0.542	0.508	1.271	1.023	0.214
c.xbhat#c.lackofcreditcapital	0.078	0.110	0.478	-0.013	0.109	0.907	0.017	0.103	0.873	-0.144	0.178	0.419
c.xbhat#c.low fertility	-0.045	0.106	0.672	0.072	0.128	0.573	0.014	0.096	0.881	-0.270	0.214	0.208
c.xbhat#c.diversity	-0.065	0.148	0.662	-0.110	0.150	0.461	0.093	0.146	0.523	0.628	0.308	0.042
Constant	-2.057	1.519	0.176	-0.220	0.550	0.689	-1.781	1.700	0.295	-7.618	3.402	0.025
LR chi^2		81.30			55.31			90.72			77.41	
Prob > chi^2		0.000			0.012			0.000			0.000	
Pseudo R^2		0.262			0.174			0.293			0.392	
chi^2		16.88			5.60			16.31			22.40	
Prob > chi^2		0.462			0.996			0.502			0.170	

Annex 4 Exclusion restriction – bank account

	Owned machinery			SAPs			Chemical inputs			Irrigation		
	Coef.	Standard err.	Marg. effect	Coef.	Standard err.	Marg. effect	Coef.	Standard err.	Marg. effect	Coef.	Standard err.	Marg. effect
Treatment variable												
Remittances	-0.013	0.203	-0.004	-0.094	0.200	-0.030	-0.026	0.208	-0.008	0.500**	0.246	0.097
Farmer characteristics												
Gender	-0.502**	0.198	-0.152	0.327*	0.191	0.105	0.108	0.201	0.031	0.163	0.235	0.032
Age	-0.000	0.008	-0.000	-0.008	0.007	-0.003	0.008	0.008	0.002	-0.006	0.009	-0.001
Primary educ.	-0.157	0.387	-0.048	-1.014**	0.432	-0.326	-0.352	0.408	-0.102	-1.102**	0.526	-0.213
Secondary educ.	-0.103	0.211	-0.031	-0.036	0.200	-0.012	-0.164	0.208	-0.048	-0.560**	0.247	-0.108
Agriculture main income	0.622***	0.218	0.189	0.174	0.215	0.056	0.547**	0.218	0.158	0.164	0.253	0.032
Household characteristics												
HH size	0.141*	0.077	0.043	-0.029	0.074	-0.009	0.074	0.076	0.022	0.042	0.089	0.008
No. of agr. workers	-0.006	0.104	-0.002	-0.160*	0.100	-0.052	-0.222**	0.107	-0.064	0.044	0.122	0.009
No. of hired work.	0.143	0.123	0.043	0.161	0.111	0.052	0.007	0.119	0.002	0.046	0.136	0.009
Farm characteristics												
South region	0.329	0.235	0.100	0.423*	0.236	0.136	1.020***	0.241	0.295	-0.213	0.288	-0.041
Central region	-0.060	0.242	-0.018	0.311	0.243	0.100	-0.103	0.257	-0.030	-0.205	0.300	-0.040
No. of plots	0.092	0.075	0.028	-0.197**	0.083	-0.063	0.064	0.083	0.019	0.236***	0.087	0.046
Land size	0.620***	0.195	0.188	0.039	0.192	0.013	0.833***	0.205	0.241	0.454*	0.233	0.088
Extension service	-0.313	0.279	-0.095	0.324	0.260	0.104	-0.120	0.276	-0.035	0.261	0.298	0.050
Lack of credit /capital	-0.118**	0.058	-0.036	0.036	0.053	0.011	0.099*	0.056	0.029	0.044	0.068	0.009
Low fertility	0.101*	0.059	0.031	0.115**	0.056	0.037	-0.029	0.061	-0.009	0.011	0.071	0.002
Diversity	0.047	0.075	0.014	0.281***	0.075	0.090	-0.032	0.076	-0.009	0.163*	0.089	0.032
Constant	-1.737***	0.537		-0.220	0.519		-1.806***	0.565		-2.631***	0.655	
Bank account	0.106	0.196	0.032	-0.293	0.189	-0.094	0.105	0.201	0.031	0.257	0.238	0.257
LR chi^2		59.85			51.81			68.69			34.99	
Prob > chi^2		0.000			0.000			0.000			0.010	
Pseudo R^2		0.193			0.163			0.222			0.177	

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

Annex 5 Exclusion restriction – migration to the European Union countries

	Owned machinery			SAPs			Chemical inputs			Irrigation		
	Coef.	Standard err.	Marg. effect	Coef.	Standard err.	Marg. effect	Coef.	Standard err.	Marg. effect	Coef.	Standard err.	Marg. effect
Treatment variable												
Remittances	0.041	0.202	0.012	-0.206	0.202	-0.066	0.053	0.210	0.015	0.637**	0.250	0.123
Farmer characteristics												
Gender	-0.500**	0.198	-0.152	0.337*	0.192	0.108	0.103	0.202	0.030	0.144	0.236	0.028
Age	-0.000	0.008	-0.000	-0.008	0.007	-0.002	0.008	0.008	0.002	-0.006	0.009	-0.001
Primary educ.	-0.163	0.387	-0.049	-1.017**	0.441	-0.327	-0.340	0.411	-0.098	-1.099**	0.530	-0.212
Secondary educ.	-0.110	0.211	-0.033	-0.015	0.201	-0.005	-0.192	0.211	-0.055	-0.593**	0.250	-0.114
Agriculture main income	0.615***	0.218	0.187	0.167	0.214	0.054	0.557**	0.218	0.160	0.131	0.252	0.028
Household characteristics												
HH size	0.140*	0.076	0.042	-0.024	0.074	-0.008	0.072	0.076	0.021	0.027	0.088	0.005
No. of agr. workers	-0.000	0.104	-0.000	-0.169*	0.100	-0.054	-0.214**	0.106	-0.062	0.076	0.121	0.015
No. of hired work.	0.155	0.122	0.047	0.133	0.112	0.043	0.027	0.117	0.008	0.077	0.138	0.015
Farm characteristics												
South region	0.317	0.235	0.096	0.411*	0.235	0.132	1.013***	0.242	0.292	-0.211	0.284	-0.041
Central region	-0.049	0.241	-0.015	0.279	0.242	0.090	-0.098	0.257	-0.028	-0.240	0.305	-0.046
No. of plots	0.093	0.075	0.028	-0.183**	0.080	-0.059	0.063	0.084	0.018	0.239***	0.089	0.046
Land size	0.620***	0.195	0.188	0.024	0.192	0.008	0.840***	0.206	0.242	0.446*	0.233	0.086
Extension service	-0.320	0.279	-0.097	0.342	0.260	0.110	-0.132	0.276	-0.038	0.236	0.302	0.045
Lack of credit /capital	-0.128**	0.058	-0.039	0.052	0.054	0.017	0.084	0.057	0.024	0.027	0.068	0.005
Low fertility	0.098*	0.059	0.030	0.123**	0.057	0.040	-0.033	0.061	-0.010	0.002	0.071	0.000
Diversity	0.046	0.075	0.014	0.281***	0.075	0.090	-0.029	0.076	-0.008	0.161*	0.089	0.031
Constant	-1.642***	0.541		-0.450	0.523		-1.692***	0.570		-2.385***	0.659	
EU	-0.151	0.215	-0.046	0.309	0.214	0.099	-0.257	0.225	-0.074	-0.380	0.277	-0.073
LR chi^2		60.05			51.48			69.74			35.78	
Prob > chi^2		0.000			0.000			0.000			0.008	
Pseudo R^2		0.193			0.162			0.225			0.181	

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

Annex 6 Photo documentation – data collection

Annex 7 Questionnaire - small-scale farmers (prepared in Romanian and English version)

Dear respondent,

I would like to thank you in advance for participating in this questionnaire. This survey aims to address the current situation of migration and its impact on the agricultural production in the Republic of Moldova.

The survey will take approximately 30 minutes to complete. The questionnaire is voluntary and completely anonymous.

Thank you for your time and your help.

Tereza Pilařová pilarovat@gmail.com

The Czech University of Life Sciences Prague, the capital city Prague

A) LAND OWNERSHIP AND CROP PRODUCTION

Do you own agricultural land?

- Yes
- No

Do you rent agricultural land?

- Yes
- No

Do you grow some crop (vegetable, fruit, grain, nuts, etc.)?

- Yes
- No

Represent agriculture the main source of income for you?

- Yes
- No

B) PERSONAL CHARACTERISTICS

Gender	men		women		
Age					
Marital Status					
Level of education completed	Primary education	Secondary education	Tertiary education (university)		
Citizenship	Moldavan	Romanian	Russian	Ukrainian	Bulgarian
Region					
Village					

C) HOUSEHOLD COMPOSITION - NUMBER OF MEMBERS LIVING IN HOUSEHOLD

Number of adults _____

Number of children ≤ 15 _____

Number of elderly ≥ 60 _____

Who is household head?

- ○ Mother
- ○ Father
- ○ Sibling
- ○ Grandmother
- ○ Grandfather
- ○ Me
- ○ Other _____

Please write down number of HH members and hired workers involved in agriculture

	Household members	Hired workers
Women		
Man		

LAND OWNERSHIP

Agricultural land (ha)	Total area cultivated (ha)	Number of plots	Total area rented/leased (ha)	Distance from residence (m)

D) CROP AND ANIMAL PRODUCTION

Number of animals

	Ownership		total	males	females	milk/egg	meat	How many acquired last year
Cattle	yes	no						
Horse	yes	no						
Goats	yes	no						
Chicken	yes	no						
Pig	yes	no						
Ducks	yes	no						
Sheep	yes	no						
Rabbits	yes	no						
Gooses	yes	no						

Crop production

	Name of crop	Area cultivated (ha)	Quantity of production (kg)
1			
2			
3			
4			
5			

Do you sell production?

- Yes
- No

If yes, what product do you sell?

	Name of crop	Quantity of production (kg)
1		
2		
3		
4		
5		

What marketing channel do you use?

- Consumers at the farm gate
- Neighbours, friends, or family members outside the household
- Local trader/collector
- Directly to retail markets (e.g., small shop owners)
- Directly to traders in wholesale markets
- Directly to consumers in wholesale markets
- Directly to consumers on the street in town
- Directly to middleman
- Directly to a food processor, winery, factory, or consolidation centre

Did you use draft animal last year?

- Yes
- No

Number of draft animals _____

E) OTHER PRODUCTION

- Mushrooms collecting
- Fishery
- Beehives

F) EQUIPMENT AND MACHINERY

Please write down owned equipment and machinery which you use

- No
- Tractor
- Plow
- Chisel plow
- Cultivator
- Seedler
- Greenhouse
- Planter
- Combine

Please write leased equipment and machinery

- No
- Tractor
- Plow
- Plow chisel
- Cultivator
- Seedler
- Planter
- Combine

Please select type of used plant protection and fertilizers:

- Pesticide
- Herbicide
- Mineral/chemical fertiliser
- Organic fertilizer

Please select type of used irrigation

- No
- Drip irrigation
- Sprinkler irrigation

G) ECOLOGICAL PRACTICES + CROP RESIDUES (PLEASE SELECT PRACTICES WHICH YOU USE)

- Crop rotation
- Combination of different crops
- Planting trees and shrubs around the farmland
- Using of cover crops
- Cultivation of crops in alternative strips
- Growing of green manure
- No or minimum tillage/ploughing
- Planting legumes
- Crop residues used for compost
- Crop residues left on the field
- Crop residues burnt
- Crop residues plough to soil
- Mulching (covering the ground with a layer of loose material)

H) MIGRATION

	Family member (Code 1)	Reason of migration	Place of destination	Currently abroad		Past responsibilities in HH (Code 4)
1				yes	no	
2				yes	no	
3				yes	no	
4				yes	no	
5				yes	no	
6				yes	no	
7				yes	no	

Code 1: 1) mother 2) father 3) sibling(s) 4) children 5) husband/wife 6) grandmother 7) grandfather 8) Other
Code 2: 1) Land preparation 2) Planting 3) Weeding 4) Harvesting 5) Marketing 6) Livestock feeding and health care 7) Others, specify

I) REMITTANCES

Do you receive remittances from member working abroad?

- yes
- no

If yes, please specify what you purchase

- Food
- Clothes
- Electronic (radio, TV, fridge)
- Education
- Health expenses
- Vehicles (bicycles, cars, etc.)
- House construction and maintenance
- Buying land
- Buying animals
- Buying seeds and plants
- Pesticides and fertilisers
- Agricultural tools and machines
- Invest in private business other than agriculture
- Repay debts
- Financing migration costs of additional family members
- Traditions (weddings, dowry, funerals, parties, festivals)
- Savings (e.g. money in the bank account)
- Other

J) CONSTRAINTS OF AGRICULTURAL PRODUCTION OF FARM:

Please specify constraints affecting your production

	Effect on the production (1 = low ; 5 = high)				
Constraint	1	2	3	4	5
Drought					
Hail					
Wind erosion					
Low soil fertility and productivity					
Pest infestation					
Problem with irrigation infrastructure					
Limited access to land (cost, availability)					
Market instability, low demand					
Limited transportation infrastructure to closest market					
Lack of infrastructure					
Lack of credit/capital					

K) HOUSEHOLD ASSETS

What assets do you have?

- Owned house/flat
- Rented house/flat
- Water supply – piped water
- Electricity
- Sewer
- Indoor toilet
- Garbage disposal
- Stove
- Refrigerator
- Radio
- TV
- Mobile Phone
- Personal computer
- Internet Service
- Bank account
- Car

Please specify services what you use

- Agriculture extension services
- ACSA
- Governmental assistance
- NGO assistance

Annex 8 Local expert online questionnaire survey (prepared only in Romanian version)

Chestionar

Stimat respondent,

Aș dori să vă mulțumesc anticipat pentru participarea la acest chestionar. Acest sondaj are drept obiectiv abordarea situației actuale a migrației și impactul acesteia asupra producției agricole în Republica Moldova.

Sondajul va dura aproximativ 10 – 15 de minute pentru a fi completat. Chestionarul este voluntar și complet anonim.

Vă mulțumesc pentru timpul si ajutorul dumneavoastră.

Tereza Pilařová pilarovat@gmail.com

Universitatea Cehă de Științe ale Vieții din Praga

1. Credeți că migrarea are impact asupra agriculturii?

- Da
- Nu

2. Dacă ați bifat da la întrebarea anterioară, vă rugăm specificați de ce

- Impacult asupra procurarea terenului
- Impactul asupra procurarea animalelor
- Impactul asupra procurarea semințelor și plantelor
- Impactul asupra investiții în pesticide și fertilizanți
- Impactul asupra investiții în echipament agricol și mașini
- Impactul asupra investiții în irigare
- Impactul asupra activitatii agricole
- Impactul asupra volumului de lucru a copiilor și a femeilor
- Impactul asupra utilizării terenurilor

3. Migrația are un impact diferit, vă rugăm să specificați _____

4. Există diferențe între gospodăriile cu migranți și fără migranți?

- Da
- Nu

5. Dacă ați bifat da la întrebarea anterioară, vă rugăm specificați de ce

- Gospodăriile cu migranți au o productivitate mai scăzută
- Gospodăriile cu migranți trecerea de la producția vegetală în producția animală
- Gospodăriile cu migranți au investiții mai mari în tehnologia agricole
- Gospodăriile cu migranți au investiții mai mici în tehnologia agricole
- În gospodărie migrant este sarcina de lucru mai mare pentru femei
- În gospodărie migrant este sarcina de lucru mai mare pentru copii
- Gospodăriile cu migranți au investiții mai mari în pesticide şi fertilizanţi

- Gospodăriile cu migranți au investiții mai mici în pesticide şi fertilizanţi
- Gospodăriile cu migranți au investiții mai mari în irigare
- Gospodăriile cu migranți au investiții mai mici în irigare

6. Altele, vă rugăm să specificați _____

7. Vă rugăm să specificați ce constrângeri (dificultăți) la producția agricolă fermierii moldoveni îndeplinesc

Efect asupra producţiei (1 = scăzut ; 5 = înalt)

- Secetă
- Grindină
- Inundaţii/prea multe ploi
- Alunecărilor de teren/ eroziuni provocate de apă
- Eroziune eoliană
- Fertilitatea scăzută a solului și productivitatea scăzută
- Infestare de dăunători
- Calitatea semințelor scăzută, lipsa de semințe îmbunătățite
- Accesul limitat / inadecvat sau disponibilitatea echipamentelor agricole
- Lipsa animalelor de tracţiune
- Problema cu infrastructura irigării
- Acces limitat la pământ (cost, disponibilitate)
- Instabilitatea pieţii, cerere scăzută
- Informaţie limitată de piaţă
- Infrastructura de transport limitată la cea mai apropiată piață
- Deficit forței de muncă
- Lipsa infrastructurii
- Lipsa fertilizanţilor şi pesticidelor
- Lipsa de credit/capital
- Lipsa infrastructurii de marketing
- Calitatea scăzută a apei
- Acces la credit/împrumut
- Situaţia politică
- Migraţia

8. Altele, vă rugăm să specificați _____

9. Credeți că schimbărilor climatice are impact asupra migrarea oamenilor?

- Da
- Nu

10. Dacă ați bifat da la întrebarea anterioară, vă rugăm specificați de ce

- Secetă
- Grindină
- Inundaţii/prea multe ploi
- Alunecărilor de teren/ eroziuni provocate de apă
- Eroziune eoliană
- Fertilitatea scăzută a solului și productivitatea scăzută
- Infestare de dăunători
- Probleme legate de apă
- Creșterea migrației ca urmare a schimbărilor climatice

11. Vă rugăm să specificați _____

12. Vă rugăm să specificați tipul de organizare dumneavoastră

- Servicii de extindere a agriculturii
- ACSA
- Asistenţă guvernamentală
- Asistenţa ONG
- Asociația fermierelor profesională
- Universitate

13. Vă rugăm să scrieți numele organizației dumneavoastră _____

14. Vă rugăm să scrieți mai jos regiunea de ședere

- Anenii Noi
- Bălți
- Briceni
- Cahul
- Cantemir
- Călărași
- Căușeni
- Cimișlia
- Criuleni
- Dondușeni
- Drochia
- Dubăsari

- Edineț
- Fălești
- Florești
- Glodeni
- Hîncești
- Chișinău
- Ialoveni
- Leova
- Nisporeni
- Ocnița
- Orhei
- Rezina
- Rîșcani
- Sîngerei
- Soroca
- Șoldănești
- Ștefan Vodă
- Strășeni
- Taraclia
- Telenești
- Ungheni