Sudan University of Science and Technology

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Sustaining Livelihoods to Alleviate Poverty Through Adoption of Technical Packages of Improved Potato Crop in Jebel Marra Area

استدامة سبل كسب العيش لتخفيف الفقر من خلال تبني الحزم التقنية لمحصول البطاطس بمنطقة جبل مرة

By:

Heitham Elhaj Mohammed Musa

B.Sc. of in Agricultural Extension & Rural Development

Sudan University of Science and Technology, 2002

M. Sc. of Science in Agricultural Extension & Rural Development

Sudan University of Science and Technology, 2006

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Main supervisor:

Dr. Mohammed Badawi Hussain

Co- supervisors:

1- Prof. Hag Hammed Abdelaziz

2- Senior lecturer. Abdelmahmood Hassan Elshaikh

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Dedication

To My parents who gave me the pen to go on with

To my wife who supported me with her patience and encouragement, my daughter Rahaf and the new son Mohammed

To my brothers, sisters and friends

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I would like to express my deepest indebtedness and sincere gratitude to my supervisor Dr. Mohammed Badawi Hussein for his keen guidance, genuine and professional support during the course of this study.

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ABSTRACT

This study was conducted as a contribution towards searching the performance of different agricultural technologies, agricultural extension methods, social and economic factors that increase small farms productivities using potato crops as a sample in order to sustain the livelihoods and alleviate or reduce the poverty of the poor farmers affected by Darfur conflicts. This study is an attempt to show the elements affecting the adoption of improved potato crops and proposing recommendations that can be used for developing strategies for effective agricultural extension work and alleviation or reduction of poverty among the potato's small farmers around Jebel Marra area.

Non-probability sampling was chosen and 180 representatives' farmers were selected in the study area for the purpose of collecting primary data. A Questionnaire was designed to collect information from the small farmers from Nertiti, Zalingei, Thur, Gurney Dankogand Delaig. The analytical statistical techniques such as descriptive statistics and Chi- square were applied to analyse the data obtained from filed survey.

The study revealed that there was a positive relationship between personal characteristic (age, sex, education level, income and family size) and adoption of improved potato by small farmers in order to sustain their livelihoods and alleviate the poverty. The study also reflected that there was no significant relationship between social factors (social status, living standard, and marital status) and adoption of improved potato to sustain the livelihoods of the small farmers. The study showed that there was a positive significant relationship between gender and adoption of recommended soil to grow improved potato. The study also detected that there was strong significant relation between agricultural extension methods used by agricultural extension agents to

provide information on improved potato to the small famers and increasing productivity of improved potato during the farming season.

The result indicated that there was a significant association between obtaining training on improved potato and practicing and adoption of the recommended sowing date, type of soil, methods of improved potato and time of adding fertilizers,. However, there was no relationship between obtaining training and adoption of recommended number of tuber per hole. The study reflected that there was a significant association between obtaining training on improved potato and high productivity of the improved potato.

The results of the study showed that a high percentage numbers of farmers are practicing some economic activities to get income after the end of agricultural season in order to sustain their livelihoods and alleviate the poverty. These activities include petty trade, sale of fire wood, making and sailing charcoal, masonry labour, sale of grass or fodder, making bricks, sewing work, wood work, sale of handicraft and remittances from their relatives inside and outside Sudan.

Based on the results, the study recommended the following:

The agricultural extension agents should raise the awareness of poor farmers on technical packages of improved potato through agricultural extension methods. More information about agricultural technologies should be conveyed to the small farmers, improve the rate of adoption and to boost the dissemination of improved potato. The Ministry of Agriculture in central Darfur should exert efforts to improve the agricultural extension program in Jebel Marra areas and the program should be directed to bring about change in attitudes and practices among poor farmers to alleviate or reduce their poverty.

ملخص الأطروحة

أجريت هذه الدراسة كمساهمة للبحث عن أداء التقنيات الزراعية، والطرق الإرشادية والعوامل الاجتماعية والاقتصادية التي تعمل على زيادة إنتاج المزارع الصغيرة وذلك باستخدام محصول البطاطس بهدف استدامة سبل كسب العيش وتقليل الفقر للمزارعين الفقراء الذين تأثروا بحرب دارفور.

هذه الدراسة محاولة للإشارة للعوامل التي تؤثر على تبني محصول البطاطس المحسنة والوصول إلى توصيات لاستخدامها في تطوير استراتيجيات تهدف إلى تفعيل العمل الإرشادي وتقليل الفقر بين صغار مزارعي البطاطس حول جبل مرة.

تم اختيار 180 كعينة غير احتمالية ممثلة للمزارعين بغرض جمع البيانات الأولية. ولقد تم تصميم استبيان لجمع المعلومات من صغار المزارعين من مناطق نيرتتي، زالنجي، طور، قورني، دانكوج، ودليج.

تقنيات التحليل الإحصائي مثل التحليل الإحصائي البسيط والتحليل الإحصائي المتقدم (تحليل مربع كاي) استخدمت في هذه الدراسة بغرض تحليل المعلومات التي جمعت من المسح الحقلي.

لقد أوضحت الدراسة أن هنالك علاقة معنوية بين الخصائص الشخصية للمبحوثين وتبني البطاطس المحسنة بواسطة صغار المزارعين من أجل استدامة سبل كسب عيشهم وتقليل الفقر، وأشارت الدراسة أيضا إلى عدم وجود علاقة معنوية بين العوامل الاجتماعية (المكانة الاجتماعية، مستوى المعيشة، الحالة الاجتماعية) وتبني البطاطس المحسنة لاستدامة سبل كسب العيش وتقليل الفقر، وعلى حسب النتائج فإن الدراسة أشارت إلى وجود علاقة معنوية بين الجندر وتبني نوع التربة الموصى به لزراعة البطاطس المحسنة، ودلت الدراسة أيضا إلى وجود علاقة معنوية كبيرة بين الطرق الإرشادية التي استخدمت بواسطة وكلاء الإرشاد الزراعي لتزويد صغار المزارعين بالمعلومات عن البطاطس المحسنة وزيادة إنتاجية البطاطس المحسنة.

دلت الدراسة إلى وجود علاقة معنوية بين الحصول على تدريب عن عمليات زراعة محصول البطاطس المحسنة وممارسة وتبني التوصيات الخاصة بتاريخ الزراعة، نوع التربة، طرق الزراعة، زمن السماد الموصى به، بينما لا توجد علاقة معنوية بين الحصول على تدريب في محصول البطاطس وتبني عدد الدرنات في الحفرة الواحدة.

ولقد توصلت الدراسة إلى وجود علاقة معنوية بين الحصول على تدريب في البطاطس المحسنة والإنتاجية العالية للبطاطس المحسنة.

وأشارت نتائج الدراسة إلى وجود نسب مقدرة من المزارعين يمارسون بعض الأنشطة الاقتصادية للحصول على دخل بعد نهاية الموسم الزراعي بغرض استدامة سبل كسب عيشهم وتقليل الفقر. هذه الأنشطة تشمل أعمال التجارة، بيع العلف، صناعة وبيع الفحم، الحياكة، بيع الخزف والجوالات من الأقارب داخل وخارج السودان.

وبناءا على النتائج التي توصلت إليها الدراسة فإن الدراسة أوصت بالآتي:

- نصح المرشدين الزراعيين بزيادة وعي المزارعين الفقراء بالحزم التقنية الخاصة بمحصول البطاطس المحسنة عبر الطرق الإرشادية.
- ينصح بتزويد صغار المزارعين بمزيد من المعلومات عن التقانات الزراعية الحديثة لرفع معدل التبني ونشر تقانات البطاطس المحسنة. وعلى وزارة الزراعة بولاية وسط دارفور بذل مزيد من الجهود لتطوير برنامج الإرشاد الزراعي بجبل مرة وتوجيه البرنامج لتغيير المفاهيم والاتجاهات والممارسات للزارعين الفقراء وذلك بغرض تقليل فقرهم.

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CHAPTER ONE

INTRODUCTION

1.1Background

For the past 200 years, some critical important factors have shaped the political, social and economic life of Darfur and neighbouring states: Islamism, trade and tribal identity. These factors have contributed to social dominance of religious leaders, tribal leaders and merchants in the region, combined with its driver's ecology; they shed light on the distribution and use of agricultural and pastoral resources in Darfur.

The armed conflict in Darfur Region, which erupted in early 2003, has had unprecedented, severe and lasting consequences on local communities, by destruction of infrastructure and livelihoods. Civilians have been subjected to widespread violations, causing massive displacement and the creation of a huge Internal Displaced people community in the region (Helen, Monim2005).

As the conflicts in Darfur enter its tenth year, how to support, protect and promote the livelihood of different groups has become an ever more pressing issue. In the early years of the conflicts the international humanitarian response prioritizes immediate life-saving interventions, although some agencies undertook livelihoods assessments with a view to introducing livelihoods programming.

More recently the interest of livelihoods programs has extended with a wider range of agencies paying attention to how livelihoods can be supported. Over the same time period, the humanitarian community has also begun to respond to environmental and agricultural concerns within Darfur, which are a keyto effectively supporting livelihoods in the region (B, A. A. Adam, et al (2007).).

To promote livelihoods through developing small farms in the area, its recommended to use sustainable livelihoods approach. The terms livelihoods describes the capacities, capital (human, social, productive/ economic, natural) and activities needed to sustain life (Chambers and Conway 1992).

A livelihood is considered sustainable when it can respond and recover from abrupt shocks and can maintain or improve its capacities and capital without understanding the natural resource bases. Achieving sustainable livelihoods is the result of a combination of factors within the area such as available resources, organizations and institutions. To understand the livelihoods of people in Jebel Mara area and possible way of improving them, there is a need to analyze their resources such as the way of farming, livestock….etc.

Most rural livelihoods depend on the natural resources base. The concept thus refers to the system's ability to maintain productivity when faced with disturbances, including stress or abrupt changes. This implies preventing natural resources reserves from diminishing to a level that result in the effective and permanent reduction of products and services that generate to achieve "the means by which to live" (Chambers and Conway 1992).

The concept of sustainable livelihoods (SL) is an attempt to go beyond the conventional definitions and approaches to poverty eradication. These had been found to be too narrow because they focused only on certain aspects or manifestations of poverty, such as low income, or did not consider other vital aspects of poverty such as vulnerability and social exclusion. It is now recognized that more attention must be paid to the various factors and processes which either constrain or enhance poor people's ability to make living in an economically, ecologically, and social sustainable manner. The Sustainable Livelihoods concept offers the prospects of a more coherent and integrated approach to poverty (Lasse Krantz 2001).

Small farmers who represent the majority of the population in Jebel Mara also take the biggest share of people living below the poverty line in the world. They also represent a major link between the economy and the environment because their livelihoods depend so directly on the use of land resources. In a bid to alleviate poverty and promote sustainable resources management among rural farmers a number of policies and initiatives have often had limited success because they are delivered as single component solutions and rarely address the complexity of farmer livelihoods

With the current conflict and other epidemics in Darfur, researchers and development practitioners are increasingly advocating for more dynamic models of the small holder farmer. These should take into account the emergence of increasing classes of the small farmer, changing trends in household structure and the effect of current phenomena like tribal conflicts and climate change on resources use, productivity and sustainability.

Apart from their own labour which they engage in both on-farm and off-farm activities, the majority of small farmers lack material resources like adequate land and capital. Understanding the relations and behaviour in such a complex farmer mix with respect to decisions on allocation of their resources to different activities is useful for effective technology transfer and implementation.

1.2 Problem Statement

Resource- poor farmers in Jebel Mara have different strategies to manage crop-livestock systems based on both local and research-driven knowledge. For crop production, a vast set of traditional or local and alternative technologies have been tested in the past, showing promising results for improving and/or maintaining soil quality and sustaining food production for both consumption and the market. However, the implementation of such technologies has been considerably limited to sustain their livelihoods. Some

of agricultural innovation packages of improved potato diffused by Jebel Marra scheme during last century however, the small farmers still have little knowledge and not aware enough about the practices of these agricultural packages of the improved potato to increase their income and reduce their poverty. The small farmers in Jebel Mara areas still practicing traditional methods of growing potato crops and most of the farmers affected by the ongoing Darfur conflicts. The limited land, resources and livelihoods assets and /or labour –demanding, have affected the decisions of farmers to adopt the new agricultural technologies and innovation packages of improved potato to reduce their poverty. .

This study will address the potential impacts of small farms to alleviate or reduce poverty of the farmers in Jebel Marra areas.The study will also examine the role that potatoes, especially the improved potatoes, can play in improving the livelihoods of poor people. The study draws on existing studies using the livelihoods lens to highlight the assets of the poor in these communities that are often overlooked in conventional development approaches.

1.3 Objectives

A) To measure the effect of personal characteristics on use of new recommended practices of potato in small farms.

B) To measure the relationship between the social factors and adoption of package of new technologies for potato crop.

C) To assess to what extent those small farmers participate in agricultural extension activities to develop their traditional farming methods.

D) To identify the economic factors increase the productivity of potato in small farms.

E)To evaluate the performance of different agricultural technologies and agricultural extension methods in increasing small farms productivities.

1.4 Hypotheses:

The main testable hypotheses include the following:

a) The adoption of potato innovations will improve the incomes of small farm households.
b) The adoption of recommended agricultural practices will increase small farms productivities.
c) The small farmers planted potato in small farms to sustain their livelihoods
d) Using local and traditional techniques by small farmers will decrease potato production.
e) Although the modern techniques are available, the adoption of improved potato by small farmers is low.

1.5 Independents and dependents variables:

Independent variables	Dependent variables
Agricultural technology Agricultural Extension Methods used Planting potato Traditional techniques Personal characteristics: • Age • Sex • Education • Income • Family size Social Factors: • Living standard • Social Status • Marital Status Economic factors: • Income generating activities • Bricks making • Collection of fire wood • Labour • Land accessibility	Increasing production of potato Participation Sustainable livelihoods& Poverty alleviation Decreasing production of potato Adoption & recommended practices of Potato: • Type of soil • Seed rate • Improved varieties • Sowing date • Spacing or distance between holes • Seed dressing or pesticides • Supplementary irrigation • Thinning • Harvesting time

1.6 Analytical Framework

The study aimed at studying and defining the links between the major concepts of small farms, sustainable livelihoods, the potential for new agricultural technologies and innovation packages of improved potato to reduce the poverty within small farmers. The research unit is small farm households and livelihoods activities will include a quantitative research method.

1.7 Methodology

The study focused on the household as the unit of analysis. A quantitative research methodology used to gather both primary and secondary data. Quantitative data collected on independent and dependent variables. This was done using a structured questionnaire.

Documentation, participatory rural appraisals and informant interviews were used to collect more data.

1.8 Organization of the study:

This study consists of five chapters:

1- Chapter one: an introductory chapter provides introduction about the study, problem statement, objectives, independent and dependent variables, analytical framework, methodology and organization of the study.

2- Chapter two covered the literature review

3- Chapter three introduced research methodology

4- Chapter four covered analytical results and discussion

5- Chapter five provides summary, conclusions and recommendations of the study

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction:

According to the United Nations, Darfur is in the throes of the "world's worst humanitarian disaster." The systematic assault on civilian livelihoods and means of survival is unprecedented in Sudan's history. Rural livelihoods in Darfur are relatively simple to understand, in that all tribes, Arab and non-Arab, cultivate crops and raise livestock to varying degrees. The livelihoods of farmers and herders have converged, although factors such as access to land, differing soil types, rainfall and altitude have all influenced the precise patterns of rural production.

Most groups supplement their farming and livestock-rearing activities with strategies such as labour migration and remittances, collection of natural resources (firewood, fodder and wild foods) and trade. Other livelihood strategies are specific to certain groups, including, for example, the production of Tombac (chewing tobacco), artisanry (leatherwork, metalwork, handicraft; etc.), membership of the military and a range of illegal activities (smuggling, banditry, brewing, prostitution etc.) (Helen Young 2005).

Crop production has plummeted the past eight years. Livestock are lost, stolen, trapped or dead. Conflict is escalating, civilians are fleeing and humanitarian conditions are deteriorating. Aside from scattered pockets of peace, rural areas are in social turmoil and economic paralysis. Darfur people from all walks of life unanimously identify conflict and insecurity as the most significant factors that seriously disrupt their livelihoods. Very few internally displaced persons (IDPs), if any, will return home for the agricultural season that starts in June-July. At best, crop production in 2005/06 might equal the deficit production in 2004/05, even if the rains are good. There is still hope of

avoiding a further decrease in security, cut-off of humanitarian access and departure of implementing partners, but the future for Greater Darfur is grim.

Darfur occupies a vast, sparsely populated territory in western Sudan. Seasonal weather patterns govern livelihood options and rhythms. Agriculture and livestock, the main productive sectors, are often hit by drought, particularly during the single rainy season between late June and late September. Sedentary agro-pastoralists grow rainfed millet, sorghum, groundnuts and sesame. Yields are relatively low, reflecting unreliable rainfall, poor soils and low-input agriculture. For agro-pastoralists, the hungry season occurs during the rainy season when labor requirements (calorie expenditures) are highest but consumption availability (calorie intake) the lowest. The main season harvest occurs during October-December.

Many households are able to cope, for the most part, with expected seasonal stresses. Nearly all households attempt to diversify their incomes by engaging in some sort of trading and marketing; long distance labor migration and remittance of income; and gathering and consumption of wild foods and hunting (FAO 2005).

Over time, shared vulnerabilities led to a system of mutual dependence and intricate rules between the main traditional livelihood groups. Nevertheless, this mutual dependence did not prevent frequent friction over access to seasonally scarce water and pasture in drought years.

The past complementary relationship between distinct livelihoods and seasonal demands on water, pasture, and cropland has become blurred. From a livelihoods perspective, the conflict in Darfur hinges on converging livelihoods between those who are living in their origin villages and internal displaced people, in particular.

Livelihoods in Darfur and in west Darfur in particular are difficult and at times harsh, but not impossible. Many households are able to cope with

expected seasonal stresses, with varying success. Depending on their resilience, many households usually recover from a year or two of drought or other natural calamity

The core livelihood strategies applied by IDPs in their original homes are no longer available, in particular goz and wadi cultivation and rearing livestock. In their new locations, large numbers of IDPs are competing for the very few job opportunities or sources of income that are available. In Kebkabiya, for example, the only work is for construction labourers and domestic servants. IDPs frequently rely on being able to sell some of their food aid ration, to buy essential goods and in some cases to pay rent. Profits are being made by those able to exploit the situation. Rents for houses and plots of land have increased by up to five-fold, and a building boom is visibly occurring.

Furthermore, livelihoods are a critical component of the humanitarian imperative – 'life with dignity' therefore; the systematic destruction of livelihoods is not only a critical human rights issue, but also a fundamental humanitarian one. Livelihood issues such as means of primary production, access to markets, and access to income and employment, for example, are covered by the Sphere Project's Minimum Standards in Disaster Response. Protecting and supporting livelihoods is a recognized strategy for preventing and alleviating human suffering. Displacement can be an intended or unintended consequence of war, or a coping strategy.

Displacement separates people from their livelihood sources. Whether people can access resources is determined in part by government policies and regulations on access to land and employment, the livelihoods of host populations, and relations between their hosts and the displaced.

The nature of the political economy of war determines the degree of exploitation and abuse of certain groups. Predatory war economies create some of the most severe impacts on livelihoods, as armed groups relate to

local populations and economic resources through violence, predation and forced labour. This can result in massive displacement, destitution and death (Le Billon, 2000). In many such economies, it is groups that have been historically marginalized and oppressed that are abused. In predatory war economies, violence becomes a means of asserting power and economic control. Violence may be perpetrated by states, warlords or other forms of leadership or by ordinary people. Forms of violence by states and warlords may include: asset stripping of weak or marginalized groups, looting, forced labour (e.g. in mining), and unscrupulous taxation by warlords (Le Billon, 2000). The longer a civil war, the more likely it becomes that people will find a way to profit from it.

Livelihood options are constrained by insecurity, on-going conflict and a lack of basic services. Certain livelihood strategies are part of the dynamics that also sustain conflict and instability (Schafer, 2002). Sustainable livelihoods will be difficult to achieve under such circumstances. This definition excludes notions of sustainability while bringing in survival in addition to longer-term well-being. It also introduces the concept of vulnerability which, some have argued, needs to be placed more centrally within a livelihoods framework (Pain and Lautze, 2002). Young et al.(2002) define livelihoods as: The ways in which people access and mobilize resources that enable them to pursue goals necessary for their survival and longer-term well-being, and thereby reduce the vulnerability created and exacerbated by conflict (Young et al. 2002).

The livelihoods framework emphasizes the integral relationship of Vulnerability to other aspects of the framework (Collinsonal. 2002). Common components of Livelihoods frameworks include (Carney *et al*. 1999):

* Vulnerability context – including resources, infrastructure, economic, political, environment, shocks and stresses;

* Resources or assets (although sometimes considered under strategies) – including financial, human, natural, physical, social and political assets;

* Transforming structures and processes, or policies, institutions and processes – government, non-government and private-sector organizations, and laws, policies, culture and institutions;

* Livelihood strategies;

* Livelihood outcomes or goals.

Livelihood strategies are composed of the activities that generate the means of household survival and longer-term well-being. Livelihood strategies may be divided into natural resource based activities (e.g. collection and gathering, cultivation, livestock-keeping, weaving) and non-natural resource based activities (e.g. trade, services, remittances, etc.) (Ellis, 2000). In many of the assessment approaches reviewed, livelihood strategies are referred to as production strategies, income-earning strategies, gifts and loans. Livelihood strategies are dynamic: they are able to respond to changing pressures and opportunities and adapt accordingly (Ellis, 2000), which contributes towards the overall resilience of livelihoods.

Livelihood outcomes and goals are also subject to change: for example, in peaceful and politically stable situations, livelihood goals might include increased well-being or more income; whereas in times of crisis, people's goals might become focused on such short-term objectives as personal safety, food security, reduced vulnerability and survival.

2.2.1 The impact of armed civil conflict on IDPs livelihoods

Individuals and households in developing countries face severe economic risks even in the absence of armed conflict as outbreaks of armed conflict are likely to increase insecurity. Further, insecure socio-economic environments force vulnerable people into deprivation and distress. These are typically associated with the destruction of essential infrastructure, livelihoods and social services, the breakdown of the rule of law, as well as with significant reductions in private and public investment.

Armed conflicts kill and displace populations, often limiting the access of households to employment and earnings (due, for instance, the death or recruitment of young adult males) and increasing levels of instability and loss of trust. This situation can be aggravated once displaced and refugee populations and demobilized combatants return to their communities in post-conflict situations, particularly when food aid and medical help (at least for those that were in refugee camps) may no longer be available(Patricia Justino 2011).

Conflict, and subsequent times of insecurity and fear, may impact on the ability of individuals and households to fall back on known survival strategies. In poorer, more vulnerable areas, or amongst the poorest, more vulnerable households, these consequences of conflict will add to already difficult circumstances(Patricia Justino 2011).

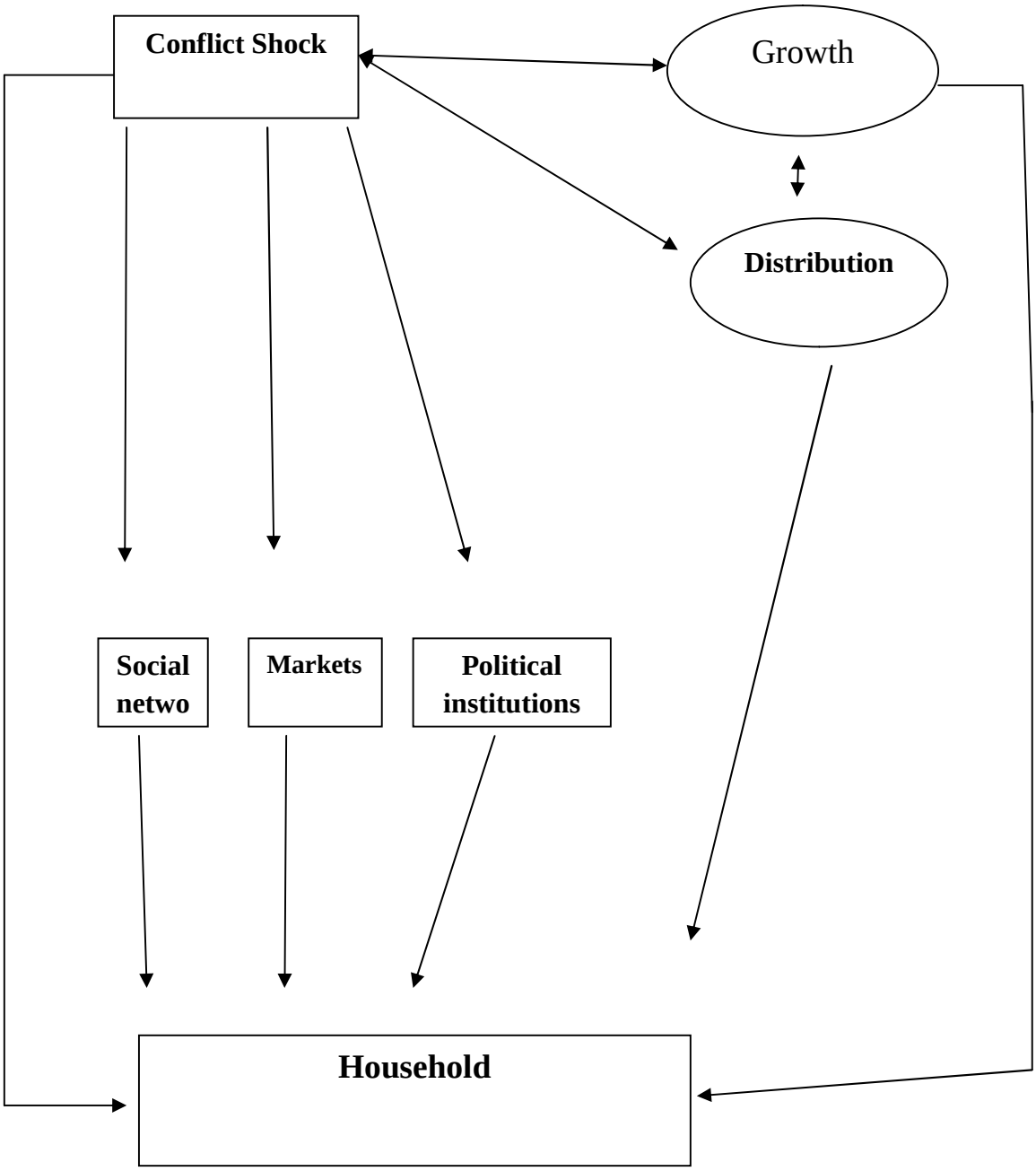
Those that were not poor may well become so due to reductions in food security following market disruption, increased difficulties in getting to markets to sell and buy goods, and the loss of earnings capacity, savings and formal and informal risk-sharing networks (Patricia Justino 2011).

Direct effects of armed conflict on the household include changes in household composition due to killings, injuries and recruitment of fighters by either the government or the rebel groups, changes in the household economic

status due to the direct destruction of assets and effects caused by forced displacement and migration. Indirect effects include changes in households' surrounding institutions and environments such as changes in social networks, changes in access to or destruction of exchange and employment markets and changes in local and national political institutions (Patricia Justino 2011).In addition it should be considered the important indirect effects of armed civil conflict on household welfare, transmitted through two key macroeconomic variables: economic growth and distributional channels.

Violent conflicts kill and injure civilians and combatants alike and cause severe psychological damage to those involved in fights, to those living in war-torn communities and to displaced populations. The levels of mortality and morbidity associated with armed conflict are explained not only as outcomes of fighting but are also for the most part the result of spreading disease and malnutrition (Guha-Sapir and Degomme 2006).

Figure 1.1 The main channels through which conflict shocks are transmitted to household welfare.



Source IDS Patricia Justino 2011

2.2.2 Destruction of assets:

During violent conflicts assets get loss or destroyed through heavy fighting and looting. These include houses, land, labour, utensils, cattle, livestock and other productive assets. The very poor are likely to be the worst affected. A twelve per cent of all households lost their house during the 1994 Rwandan genocide, while cattle stock on average decreased by 50per cent. The homes and livelihoods of around seven per cent of households were damaged during the civil war in Tajikistan between 1992 and 1998. The Burundi conflict in the 1990s was associated with severe asset depletion (Bundervoet & Verwimp 2005).

In Latin America, violence has significantly affected the efficiency of farm holdings due to the disruption of rural labour markets and limits imposed on the operation of larger farms. The number of deaths and injuries in these conflicts were extremely high with unaccountable impacts on individual livelihoods (Bundervoe & Verwimp 2005;Shemyakina 2006),

The destruction of assets by armed conflict, in addition to unstable economic, social and political environments, will impact significantly on the ability of affected households to recover their economic and social position in post-conflict settings. On the other hand, armed civil conflicts take place because there is something worth fighting for, implying that some groups and individuals will benefit from violence through looting, redistribution of assets during conflict and privileged access to market and political institutions for those that ‘win’ the conflict or support winning groups during the conflict.

These effects are as important in understanding processes of armed conflict as the more negative effects of fighting as both will have significant bearing on the sustainability of peace during the post-conflict period (Patricia & Justino 2011).

2.3 The Livelihoods of IDPs in Jebel Marra area

In conflict zones where displacement and insecurity undermine people's ability to pursue livelihoods, links with the diaspora, particularly the remittances they send, are an important source of support. But displacement and insecurity obstruct existing remittance channels, and it is thought that remittance receipts tend to decline after displacement even as they assume relatively greater importance in supporting livelihoods. Primary research on the change in remittance patterns before and after displacement is difficult to conduct, and there are very few studies that have explored this important livelihood dynamic (Young, Osman, and Dale, 2007)

In Darfur region, livelihood systems are closely linked with migration. Rural production systems are predominantly based on sedentary cultivation (farming) or transhumant pastoralism, but households also diversify their livelihood strategies to exploit opportunities within the region and in more distant countries. These strategies include trade, seasonal employment, longer-term labour opportunities linked with remittance transfers, and the long-distance livestock migration of pastoralists. Household mobility has also enabled adaptation to climate variability, when core activities came under ecological pressures of drought. In the early seventies and mid-eighties, extreme drought and famine led to the southward migration of agro-pastoralists, and displaced people seeking relief settled spontaneously in camps bordering the main towns. Following these famine years, an increasing number of migrant households settled permanently in the southern part of North Darfur and also in South Darfur. Mobility is therefore an integral part of peoples' lives, and their livelihoods domain extends across regional and national boundaries. This transnational dimension means the people of Darfur are subject to the national, regional and global economic and political forces, as well as the conditions in their immediate locality (Young, Osman, and

Dale, 2007; Buchanan Smith and Jaspars, 2007; Jaspars and O'Callaghan, 2008).

Before Darfur conflict in 2003, Jebel Marra people in western side of Darfur depending on their livelihoods on small farms cultivating vegetables, crops, espy sis, citrus and fruits. However after conflict some people displaced from their area and left the system of inherited livelihoods which was totally changed in IDPs camp and depending on food ration from INOs and UN agencies. In the same time other IDPs are still using the same livelihoods system by renting land or sharing the benefit after using land with people from host community.

Since the conflict intensified in Darfur in 2003, the pattern of conflict, level of protection threats, and numbers of conflict affected and displaced (as recognized by the humanitarian community) have evolved and changed. The worst of the counter-insurgency took place from mid-2003 to early 2004, and so coincided with most of the forced displacement. Villages were attacked, homesteads looted, burned and destroyed. Civilians fled for their lives, seeking safety by hiding out in nearby hills and *wadi's*, some crossing the border into Chad, and others wandering within Darfur in search of refuge and safety. After several weeks in transit many arrived in towns or the nearby camps of displaced people.

Atrocities were committed by both sides of the conflict, although the scale of the counter-insurgency was unprecedented. By July 2004 there were 1.1 million displaced people in the larger towns of Darfur, and more than 100,000 refugees in the camps in neighboring Chad. The numbers of displaced continued to increase through 2004 into 2005, as a consequence both of direct attacks, and the localized insecurity and loss of livelihoods which made it untenable for people to survive in their home rural areas. With time, humanitarian capacities increased and by the end of 2005 the numbers of displaced were approximately 1.6 million out of a total of 3.25 million

conflict-affected people. The conflict-affected population of Darfur includes IDPs in camp settings, IDPs in mixed IDP/host communities (rural and urban), and rural and urban (non-displaced) residents (Young, Osman, and Dale, 2007).

Nertiti and Zalingei are urban centers and sites of major displacement in Jebel Marra. Each represents a strategically important locus of the Darfur conflict. Since the 1980s both areas have experienced inter-tribal conflict between the sedentary farmers and livestock herding groups. Zalingei is located in the west of Central Darfur State and Nertiti in the east of Central Darfur State. Each is the capital of a locality (*mahaliya*), one administrative level below the State, and is governed by a Commissioner. Both sites are situated in the relatively fertile 'central cultivating zone' of Darfur, characterized by good rainfall and fertile alluvial soils. Both are in the traditional heartland of the Fur, the original homelands or '*dar*' of the Fur tribe. Important livestock migration routes traverse the region.

During the native administration, livestock movement was well organized and administered, but conflicts began to emerge first between the sedentary Fur and the livestock herding Bedeyat and Zaghawa, and then with the camel-herding Arab groups in the eighties (Young et al., 2009).

Inter-tribal reconciliation efforts and conferences agreed compensations and blood money, but these were only partly paid and tensions and violent disputes continued, including burning of villages. The areas surrounding Nertiti and Zalingei were directly affected by the Government-backed counter-insurgency starting in 2003. Around Zalingei, the predominantly Fur farming population were also driven out of their villages and into the IDPs camps of Zalingei. Zalingei is also strategically important because it was home to some of the leading figures in the rebel movement, including Abdal Wahid al Nur, leader of the rebel Sudan Liberation Movement/ Army, who was born and raised in Zalingei. Other prominent Fur are also from this

region, including Ahmad Ibrahim Diraige, former governor (and first Fur governor) of Darfur (1981-1983) and leader of the Sudan Federal Democratic Alliance, and also rotating head of the now defunct National Redemption Front (an alliance of rebel groups that emerged after the partial signing of the DPA). The families of Ahmed Direige and other political figures in the rebel movement (Ahmed Abdel-Shafi) are living in HassaHissa camp in Zalingei, and it has become a 'closed camp' meaning that people cannot leave and it is not officially open to government or even the African Union. Many of the IDPs have close contacts with the rebel movements as well as their diaspora overseas. Four camps are centers of rebel support and they mounted violent protests in the days following the partial signing of the Darfur Peace Agreement.

Since 2006 there has been a spate of assassinations and attempted assassinations of tribal leaders in the camps. A recent 2008 news report states that "11 tribal sheikhs around Zalingei, have been killed since the beginning of 2007" (Mac Farquhar, 2008).

The cases remain unsolved and suspicions vary from suspecting that the government is behind them to suspecting that new pro-rebel youth groups are responsible. The camps of Zalingei are clearly highly politicized. Both Zalingei and Nertiti are located relatively close to the upland area of Jebel Marra, a rebel stronghold (east of Nertiti) which also contributes to their strategic importance. In 2006 Nertiti and Zalingei had a large African Union contingent posted on the outskirts of the town.

2.4.1 Shifts in Livelihood Strategies and the Expanding Livelihoods

IDPs have shifted from agriculturally based livelihoods to more diversified urban livelihoods based on less secure sources of food and income. Between Jebel Marraand Zalingei there were important differences in the development of new livelihood strategies. In Jebel Marra most of IDPs engaged in casual

daily labour, while only few people did so in Zalingei. We attribute this difference to their local setting: IDPs in Zalingei are relatively confined to camps, while the IDPs in Jebel Marra live in the town and are more integrated with the host community. The diversification of strategies pursued by IDPs does not add up to an adequate livelihood or source of food security or income, because of the massive increase in the urban population with large numbers of IDPs chasing the same limited opportunities.

Most IDPs continue to depend on food assistance, which despite 50% ration cuts in May 2008, continue to comprise a significant share of their food sources. Many of the new strategies involve protection threats, or, like daily casual labour, are short-term, or limited, as in the case of food aid where rations can be cut by half over-night (Young, 2007).

IDPs who leave the camps to collect firewood or to try to cultivate potentially risk intimidation, harassment, looting or violence. The collection of firewood by IDP women is widely associated with gender based violence, specifically rape. However, not all our IDP respondents faced this security risk. For example, the Hottiya IDPs of Taibacamp in Zalingei is Arabs and they were able to collect firewood without risk. IDP women buy firewood from Arab groups and then re-sell this wood beside the camps which are closed to outsiders i.e. the Arab groups. The livelihood links between perpetrators of GBV (Gender Base Violence) and their victims are often overlooked by outsiders. Some of the new strategies adopted by IDPs, such as the sale of firewood, water-selling and brick-making, are unsustainable either because they over exploit limited natural resources in a fragile ecosystem, or because they are linked to markets distorted by the conflict, the presence of the international community and large scale of displacement. Firewood collection puts considerable pressure on natural resources in areas around IDPs camps, which have been reportedly cleared of tree cover for many kilometers(Buchanan-Smith and Fadul, 2008).

Borehole water, provided for humanitarian purposes, is often collected and sold to urban residents, thereby exhausting limited resources. The massive food assistance programme has similarly affected market supply and prices of cereal grains (Buchanan-Smith and Fadul, 2008).

Pastoralist groups in particular have benefitted from the widely available and relatively cheaper food aid sorghum, which has become a regular source of fodder for horses. The construction boom, which is linked with the increasing scale of the international interventions in Darfur and the demand for housing from residents and IDPs, is driving brick-making, another new livelihood strategy available to IDPs. However, researchers have concluded that: "The environmental consequences are devastating. Rough estimates indicate that the brick kilns are consuming over 52,000 trees-worth of wood per year; and since the conflict began much of this is green wood. The brick kilns are occupying and in many cases destroying valuable agricultural land by digging up clay soils around towns" (UNEP, 2008). In this fragile economy, fractured by its links with coercion and violence and where the natural environment is over-exploited with few if any controls, livelihoods are extremely precarious and very few IDP livelihood strategies could be considered secure or sustainable in the longer-term.

2.4.2 The Distorting Effects of the International Community on the Local Economy and Environment

The international humanitarian programme and UNAMID peace-keeping operations have had a significant impact on the local and regional economy, including local employment generation and linked multiplier effects. There has been increased demand for imported luxury goods and for property (for example, rentals by aid agencies), a construction boom, and a growing black market in looted humanitarian assets, especially vehicles and Thuraya (satellite) phones. One multiplier effect resulting from the injection of cash and other assets into the Darfur economy by the international humanitarian

community is increased aggregate demand. More jobs have generated more spending and net transfers to a wider group of people. The demand for imported luxuries by expatriate groups, unlike spending on locally produced goods, does not boost Darfur's economy but rather stimulates imports and financial transfers out of Darfur. Interviews with bank personnel indicate a net growth in outgoing transfers from Darfur to Khartoum or outside of Sudan since late 2007 to 2008. Our banker informants linked this increase to demand for specific products associated with the international community, including luxury goods and fruits desired by international humanitarian agencies and peace-keeping forces. One in El Fasher bank indicated that daily in-transfers of goods had increased by 344% (from 45 in 2003 to 155 in 2008), while the outgoing transfers had increased by 366% from 60 in 2003 to 220 in 2008. (Fadul, 2008).

2.4.3 The Implications for the Future

In Darfur, as in other conflict zones, livelihood systems are in transition. IDP strategies are constantly evolving in response both to partial blocking of previous livelihood strategies, and the new opportunities presented by urbanization and the distorting effects of the international community. Livelihood adaptations in the context of ongoing conflict and insecurity, distorted markets, lack of regulations and imposition of punitive taxation regimes and protection payments, cannot be considered either sustainable or equitable. Mal-adaptative livelihood strategies might provide food and income in the short-term, but they often incur indirect longer-term costs for the household, and can increase societal inequities and marginalization as well as over-exploiting limited natural resources. Locally appropriate and innovative approaches to support livelihoods are badly needed, but their newness makes it all the more important to monitor and evaluate their impacts on other livelihood groups, the local economy and environment. In particular

the implications of livelihood mal adaptations need to be recognized and where possible avoided.

Unlikely all or even most IDPs will return to their rural home areas and previous livelihoods. A more likely scenario is that IDPs will continue to foster their increasingly urbanized, 'multi-nodal' and transnational livelihoods. This has implications for the policy environment. Given the balance and coverage of current international humanitarian programming and lack of access to rural areas, livelihood interventions are likely to promote and support urban livelihoods in Darfur, and are unlikely to support return movements. Policy planners must also consider the potential that are taking place, particularly in terms of overexploitation of limited natural resources, including water, agricultural land close to towns and forestry resources (timber). The 'multi-nodal' and transnational nature of livelihoods broadens the potential arena for intervention, particularly when it comes to remittances. Earlier studies of remittances to conflict zones suggested that humanitarian agencies could contribute to livelihoods and recovery by "facilitating the renewal of remittance flows" for example by providing assistance with communications, transport, identity documents and banking (Savage and Harvey, 2007).

Whether such interventions will have much impact on the Darfur remittance receiving context is debatable. Banking seems to have taken off on its own, without the need for further intervention by the international community. Adaptations by the IDPs themselves appear to have accommodated such problems as lack of identity documents for accessing remittances. A key question is whether efforts should be made to promote remittances, i.e whether remittance flows do indeed make an important difference in the livelihoods of displaced people and their communities, and what indirect, potentially harmful consequences might ensue. Even assuming international interventions could facilitate and increase remittances, the issue of the impact

increased remittances will have on displaced and non-displaced urban communities needs to be further understood. We think more attention should be paid to the problems of protection and security of remittance senders and receivers. It is also important to consider the community inequities that remittances can create or aggravate which in turn lead to tensions. These tensions can also occur depending on the purposes to which remittances are put. For example, remittances used for community purposes (like the building of a mosque or school) are likely to have very different social effects than if remittances are used to invest in household wealth-increasing activities or increase conspicuous consumption (Helen, Osman, Karen,2007).

Some studies found that remittances receipts, while probably useful or even important to the consumption patterns of receiving households, benefit only a small proportion of the population. Rather than focusing on remittances, it is probably more helpful to recognize the globalized nature of IDP livelihoods, and how they encompass multiple policy and programming environments. Such a wide-angle lens on IDP livelihoods allows us to see a broader range of programming opportunities, and it presents the vulnerability of IDPs in a somewhat different light. Unless the expanding livelihoods domain of IDPs is supported by legal and governance frameworks, such as natural resource governance, or legal rights as migrant workers, IDP livelihoods will remain inherently vulnerable.

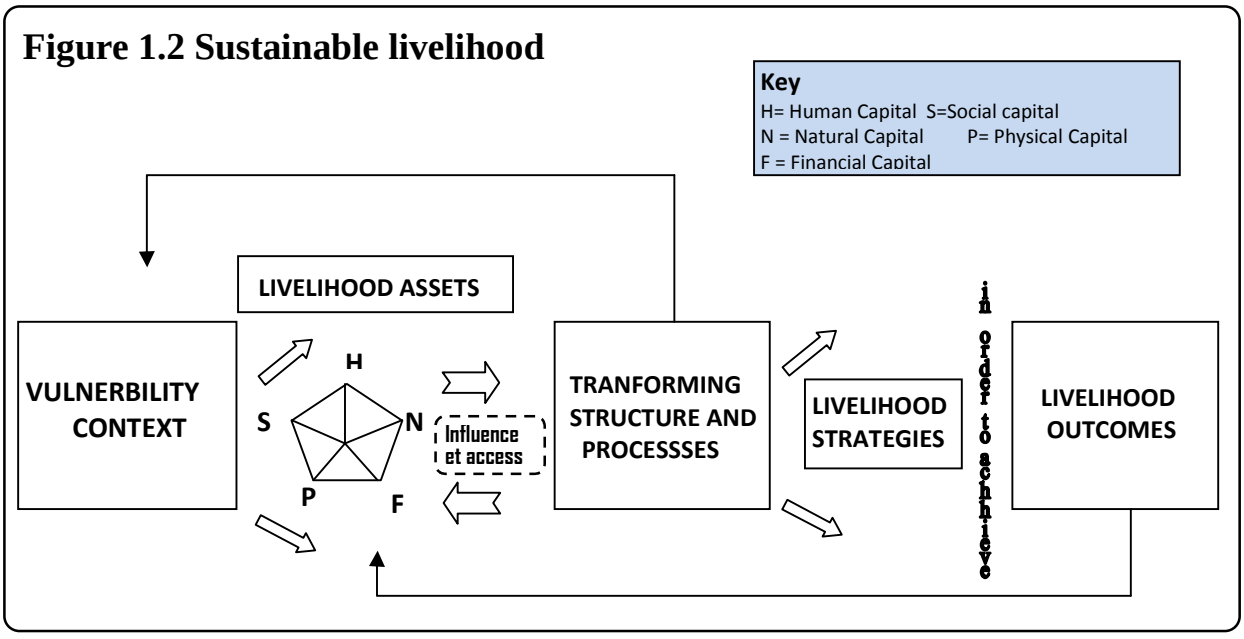
Localized protection threats endured by many IDPs in Darfur are likely to remain so long as the conflict continues, particularly the liabilities of asset ownership and risk of asset-stripping. The constant risk of marginal activities means IDPs are unable to provide adequate food or income for their households. This localized vulnerability affects women more than men who are more likely to be absent from camps. Women tend to carry the burden of displacement and have to develop alternative livelihood strategies in the limiting environment of the IDP camp. Women also have to face the day to

day protection risks associated with many livelihood strategies. Our data on women's education – the significant differences in all education levels between men and women, with women having much less education – is a chilling reminder of the profound and deeply embedded discrimination against women regardless of whether they were IDPs or urban residents (Helen, Osman, Karen,2007).

The impact of international humanitarian assistance on the livelihoods of IDPs is not simply about the immediate impact of aid transfers. For most IDPs the impact of international interventions in Darfur has consequences for the wider urban settings, local economy and security. Understanding this wider impact requires the kind of reflection and monitoring that is not usually incorporated into the information systems of the UN or others, yet is crucial to a more nuanced and holistic view of humanitarian needs, impact and long-term implications.

Livelihoods diagram:

Figure 1.2 Sustainable livelihood



Source:

Building Livelihoods - WOMEN'S REFUGEE COMMISSION ,MAY 2009

2.4.3 Potato and poverty

Potato is the world's most important root and tuber crop worldwide. It is grown in more than125 countries and consumed almost daily by more than a billion people (NeBambi Lutaladio, Oscar Ortiz, Anton, Haverkort and Daniel Caldiz 2009).

Potatoes are native to the Andean region of South America. European explorers introduced potato to Europe in 1536 and Potatoes are the number one non-grain food crop in the world. Potato cultivation is expanding strongly in the developing world, where the potato's ease of cultivation and nutritive content has made it a valuable food security and cash crop for millions of farmers. Developing countries are now the world's biggest producers – and importers – of potatoes and potato products(Ne Bambi, Oscar, Danniel and Anton 2009). Once harvested, potatoes can be used for a variety of purposes: as a fresh vegetable for cooking at home, as raw material for processing into food products, food ingredients, starch and alcohol, as feed for animals, and as seed tubers for growing the next season's crop.

Potatoes are a cool season crop; ideal temperatures for crop growth are 65 to 80 during the day and 55 to 65 at night. The soil should be cultivated 6 to 8 inches deep in the spring, and large soil clods should be broken up or removed before planting. Plant potatoes when soil temperatures are above 45 F. Cold, wet soil at planting time increases the risk of seed piece decay, and planting into cool, dry soils can cause delayed sprouting and emergence of the potatoes (Kelly , Donna , David and C. Robin 2006).

Potato is essentially a "cool weather crop", with temperature being the main limiting factor. In tropical areas, potato should be grown where the climate is tempered by altitude (1 500 – 4 200 m) or at lower altitudes provided the crop is grown during the cool season (NeBambi , Oscar , Anton and Daniel 2009).

The ideal condition for tuberization is a night temperature of around 16°C, while optimum yields are obtained where mean daily temperatures are in the

18-20°C range. Loose, moist and well-drained slightly acid soil (with pH of 5.0-5.5) or volcanic upland soils are preferred. The water supply for the potato crop should be regular, especially from the stage of tuber initiation until the end of tuber enlargement (NeBambi, Oscar, Anton and Daniel 2009) Plant tuber seed pieces 3 to 4 inches deep. Leaving 30 to 36 inches between rows and spacing seed pieces 9 to 12 inches apart in the row will generally produce an acceptable yield of medium-sized tubers. Five pounds of seed potatoes should plant 40 feet of row with 12 inches between seed pieces. You can expect to harvest 3 to 5 pounds of potatoes per potato plant. Larger tubers are produced at wider plant spacing, though some varieties, for example, Yukon Gold, develop growth defects such as hollow heart at a wider spacing (Kelly , Donna , David and C. Robin**).**

A successful potato crop depends on judicious cultural practices. These include good knowledge of variety purity and characteristics such as dormancy duration, the physiological condition of seed potato tubers (well sprouted and 30-80 g in weight, depending on variety) and resistance to the main transmissible potato diseases and nematodes (NeBambi, Oscar, Anton and Daniel 2009)

Potatoes are best grown in rotation. In the Andes, it is usually the first crop in the rotation. In other regions, it can be planted after cereals and before legumes, but not with crops (e.g. tomato and other solanaceae) that are susceptible to the same pathogens as the potato. Sometimes natural fallow is necessary to prevent soil impoverishment and the build-up of potato specific diseases and insect pests. Soil preparation for potato crop should be adequate with minimum soil disturbance. Naturally loose soils, and loamy and sandy loam soils that are rich in organic matter with good drainage and aeration, are the most suitable. Planting depth, density and spacing depend on the variety chosen and tuber size, and should allow for shallow inter-row ridging, when required. Usually, about two tons of seed tubers are planted per hectare (NeBambi , Oscar , Anton and Daniel 2009).

To give the crop a competitive advantage, weeding should be performed after full crop emergence (about 4 weeks after planting) and after the plants have reached a height of about 20 cm. Shallow ridging is done subsequently to prevent the stolon becoming aerials, and to protect tubers against insect pests, disease infection and greening. Crop rotation and careful chemical control with herbicides, applied at minimum lethal doses, may be part of an integrated weed management system, although in most developing countries weed management is usually carried out manually (Kelly , Donna , David and C. Robin).

2.4.4 The diffusion and adoption of agricultural technologies

There is no more distinctive feature of agriculture than its dynamism farming practices change continually. Farmers build on their own experience and that of their neighbors to refine the way they manage their crops. Changes in natural conditions, resource availability, and market development also present challenges and opportunities to which farmers respond. In addition, farmers learn about new technologies from various organizations, programs, and projects dedicated to research, extension, or rural development. These organizations develop and promote new varieties, inputs, and management practices. It is essential that such organization be able to follow the results of their efforts and understand how the technologies they promote fit into the complex pattern of agricultural change in which all farmers participate. (Derek Byerlee 1993).

The process of adopting new innovations has been studied for over 30 years. Adoption is a decision of “full use of an innovation as the best course of action available” and rejection is a decision “not to adopt an innovation. The diffusion has been defined as “the process in which an innovation is communicated thorough certain channels over time among the members of a social system. As expressed in this definition, innovation, communication

channels, time, and social system are the four key components of the diffusion of innovations. (Rogers 2003).

Any program that attempt to develop and promote improved farming practices should be to assess progress and use that information to mark future action more effective. One of the principal incentives behind the development of adaptive research methods such as farming systems research or on-farming research was the criticism that much agricultural research was being done on experiment stations, isolated from the field, problems, and perspectives of client farmers. (Derek Byerlee1993).

Four Main Elements in the Diffusion of Innovations:

Innovation

"An *innovation* is an idea, practice, or project that is perceived as new by an individual or other unit of adoption". An innovation may have been invented a long time ago, but if individuals perceive it as new, then it may still be an innovation for them. The newness characteristic of an adoption is more related to the three steps (knowledge, persuasion, and decision). In addition, Rogers claimed there is a lack of diffusion research on technology clusters. According to Rogers, "a technology cluster consists of one or more distinguishable elements of technology that are perceived as being closely interrelated. (Ismail Sahen 2006).

Communication Channels

The second element of the diffusion of innovations process is communication channels. The communication is "a process in which participants create and share information with one another in order to reach a mutual understanding". This communication occurs through channels between sources, "a *source* is an individual or an institution that originates a message. A channel is the means by which a message gets from the source to the receiver. (Rogers 2003).

Rogers states that diffusion is a specific kind of communication and includes these communication elements: an innovation, two individuals or other units

of adoption, and a communication channel. *Mass media* and *interpersonal communication* are two communication channels. While mass media channels include a mass medium such as TV, radio, or newspaper, interpersonal channels consist of a two-way communication between two or more individuals. On the other hand, “diffusion is a very social process that involves interpersonal communication relationships. (Ismail Sahen 2006).

Time

According to Rogers (2003), the time aspect is ignored in most behavioral research. He argues that including the time dimension in diffusion research illustrates one of its strengths. The innovation-diffusion process, adopter categorization, and rate of adoptions all include a time dimension. These aspects of Rogers’ theory will be discussed later in more detail.

Social System

The social system is the last element in the diffusion process. Rogers (2003) defined the social system as “a set of interrelated units engaged in joint problem solving to accomplish a common goal”. Since diffusion of innovations takes place in the social system, it is influenced by the social structure of the social system. The structure is “the patterned arrangements of the units in a system”. He further claimed that the nature of the social system affects individuals’ innovativeness, which is the main criterion for categorizing adopters.

Most extension services are actively engaged in promoting new technologies with farmers. Resources are invested in various extension activities, such as field days or demonstrations, and the extension service may undergo considerable reorganization, such as with the training and visit. But only infrequently are resources reserved for monitoring the outcome of these extension efforts and using the analysis to understand why some recommendations or extension techniques are more successful than others. For example, if the extension service is recommending a green manure crop, it will be very useful to know what proportion of farmers is using the new

practice. For those farmers who have not adopted, do they find disadvantages with the new practice, is the practice too far removed from farmers' knowledge base, or has the extension methodology not been effective in acquainting these farmers with the new technique?. (Derek Byerlee 1993).

Adoption studies are also useful for illustrating the degree to which acceptance of new technologies is limited by insufficient inputs, credit, or marketing infrastructure. If it appears that farmers are unable to take advantage of a new technology because they lack inputs, this information can be presented to policymakers who have responsibility for the agricultural inputs that are available and the way they are distributed. If adoption study shows that access to credit significantly influences the type of technology that farmers use, then this information may be presented to those responsible for designing and funding credit programs. Similarly, adoption studies may be used to highlight marketing bottlenecks that limit the acceptability of new technologies. (Derek Byerlee 1993).

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 The area of study, overview of methodology

Darfur region extends over an area as large as Spain. In 1995, it was divided into three states: west, north and south Darfur. West Darfur state covers more than 75,000 square kilometers in the westernmost region of Sudan. It features a marked agro-climatic gradient, with west Darfur's northern zone consisting largely of semi-desert hills and rocky land-escapes. The state central zone, located between latitudes 12-14 N, contains a dry savanna as well as the Jebel Mara mountains range and plateau, which includes fertile and forested land (Satti and A. Peter Castro 2012). Central Darfur, with the capital Zalingei located in central zone, west of Jebel Mara mountain range and plateau, a volcanic whose highest peaks rise to 3,000 meters above sea level. Jebel Mara serves as its chief supplier of water, including seasonal streams which flow through the area's valleys, farm-land and pastures during rainy season. Almost two-thirds of Zalingei's annual average total of approximately 570 mm during July and August (Satti, Castro 2013). However, considerable variation occurs from year to year.

West Darfur has more than one million inhabitants who are distributed in 6 administrative localities, (with El Genianaserved as capital since 1995 up to 2012). The state is limited to only very basic administrative activities. The study conducted in six areas namely, Nertiti, Thur, Gurney, Zalingei, Dankog and Delaig. The area was selected according to the place of planting potato. The total number of population samples studied was "180" individuals selected from targeted villages randomly and some of the target group were IDPs and others were residents. The target group also involve men and women at all areas and it's worth noting that women in all areas were productively more active.

3.2 The Research population

Before Darfur conflict in 2003 Central Darfur and Jebel Marra area contained more than 400 villages, however during the conflict most of these villages abandoned. Ten of the remaining villages which were familiar with growing potato were the research population. The villages of the research selected according to the stability of security situation and availability of the target group in the areas. Six villages out of ten were chosen to be the research sample. The selected villages were specifically Nertiti, Thur, Gurnee, Zalingei, Dankog and Delaig.

3.3 Respondents sample:

Non-probability sampling (Necessity sample because of ware and insecurity was chosen). 180 persons were chosen from the research population. The head of Shaikhs of every area selected the names of small farmers of potato crops and 30 persons were chosen from each village because all villages were synonymously similar in density and distribution of people.

3.4 Research Methodology

Social survey were conducted in this research

3.5 Data collection:

Primary data was collected using questionnaire, personal interviews and observation. While secondary data was collected through reference books, reports, reviews related research and the internet. The data collected by four people having experience on data collection and also trained to collect such information. The collection of data took almost four months from February 2013 to May 2013 because of insecurity situation in the areas of study

3.6 Data analysis:

Simple descriptive statistic and Chi-Square tests were used for the analysis of the study. The conceptual model of the study made up of adoption of recommended practices from agricultural extension office by farmers as a dependent variable. The independent variables for farmers involved in the conceptual model include: age, sex, education level, income, family size, farm size, social factors and economic factors. See fig (1.1)

3.7 The Hypotheses:

Principle hypotheses were generated from the conceptual model for testing the present study involving farmers growing improved potato's from six villages and the definitions of the study variables, the exogenous variables which include age, sex, education level, income, family size, farm size social factors and economic factors were defined for the purpose of the study.

Operational definition of terms:

Age:

Age of farmers in years

Education:

Years of formal education completed by the respondents. This variable measured by the level of formal schooling completed by the farmer. It is measured in terms of scores assigned for each farmer according to his level of education. Zero score assigned for an illiterate farmer, and more additional score is given for each level of formal schooling completed by farmer. Thus the variable is measured by a scale of (0-3)

Farm size:

Total area of farm land cultivated by the respondent (privately owned, shared, rented.)

Access to the farm:

This variable measured the constraints that faced farmers to access their farms.

Access to the inputs:

This variable measures the availability and value of inputs (big hoe, small hoe, donkey plough, Tridle pump, watering tools spray tools, fertilizers tools and harvesting tools) in Sudanese pound purchased by farmers growing improved potato.

Adoption of innovation:

This variable measures the total value of all innovation adopted by the respondents. These include improved potato, fertilizers, insecticides, mechanical land preparation, agricultural equipment and recommended practices used during the agricultural season of 2013.

Training:

This variable measures the number of trainings conducted by different institutions and attended by the respondents while cultivating improved potato.

Access to agricultural information:

This variable measures the numbers of sources that the farmers obtain the agricultural information. These sources include:

- Extension leaflets
- Posters
- Training courses
- Radio
- TV
- Agricultural extension agents

- Neighbors and relatives
- Field visits
- Office visits
- Field days

3.8 The problems faced the researcher

1- Difficulties to get data due to conflict and insecurity situation in the areas of study.

2- Additional financial cost for the long time that the research took.

CHAPTER FOUR

FINDINGS AND DISCUSSION

This chapter is devoted for presentation of findings or results obtained from data analysis. The results are accentuated according to the different statistical techniques being used for data manipulation and presented in this section. Frequency distribution results have inferences about some variables concerning the respondents in this study (improved potato farmers).

Table 4.1.1: Frequency distribution of respondents according to their sex:

Gender group	Frequency	Percent
Male	156	86.7
Femal	24	13.3
Total	180	100.0

Source: Filed survey 2013

Table (4.1.1) indicates that 86.7% of potato producers were male and only 13.3% were female. The alleviation of poverty through developing the small potato farms should focus mainly on male in areas of study. Generally potato production was male dominated (86.7%).However more recently the interest of livelihoods program has expanded to be inclusive to men and women with a wider range of agencies paying attention to how livelihoods can be supported through developing small farms to alleviate poverty among rural people. (Researcher experiences with IGOs).

Table 4.1.2: Frequency distribution of the respondents according to their age:

Age Group	Frequency	Percent
20 -29	36	20.0
30 – 39	75	41.7
40 – 49	55	30.6
50 – 59	11	6.1
Over 60	3	1.6
Total	180	100.0

Source: Filed survey 2013

Table (4.1..2) indicate that 41.7% of potato producers were 30-39 years of age and 30.6 % were 40 and under 50 years of age. It shows that the producers areyouth; therefore, it will be easy to convince them to accept any new technology in order to change the traditional methods of agricultural practices.

Table 4.1.3: Frequency distribution of the respondents according to the social status:

Social status	Frequency	Percent
Single	28	15.5
Married	150	83.3
Divorced	1	.6
Abandoned	1	.6
Total	180	100.0

Source: Filed survey 2013

Table (4.1.3) shows that 83.3% of the study sample in the areas of study were married, while 15.5 were single, it worth noting that in table (4.1.2) 41.7% were between 30-39 years old which indicates the suitable age of marriage in the area. The high percentage of married farmers has family members that can contribute positively to the improvement of the economic situation of the family by adoption of the new technologies of improved potato to sustain their livelihoods.

Table 4.1.4: Frequency distribution of respondents according to level of education:

Education level	Frequency	Percent
Easily read and write	128	71.1
Not easy to read and write	36	20.0
illiterate	16	8.9
Total	180	100.0

Source: Filed survey 2013

Table (4.1.4) indicates that 71.1% of farmers in area of study were educated and easily read and write which showed that the education level among the sample of the study is high. 20 % they can't read and write easily. However the illiterate sample was only 8.9%. The high percentage of educated farmers is more likely to adopt improved potato than those who have never been to school.

According to "Yousif 2010" the more educated household head is expected to be more efficient to understand and obtain new technologies in shorter period of time than uneducated people.

Table 4.1.5: Frequency distribution of respondents according to family size:

Family size	Frequency	Percent
2 – 3	26	14.4
4 – 6	54	30.0
7 – 10	100	55.6
Total	180	100.0

Source: Filed survey 2013

Table (4.1.5) indicates that 55.6 % of the respondents' family size ranged between 7-10 individuals and the relation between family size and adoption of potato technologies to improve the livelihoods of the target family is expected to be positive bearing in mind that the big family size plays a role in labour supply. Adoption of new technology required more labour inputs. Moreover, the large families is importance to farm and nonfarm activities to meet the increased needs of their families.

Table 4.1.6: Frequency distribution of respondents according to residence status:

Residence status	Frequency	Percent
IDPs in camps	31	17.2
IDPs outside camps	25	13.9
Residents in towns	118	65.6
Returnees	5	2.8
Nomads	1	.6
Total	180	100.0

Source: Filed survey 2013

Table (4.1.6) shows that 65.6% of the respondents were residents in towns and have potential access to the financial support from government institutions such agricultural bank to get potato's inputs and easily improved their production and earn more income. The percentage of the IDPs is 31.1 % indicated that the number is small compared to the residents. Most of them left home of origin and work as labour in farms of resident people. The IDPs are more vulnerable group and the percentage of poverty is high among them, it would be very important to be under focus by development agencies to alleviate their poverty.

Table 4.1.7: Frequency distribution of respondents according to type of housing:

Type of housing	Frequency	Percent
Hut/mud/bricks	115	63.9
Hut/grass/wood/plastic	32	17.8
Hut/ grass/wood	33	18.3
Total	180	100.0

Source: Filed survey 2013

Table (4.1.7) indicates that 63.9% of farmers were living in Huts structured and made from mud or bricks; it means that they are living as residents in small villages or towns. It also shows that the living condition is very poor compared to modern living condition. However 17.8% living in huts made from grasses or wood and covered with plastic sheet are mainly IDPs and the poorest of poor. Through improving the methods of agriculture and adapting new potato's technologies their income will increase as well as their living condition will improve.

Table 4.1.8: Frequency distribution of respondents according to income sources:

Income sources	Frequency	Percent
Agriculture only	115	63.9
Agriculture and trade	38	21.1
Trade	15	8.3
Agriculture and livestock	1	.6
Labour	3	1.7
Other	8	4.4
Total	180	100.0

Source: Filed survey 2013

Table (4.1.8) indicates that 63.9 of respondents' income sources depend on agriculture only while 21.1 got income from practicing agriculture and trade. It is important to understand that farming and herding are practiced throughout Darfur, and rarely undertaken as separate activities. In other words, nearly all farmers rear livestock, while nearly all herders cultivate crops (Helen & Abdelmoneem 2005). However according to the data above .6% depend on agriculture and livestock on their income in central Darfur because of insecurity and looting of livestock which is familiar in the area. Most of the farmers do not prefer to have livestock as income resource because of security challenges. Mahran (2000) advocated that 80% of rural people in Sudan depend on agriculture for their livelihoods.

Table 4.1.9: Frequency distribution of respondents getting additional sources of income from livelihoods activities:

Contribution to income	Frequency	Percent
Sale of cereal	112	62.2
Sale of other crops& products	42	23.3
Sale of livestock	1	.6
Agriculture wage labour	9	5.0
Non-agriculture work	3	1.7
Sale of handicraft	3	1.7
Sale of firewood	3	1.7
Petty trade	3	1.7
Gift from families and relatives	4	2.2
Total	180	100.0

Source: Filed survey 2013

Table (4.1.9) shows that cultivation of cereals, sorghum and millet, supplemented by cultivating small groundnuts and maize farms were contributing 62.2% to total income of the farmers in area of study. 23.3 % of selling other crops and agricultural products (watermelon, vegetables, Tabaco..etc) are contributing to total income of the household during the year. 5.0% of the respondents working as agricultural labour to get income, and in poor households it is common to seek agricultural labour, while for middle - income households the main sources of income are trade, money sent from family members abroad and the sale of livestock. Herding is one method of acquiring livestock, as herders are often paid in kind.

Table 4.1.10: Frequency distribution of respondents according to constraints to sources of income:

Constraint	Frequency	Percent
Yes	104	57.8
No	2	1.1
sometimes	74	41.1
Total	180	100.0

Source: Filed survey 2013

Table (4.1.10) indicates that 57.8% responded that they were facing constraints to their sources of income, while 41.1% sometimes facing some constraints, whereas only 1.1% was not facing any constraints. The data shows that the source of income of 98.9% is under threat and the current conflict in Darfur negatively affected to the sources of income of the household.

Table 4.1.11: Frequency distribution of respondents according to constraints affecting sources of income:

Constraint	Frequency /Percentage				Total
	Yes	%	No	%	
Insecurity	154	85.6	26	14.4	100
Lack of manpower	156	86.7	24	13.3	100
Distance to the market	40	22.2	140	77.8	100
Low prices of agricultural products	97	53.9	83	46.1	100
Low prices of animals	15	8.3	165	91.7	100
Limited employment	34	18.9	146	81.1	100
Low agricultural production	77	42.8	103	57.2	100
Low animal production	14	7.8	166	92.2	100
Disability& health problems	59	32.8	121‘	67.2	100

Source: Filed survey 2013

Since Darfur conflict started in 2003 the security issue became as the main concerns to the farmers in the whole region. In central Darfur where the fighting started 85.6 % of the sample responded that the insecurity is one constraint facing them to cultivate potato crop in their area, however other farmers 14.4% have seen that the insecurity is not the main constraint. The insecurity can be described according to the farmers by looting their properties during the cultivation and harvesting season, killing and beating of the farmers by outlaws armed people. During the period of the study it was observed that there was natural conflict between nomads and farmers over water resources, fodder, and migration routes and farms destruction. The protection of civilian mainly farmers need more intervention from government authorities to protect them to continue their livelihoods. The table also shows that 86.7 % of sample responded that lack of manpower is constraint facing them to cultivate potato. The lack of manpower became a challenge because of displacement of Darfur people to safe area in the region or outside the region to Khartoum and Chad. (Young, Karen, Osman 2007).

Table 4.1.12: Frequency distribution of respondents according to cultivation of improved potato during the year 2012:

Cultivation of improved potato	Frequency	Percent
Yes	146	81.1
No	34	18.9
Total	180	100.0

Source: Filed survey 2013

Most of the selected sample (81.1%) cultivated improved potato this year 2012, while(18.9%)cultivated the local variety of potato. It is worth mentioning that the diffusion of improved potato started by agricultural extension agents from Jebel Mara scheme. The farmers adopted the new seed and it was observed it is available in the local markets in area of study. The local variety is common used in Jebel Mara, Thur, Gurnei, Nertiti because of its test and adaptation to climate and environment. In spite of its low productivity it has ability to be stored for long time in the traditional stores.

Table 4.1.13: Frequency distribution of respondents according to type of soil for cultivation of improved potato:

Type of soil	Frequency	Percent
Heavy soil	33	18.3
Light clay soil	86	47.8
Sand and clay soil	61	33.9
Total	180	100.0

Source: Filed survey 2013

Jebel Mara is the most fertile area in central Darfur. The type of the recommended soil for cultivating potato is available in most areas of the study. 47.8% planted in light clay soil while 33.9% used sand and clay soil. Both types of soil showed high productivity in the area. Poorly drained, heavy clay soil should be avoided when raising potatoes (Nebambi, Lutaladio, Oscar, Anton and Daneil 2009).

Table 4.1.14: Frequency distribution of respondents according to the area planted by improved variety of potato:

Number ofFedans	Frequency	Percent
Less than one	37	20.6
1-2	84	46.7
3-4	18	10.0
More than five	7	3.9
I don't know	34	18.9
Total	180	100.0

Source: Filed survey 2013

Table (4.1.14) shows that 46.7 of the participants planted potato area between 1-2 fedan, because the availability of land for planting potato is very limited in most area of study. Jebel Mara is a volcano mountain and most of its land is rocky land and the limitation of land caused tension between indigenous people, farmers and sometimes nomads over the land ownership. It was observed that the farmers in Golo and Guldo used to plant over the mountain during the rainy season.

Table 4.1.15: Frequency distribution of respondents according to land ownership:

Land ownership	Frequency	Percent
owned	82	45.6
rented	87	48.3
partenship	10	5.6
others	1	.6
Total	180	100.0

Source: Filed survey 2013

Table (4.1.15) indicates that 45.6 % of the farmers were cultivating on their own land where the high percentage 48.3% of the farmers are renting the land. The rate of renting land is high and costly for the production of potato crops. In the area of study most of the people are displaced and poorest of poor however, the high rate of renting land will affect the process of diffusion and adoption of the new technology and ideas negatively. While the farmers who owned the farm land can use their land according to their interest which will positively affect the process of diffusion and adoption of new technologies and ideas of improved potato.

Table 4.1.16: Frequency distribution of respondents according to sowing date of potato:

Sowing date	Frequency	Percent
October	18	10.0
November	111	61.7
December	30	16.7
January	21	11.7
Total	180	100.0

Source: Filed survey 2013

Table (4.1.16) shows that 10% of the participants were growing the potato in month of October because they don't know the recommended date from agricultural extension office because of non-availability of the office in some areas of study such, Thur, Gurnei, and Treij. Moreover, the farmers facing difficulties to obtain knowledge and agricultural extension services from the office because of far distances, transportation means and insecurity. The potato requires a cool growing season with abundant and well distributed rainfall. However in October the rain is rare and the temperature is hot where this is risk for plant to emerge out of soil. The recommended sowing date is November; however 61.7% of the respondents practicing the recommended sowing date. The main crop is generally being grown in area of study on with five or six week before the winter season.

Table 4.1.17: Frequency distribution of respondents according to irrigation sources:

Irrigation source	Frequency	Percent
Rain	16	8.9
Rain supplemented by irrigation from valleys	17	9.4
Irrigation from valleys	147	81.7
Total	180	100.0

Source: Filed survey 2013

Table (4.1.17) shows that 81.7 irrigated their farms from valleys which is main source of irrigation during summer and winter season, while 9.4% using supplementary irrigation and 8.9 % depend on rain. It worth noting that, the scarcity of water in Jebel Mara became a challenge to most of the people including farmers in the area. It is necessary to include water in the livelihood intervention to overcome the problem of water shortage.

The hydrogeology and hydrology of Darfur is highly heterogeneous. Blanket generalizations of whether Darfur is water rich or water scarce therefore mask the reality that people in any given location may face. Rain falls in Darfur for only about four months in the year, so storage of water in aquifers is crucial for water supplies to endure through the dry season. Most of central Darfur however, is underlain by a type of geology that makes a very poor aquifer (the Basement Complex – largely comprising hard crystalline rocks like granite and schist), so although exceptional areas with more water exist, central Darfur should be seen as having poor water resources. Exceptional areas of good water resources would include the large Wadis and areas of sandstone geology such as Geneina, and the highlands of Jebel Marra.(UNEP 2008).

Table 4.1.18: Frequency distribution of respondents according to cultivation methods of improved potato:

Cultivation method	Frequency	Percent
Ridges	71	39.4
Plots	105	58.3
Random	4	2.2
Total	180	100.0

Source: Filed survey 2013

Table (4.1.18) indicates that 39.4% of the study sample using ridges for cultivation, while 58.3 using traditional plots and 2.2 were cultivating randomly. The data shows that the majority of the farmers are not familiar with recommended methods of the cultivation and most of them obtained the knowledge and inherited it from their fathers and grandfathers. On the other hand the plot method makes the farmers to use double efforts to earth up the crops.

The earth up will support the plant when plants height is 10-15 cm and prevent the tuber greening, check weeds, and may encourage tuber formation and growth (Joy Larcom 76). The agricultural extension services are more needed to help the farmers to get new knowledge and adopt it.

Table 4.1.19: Frequency distribution of respondents according to spacing of planting improved potato:

The spacing	Frequency	Percent
14-18cm	29	16.1
18-22cm	77	42.8
22-26cm	15	8.3
26- 30cm	59	32.8
Total	180	100.0

Source: Filed survey 2013

Table (4.1.19) shows that 42.8% used the recommended spacing between the holes. The best space and practical methods between the holes is 18-22 cm (Saifeldeen 2005). It is noted that most of the farmers were not aware of the recommended spacing between the plants.

Table 4.1.20: Frequency distribution of respondents according to the number of tubers per hole of improved potato:

Number of tuber	Frequency	Percent
Half tuber	78	43.3
One tuber	83	46.1
Two tubers	14	7.8
More than three tubers	5	2.8
Total	180	100.0

Source: Filed survey 2013

Table (4.1.20) shows that 43.3% were planting a half tuber per hole while 46.1 planting one tuber per hole. The farmers usually used the one tuber with two to three eyes because they afraid of growing risk and insects.

Table 4.1.21: Frequency distribution of respondents according to using of fertilizers to improved potato:

Fertilizers	Frequency	Percent
yes	88	48.9
No	23	12.8
sometimes	69	38.3
Total	180	100.0

Source: Filed survey 2013

Table (4.1.21) indicates that 48.9% using fertilizers including Nitrogen, Phosphorus, and Potassium. The potato belongs to the group of vegetable crops having the highest fertilizers requirement. The amount of fertilizers that can be applied profitably depends not only upon soil type and fertility but also upon environmental condition affecting yields.(J. P. McCollum 1980). More nitrogen is recommended for the early crops more than the late crops. These elements are usually less available early in the season. The data shows that 38.3 % using fertilizers sometimes because of the type of soil, moreover, they planted near the valleys where the soil rejuvenating every year after the end of rain season.

Table 4.1.22: Frequency distribution of respondents according to timing of adding fertilizers to improved potato:

Time of adding fertilizers	Frequency	Percent
Before planting	10	5.6
During planting	16	8.9
After planting	85	47.2
Before and during planting	4	2.2
Before and after planting	2	1.1
After and during planting	36	20.0
No	27	15.0
Total	180	100.0

Source: Filed survey 2013

Table (4.1.22) shows that only 8.9 % adding fertilizers during planting potato, while 47.2% adding after planting potato and 5.6% before planting. The fertilizers should be used during the planting however in the above table the data shows that most of the farmers don't adopt the recommended timing of adding fertilizers. Only 8.9 % implemented the recommendation.

Table 4.1.23: Frequency distribution of respondents according to apply or use of pesticides to improved potato:

Using pesticides	Frequency	Percent
Yes	113	62.8
No	67	37.2
Total	180	100.0

Source: Filed survey 2013

Table(4.1.23) shows 62.8% using pesticides for potato crops while 37.2 did not apply pesticides. The potato is subject to many types of fungus, diseases requiring a variety of control methods. Some of these diseases cause serious losses wherever the potato is grown, while other diseases are more localized. Many of the most important diseases are seed-born, leaf diseases, therefore the importance of diseases –free seed treatment is being recognized by growers everywhere. The spraying or dusting is necessary for control of insects and leaf diseases. 37.2% of the farmers were not using pesticides and depends on crop rotation to prevent increasing destructiveness of organisms that live over in soil and on old decaying vines and tubers.

Table 4.1.24: Frequency distribution of respondents according to easiness of getting improved potato seeds:

Possibility of getting improved potato seeds	Frequency	Percent
Very easy	21	11.7
easy	22	12.2
Very difficult	67	37.2
Difficult	70	38.9
Total	180	100.0

Source: Filed survey 2013

Table (4.1.24) indicates that 76.1 % reported that they were facing difficulties to obtain improved potato seeds. Scarcity of improved potato seeds in the local market is the main challenge to the farmers, and also there is no government institutions working in distribution of improved potato seeds.

Table 4.1.25: Frequency distribution of respondents according to differences in productivity between improved potato variety and local variety:

Differences	Frequency	Percent
Very high	71	39.4
high	45	25.0
Medium	61	33.9
Little	1	.6
Very little	2	1.1
Total	180	100.0

Source: Filed survey 2013

The table shows that high percentage of 64.4% responded that the improved potato had high productivity compared to the local variety. It means that it will be easy to convince the farmers to adopt the improved variety of potato to increase their income to alleviate the poverty and to sustain their livelihoods through cultivating improved potato varieties.

Table 4.1.26: Frequency distribution of respondents according to their opinion on cost or price of improved variety of potato:

Cost	Frequency	Percent
very expensive	76	42.2
Expensive	57	31.7
Reasonable	44	24.4
Not expensive	3	1.7
Total	180	100.0

Source: Filed survey 2013

Table (4.1.26) shows that 73.9 of farmers reported that the price of improved potato is very high and expensive compared to the local variety. It indicates that the poor farmers might not adopt the improved variety of potato. It will be necessary to call on agricultural institutions such agricultural Bank to support the poor farmers by providing improved varieties of potato.

Table 4.1.27: Frequency distribution of respondents according to their desire to cultivate improved varies of potato:

The desire	Frequency	Percent
I want strongly	83	46.1
I want	74	41.1
I don’t want strongly	3	1.7
I don’t want	2	1.1
I don’t know	18	10.0
Total	180	100.0

Source: Filed survey 2013

It shows that 87.2% of the selected sample had a desire and interest to cultivate improved potato for the next year. Despite its high cost and difficulties to get the improved potato the farmers showed willingness to grow the improved potato. Moreover, the alleviation of the poverty through planting improved potato will be positive.

Table 4.1.28: Frequency distribution of respondents according to the availability of labour for planting potato:

Labour availability	Frequency	Percent
Very abundant	32	17.8
Abundant	52	28.9
Sometimes not abundant	94	52.2
Not abundant at all	2	1.1
Total	180	100.0

Source: Filed survey 2013

Table (4.1.28) shows that 17.8% reported that labour is very abundant while 28.9 % mentioned that during cultivation of improved potato in the last season the labour were abundant. The percentage of 52.2% indicated that the labour was sometimes not abundant. The availability of the labour for small farms will encourage the farmers to adopt the new technology in order to improve their productivity and livelihoods.

Table 4.1.29: Frequency distribution of respondents according to Labour cost of improved potato compared to other cash crops:

Labour cost	Frequency	Percent
Very cheap	23	12.8
Cheap	29	16.1
Very expensive	28	15.6
Expensive	100	55.6
Total	180	100.0

Source: Filed survey 2013

Table (4.1.9) shows that the cost of the labour for growing potato is not cheap compared to other cash crops, however the poor farmers could not able to adopt potato because the labour cost was very high for them . While 28.9% of farmers responded that the cost of the labour was cheap and most of those were rich farmers in the area.

Table 4.1.30: Frequency distribution of respondents according to length of growing season:

Length of season	Frequency	Percent
Very short time	40	22.2
Short time	57	31.7
Medium	77	42.8
Very long time	4	2.2
Long time	2	1.1
Total	180	100.0

Source: Filed survey 2013

Table 4.1.30 shows that 53.9% of the farmers described that the length of the growing season of improved potato were short compared to the local variety, while 42.8 % responded that the time of growing were medium.

Table 4.1.31: Frequency distribution of respondents according to possibility of getting agricultural tools:

Tool	Available and cheap to buy		Available and expensive to buy		Not available	
	F	%	F	%	F	%
Big hoe	164	91.1	7	3.9	9	5.0
Small hoe	166	92.2	6	3.3	8	4.4
Weeder	85	47.2	32	17.8	63	35.0
Donkey plough	73	40.6	91	50.6	16	8.9
Tridle pump	18	10.0	85	47.2	77	42.8
Watering can	140	77.8	8	4.4	32	17.8
Spray tools	90	50.0	5	28.3	39	21.7
Fertilizers tools	80	44.4	34	18.9	66	36.7
Harvest tools	121	67.2	14	7.8	45	25.0

Source: Filed survey 2013

Table (4.1.31) showed that 91.1 % responded that the big hoe for cultivation of improved potato is available and cheap to buy from the local market. 92.2% responded that the small hoe is available and cheap to buy from local markets. The table also shows that 47.2 %responded that the tools for weeding is available and cheap while 50.6% indicated that the donkey plough was available but expensive to be purchase from local markets and 47.2% responded that the Tridle pump was available and expensive in the market.

It was observed from the table that 77.8%,50%, 44.4% and 67.2% of the responded farmers, respectively confirmed the availability of watering tools, spray tools, fertilizers tools and harvest tools. And they also confirmed that they were cheap and available for cultivation of improved potato. Generally, it was observed from the data that the agricultural tools for growing improved potato are available and cheap to buy from the local markets which are positive to alleviate poverty through enhancing and encouraging growing of improved potato crops.

Table 4.1.32: Frequency distribution of respondents according to practicing thinning to improved potato:

Thinning	Frequency	Percent
Yes	45	25.0
No	135	75.0
Total	180	100.0

Source: Filed survey 2013

Table (4.1.32) shows that 25 % of the farmers did the thinning while a percentage of 75% did not practice thinning for their potato crops because of lack of knowledge about the importance of thinning. The agricultural extension needs to work hardly to disseminate package of knowledge about the process of growing potato in the whole area of the study.

Table 4.1.33: Frequency distribution of respondents according to the date of thinning:

The date of thinning	Frequency	Percent
1-2 week after planting	10	5.6
3-4 weeks	41	22.8
5-6 weeks	2	1.1
Random thinning	127	70.6
Total	180	100.0

Source: Filed survey 2013

The table (4.1.33) shows that 70.6 % of the responded farmers were not familiar with the date of thinning and they did not have any knowledge about it and doing the thinning randomly. This indicates that there was a big gap between farmers and agricultural extension agents and officers in the field. However, the farmers showed their desire to obtain different types of knowledge related to potato crops.

Table 4.1.34: Frequency distribution of respondents according to marketing of improved potato:

Marketing	Frequency	Percent
Very easy	57	31.7
Easy	90	50.0
Very difficult	5	2.8
Difficult	28	15.6
Total	180	100.0

Source: Filed survey 2013

Table (4.1.34) indicates that 31.7 % and 50 % confirmed that the improved potato is very easy and easy in marketing. It was noticed that the food culture in the area changed slightly from local food culture to adoption of many kinds of food made from potato. These lead to the easy marketing of potato and might increase the diffusion and adoption of improved potato by small farmers in order to get more production.

Table 4.1.35: Frequency distribution of respondents according to training:

Training	Frequency	Percent
I got enough training	35	19.4
Not enough training	68	37.8
Not at all	77	42.8
Total	180	100.0

Source: Filed survey 2013

Table (4.1.35) shows that 19.4 % and 37.8 had been trained about planting and cultivation of potato but some of them indicated that the training was not comprehensive to what they want to know about potato crops while 42.8 % responded that they did not have any training. It means that the farmers are in real need of training on potato to improve their production.

Table 4.1.36: Frequency distribution of respondents according to the source of training:

Source of training	Frequency	Percent
Jebel Mara scheme	47	26.1
Agricultural extension	8	4.4
Governmental organization	15	8.3
INGOs	25	13.9
Local organization	7	3.9
Not applicable	78	43.3
Total	180	100.0

Source: Filed survey 2013

Table (4.1.36) shows that 26.1% of the sample attended training with Jebel Marra scheme while 13.9 % were trained by international nongovernmental organizations. However, only 4.4% attended training organized by agricultural extension office which means that the agricultural extension office plays limited role and not active in the area.

Table 4.1.37: Frequency distribution of respondents according to source of agricultural information:

Source of agriculture information	Frequency	Percent
Extension leaflets	24	13.3
Posters	1	.6
Training courses	15	8.3
Radio	7	3.9
Agricultural extension agents	42	23.3
Neighbouring farmers and relatives	76	42.2
Field visits	14	7.8
Field days	1	.6
Total	180	100.0

Source: Filed survey 2013

It was clearly observed from table (4.1.37) that 42.2 % of farmers obtain their knowledge and agricultural information from their neighboring farmers and relatives. It indicates that the farmers were dependent on unreliable sources of information. It also indicates the absence of effective agriculture information sources to raise the awareness among the farmers about the agriculture process and practices of improved potato.

Table 4.1.38: Frequency distribution of respondents according to their communication with agricultural extension:

Communication	Frequency	Percent
Always	7	3.9
sometimes	47	26.1
rarely	50	27.8
No I don't	76	42.2
Total	180	100.0

Source: Filed survey 2013

Table (4.1.38) showed that 27.8 % of farmers rarely communicate with the agricultural extension agents while 42.2 did not communicate with the agricultural extension agents. This data explained that there was big gap and lack of communication between the farmers and agricultural extension office to get information on improved potato. The diffusion and adoption of new varieties of potato will not be easy unless the extension office work closely with the farmers and fill the gap of communication.

Through communication channels farmers can get agricultural information and apply the new ideas. If the new idea is used by individuals, the information about the technological innovation is thus obtained and uncertainty about its effects is further reduced. Thus, the innovation-decision process is essential and information -seeking and information- processing activity in which the individual is motivated to reduce uncertainty about the advantages and disadvantages of the innovation(Rogers 1983).

Table 4.1.39: Frequency distribution of respondents according to difficulties and constraints facing them to plant improved potato:

Difficulties and constraints to plant potato	Frequency	Percent
Yes	106	58.9
No	6	3.3
Sometimes	68	37.8
Total	180	100.0

Source: Filed survey 2013

Table (4.1.39) shows that 58.9 % of the farmers confirmed that they were facing constraints to plant improved potato and 37.8% responded that sometimes they were facing constraints while only small 3.3% indicating some constraints facing them during planting local and improved potato.

Table 4.1.40: Frequency distribution of respondents according to income activities after agricultural season:

Income activities after agricultural season	Frequency	Percent
Petty trade	48	26.7
Sale of fire wood	24	13.3
Sale of fodder	15	8.3
Masonry labour	11	6.1
Making bricks	15	8.3
Sewing work	4	2.2
Sale of handicraft	21	11.7
Wood work	9	5.0
Remittances	1	.6
Others	32	17.8
Total	180	100.0

Source: Filed survey 2013

Table 4.1.40 shows that some farmers were practicing some economic activities to get income after the end of the agricultural season. These activities include petty trade, sale of fire wood, making and sailing charcoal, masonry labour, sale of grass or fodder, making bricks, sewing work, wood work, sale of handicrafts and remittances from their relatives inside and outside Sudan. The table (4.1.40) indicates that 26.7% of the sample were working on petty trade in local markets after harvesting season of potato crops while 17.8 % were working on other work out of what we mentioned in the table and these work include teaching, working as staff with locality, staff at local and international organizations and working with government institutions.

Chi- Square test Results:

The chi-square test is used to determine whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories. Do the numbers of individuals or objects that fall in each category differ significantly from the number you would expect? Is this difference between the expected and observed due to sampling error, or is it a *real* difference? When we find the value for chi square, we determine whether the observed frequencies differ significantly from the expected frequencies.

Table 4.2.1: Sex and adoption of recommended type of soil

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.462[a]	2	.040
Likelihood Ratio	6.566	2	.038
Linear-by-Linear Association	3.081	1	.079
N of Valid Cases	180		

Source: Filed survey 2013

Table (4.2.1) shows that there was significant relation between sex and adoption type of recommended soil to grow improved potato as Chi- Square value= (6.462) at level of significant of (.040) which means that the sex has impact on adoption and practicing the recommended type of soil to grow improved potato.

- Value (0.05) or less is level of acceptance

Table 4.2.2: Sex and adoption of sowing date

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19.125[a]	3	.000
Likelihood Ratio	15.310	3	.002
Linear-by-Linear Association	7.137	1	.008
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.2) shows that there was strong significant relation between sex and adoption of sowing date on improved potato as Chi- Square value= (19.125) at level of significant of (.000) which means the existence of high relation and impact of sex on adoption of sowing date.

Table 4.2.3: Sex and adoption of recommended type of irrigation

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.942[a]	2	.624
Likelihood Ratio	1.126	2	.570
Linear-by-Linear Association	.299	1	.584
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.3) shows that there was no significant relation between sex and adoption of recommended type of irrigation to grow improved potato as Chi-Square value= (.942) at level of significance of (.624) which means that the sex had no impact on adoption and practicing the recommended type of irrigation to grow improved potato.

Table 4.2.4:Age and adoption of improved potato

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.753[a]	4	.019
Likelihood Ratio	14.045	4	.007
Linear-by-Linear Association	1.883	1	.170
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.4) show that there was a significant relation between age and adoption of improved potato as Chi- Square value= (11.753) at level of significant of (.019) which means that the age had impact on adoption of improved potato.

Table 4.2.5: Age and adoption of recommended type of soil

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.486[a]	8	.303
Likelihood Ratio	10.200	8	.251
Linear-by-Linear Association	2.348	1	.125
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.5) shows that there was no significant relation between age and adoption of recommended type of soil to grow improved potato as Chi-Square value= (9.486) at level of significance of (.303) which means that the age had no impact on adoption of recommended type of soil.

Table 4.2.6: Age and adoption of sowing date

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	31.865[a]	12	.001
Likelihood Ratio	29.461	12	.003
Linear-by-Linear Association	1.764	1	.184
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.6) shows that there was strong significant relation between the age and adoption of recommended sowing date to grow improved potato at level of significance .000 which means that the age had impact on adoption of the recommended sowing date of improved potato.

Table 4.2.7:Family size and adoption of improved potato seeds

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.062[a]	2	.216
Likelihood Ratio	3.313	2	.191
Linear-by-Linear Association	.278	1	.598
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.7) shows that there was no significant relation between the family size and adoption of improved potato seeds at level of significance (.216)which means that the family size had no impact on adoption of improved potato.

Table 4.2.8: Income and adoption of recommended type of irrigation.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.777[a]	10	.553
Likelihood Ratio	11.513	10	.319
Linear-by-Linear Association	.086	1	.769
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.8) shows that there was no significant association between the income and adoption of recommended type of irrigation to grow improved potato at level of significance (.553) which means that the income has no impact on adoption of recommended type of irrigation to grow improved potato.

Table 4.2.9: Income and adoption of recommended spacing between the holes.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	37.725[a]	15	.001
Likelihood Ratio	44.678	15	.000
Linear-by-Linear Association	.202	1	.653
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.9) shows that there was a significant association between the income and adoption of recommended spacing between the holes when growing improved potato at level of significance (.001) which means that the income had impact on adoption of recommended spacing between holes .

Table 4.2.10: Income and adoption of recommended numbers of potato tuber per the hole.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	29.507[a]	15	.014
Likelihood Ratio	31.658	15	.007
Linear-by-Linear Association	1.018	1	.313
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.11) shows that there was a significant association between the income and adoption of recommended number of potato tuber per hole when growing improved potato at level of significance (.014) which means that the income had impact on adoption of recommended number of potato tuber in the hole.

Table 4.2.11: Income and adoption of recommended type of fertilizer .

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	35.267[a]	10	.000
Likelihood Ratio	38.578	10	.000
Linear-by-Linear Association	1.143	1	.285
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.12) shows that there was high significant association between the income and adoption of recommended type of fertilizer to grow improved potato as Chi- square value= (35.267) at level of significance (.000) which means that the income had high impact on adoption and practicing of recommended fertilizer .

Table 4.2.12: Social status and adoption of improved potato.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.869[a]	3	.118
Likelihood Ratio	5.270	3	.153
Linear-by-Linear Association	3.833	1	.050
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.13) shows that there was no significant association between the social status and adoption of improved potato as Chi- square value= (5.869) at level of significance (.118) which means that the social status had no impact on adoption of improved potato.

Table 4.2.13: Residence status and adoption of improved potato

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.733[a]	4	.785
Likelihood Ratio	2.851	4	.583
Linear-by-Linear Association	.001	1	.980
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.14) shows that there was no significant association between the residence status and adoption of improved potato as Chi- square value= (1.733) at level of significance (.785) which means that the residence status had no impact on adoption of improved potato.

Table 4.2.14: Housing structure and adoption of improved potato .

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.281[a]	2	.527
Likelihood Ratio	1.386	2	.500
Linear-by-Linear Association	1.194	1	.275
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.15) shows that there was no significant association between the housing structure and adoption of improved potato as Chi- square value= (1.281) at level of significance (.527) which means that the housing structure had no impact on adoption of improved potato.

Table 4.2.15: Chi-square test for residence status and growing potato

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.733[a]	4	.785
Likelihood Ratio	2.851	4	.583
Linear-by-Linear Association	.001	1	.980
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.16) show that there was no significant relation between the residence status and growing potato as Chi- Square value= (1.733) at level of significance of (.785) which means that the residence status (IDPs, nomads, residence inside the town and refugees) had no impact on growing potato.

Table 4.2.16: Chi-square test for source of information and increasing productivity of improved potato

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	78.603[a]	28	.000
Likelihood Ratio	89.809	28	.000
Linear-by-Linear Association	12.422	1	.000
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.17) show that there was strong significant relation between agricultural extension methods used by agricultural extension agent to provide information on improved potato and increasing productivity of improved potato as Chi- Square value= (78.603) at level of significance of (.000) which illustrated that the farmers who contact or participate in agricultural extension activities and obtained package of information through individuals, group and mass agricultural extension methods on improved potato practiced the recommended technology resulting in high productivity. According to data analysis through Chi- square using agricultural extension methods had strong impact on increasing productivity of improved potato.

Table 4.2.17: Chi-square test for obtaining training on improved potato and practicing the recommended sowing date.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.707[a]	6	.033
Likelihood Ratio	13.503	6	.036
Linear-by-Linear Association	.102	1	.749
N of Valid Cases	180		

Source : Field survey 2013

Table (4.2.18) shows that there was a significant association between obtaining training on improved potato and practicing the recommended sowing date as Chi- Square value= (13.707) at level of significance of (.033) which illustrated that the training has impact on adoption of recommended sowing date.

Table 4.2.18: Chi-square test for training and adoption of recommended soil

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.961[a]	4	.041
Likelihood Ratio	9.979	4	.041
Linear-by-Linear Association	.344	1	.557
N of Valid Cases	180		

Source : Field survey 2013

Table (4.2.19) shows that there was a significant association between obtaining training on improved potato and adoption of recommended soil as Chi- Square value = (.9.961) at level of significance of (.041) which means that the training had impact on adoption of recommended type of soil.

Table 4.2.19: Chi-square test for obtaining training and adoption of recommended methods of growing improved potato

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.152[a]	4	.038
Likelihood Ratio	10.964	4	.027
Linear-by-Linear Association	.005	1	.945
N of Valid Cases	180		

Source : Field survey 2013

Table (4.2.20) shows that there was a significant association between obtaining training on improved potato and adoption of recommended methods of growing improved potato as Chi- Square value = (10.152) at level of significance of (.038) which means that the training had impact on adoption of recommended methods of growing improved potato.

Table 4.2.20: Chi-square test for obtaining training and practicing recommended number of Tuber per hole.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.112[a]	6	.311
Likelihood Ratio	7.067	6	.315
Linear-by-Linear Association	.749	1	.387
N of Valid Cases	180		

Source : Field survey 2013

Table (4.2.21) shows that there was no significant association between obtaining training on improved potato and adoption of recommended number of potato tuber per hole when growing improved potato as Chi- Square value = (7.112) at level of significance of (.311) which means that there was no relation between training and adoption of recommended number of potato tuber per hole . it might means that the farmers practicing the method from their indigenous knowledge.

Table 4.2.21: Chi-square test for obtaining training and adoption of recommended time of adding fertilizers.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	43.350[a]	12	.000
Likelihood Ratio	44.630	12	.000
Linear-by-Linear Association	4.969	1	.026
N of Valid Cases	180		

Source : Field survey 2013

Table (4.2.22) shows that there was strong significant association between obtaining training on improved potato and adoption of recommended time of adding fertilizers when growing improved potato as Chi- Square value = (43.350) at level of significance of (.000) which means that the training had impact on adoption of recommended time of adding fertilizers.

Table 4.2.22: Chi-square test for obtaining training and high productivity of potato.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.563[a]	8	.035
Likelihood Ratio	17.498	8	.025
Linear-by-Linear Association	.646	1	.422
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.23) shows that there was significant association between obtaining training on improved potato and high productivity of improved potato as Chi-Square value = (16.563) at level of significance of (.035) which means that obtaining training on recommended technologies on growing potato and practicing these technologies had significant impact on high productivity of improved potato.

Table 4.2.23: Chi-square test for adoption of improved potato and possibility of getting it.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.741[a]	3	.021
Likelihood Ratio	8.309	3	.040
Linear-by-Linear Association	7.375	1	.007
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.24) shows that there was significant association between adoption of improved potato and possibility of getting the improved potato seedas Chi-Square value = (9.741) at level of significance of (.021). It might also means that the farmers were easily purchasing the potato from the local markets.

Table 4.2.24: Chi-square test for adoption of improved potato and availability of tools.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.547[a]	2	.003
Likelihood Ratio	10.072	2	.007
Linear-by-Linear Association	6.279	1	.012
N of Valid Cases	180		

Source: Field survey 2013

Table (4.2.25) shows that there was significant association between adoption of improved potato and availability of tools to grow the improved potato as Chi- Square value = (11.547) at level of significance of (.003).

CHAPTER FIVE

Summary of Findings, Conclusion and Recommendations

5.1 Summary of findings

1- Most of the respondents (61. %)of potato producers were 20-30 and 30-40 years of age and (30.6 %) over 40.

2- 83.3% of the study sample in the areas of study was married, while 15.5 % were single.

3- Majority of farmers (71.1%) in area of study was educated and 20 % they can read and write, it also shows that the education level among the sample of the study is high.

4- 55.6 % of the respondents their family size between 7-8 individuals.

5- The findings indicated that (65.6%) of the household were residents in towns.

6- 81.7% of farmers living either in huts structured and made from mud or bricks covered with grass or huts made from grasses, wood and covered with plastic sheet.

7- Majority of respondents 63.9 their income sources depend on agriculture only while 21.1 got income from practicing agriculture and trade.

8- 62.2% getting income from cultivation of cereals, sorghum and millet.

9- 85.6 % of the sample responded that the insecurity is major constraint facing them to adopt improved potato crops in their area.

10- High percentage of respondents (81.1 %) adopted and cultivated improved potato in areas of Zalingei, Delaig, Traige ,Thur, Gurnei, Nertiti and Golo, while 18.9%cultivated the local potato.

11-47.8% planted improved potato in light clay soil while 33.9% used sand and clay soils. Both types of soils show high productivity in the area.

12- Majority of respondents 77.3% planted potato in 1-4Fedans,

13- 64.4% of farmers responded that the improved potato was high in productivity compared to the local variety.

14- 73.9% of farmers responded that the price of improved potato seeds is very high and expensive compared to the local variety.

14- Majority of respondents' sample (87.2%) had a desire and interest to cultivate improved potato for the next year.

15- The agricultural tools for growing improved potato such as big hoe, tools for weeding, donkey plough, Tridle pump, watering tools, spray tools, fertilizers tools and harvesting tools were available and cheap to buy from the local markets.

16- Majority of respondents (81.7%)confirmed that the improved potato was very easy and easy in marketing.

17- 26.1% of respondents attended training with Jebel Marra scheme while (13.9%)were trained by international nongovernmental organizations. However, only(4.4%) attended training organized by agricultural extension office.

18- 42.2% of respondents obtain their knowledge and agricultural information from their neighboring farmers and relatives.

19- 27.8 % of respondents rarely communicated with the agricultural extension agent while 42.2 % did not communicate with the agricultural extension agents.

20- 58.9 % and 37.8% of the respondents respectively confirmed that they were always and sometimes facing constraints to plant improved potato.

21- Some farmers were practicing some economic activities to get income to sustain their livelihoods after the end of the agricultural season. These activities include petty trade26.7%, sale of fire wood 13%, masonry labour6.1%, sale of grass or fodder8.3%, making bricks 8.3 %, sewing work2.2%, wood work5.0 %, sale of handicrafts 11.7%.

22- The gender was found to have a significant association with adoption of recommended type of soil, sowing date and number of potato tuber per hole; however the gender had no relation with adoption of type of recommended irrigation, agricultural method, spacing between holes, and using of fertilizers.

23- The age of respondents was found to have association with adoption of the recommended sowing date and type of irrigation but, there was no association between age and recommended cultivation methods, number of potato tuber, recommended fertilizers, spacing between holes and type of soil.

24- The size of family was found to have a significant relation with adoption of recommended number of potato tuber per hole and had no association with recommended cultivation methods, type of irrigation, recommended fertilizers, spacing between holes and type of soil.

25- The respondents' social status was not found to having a significant relation with adoption of recommended type of irrigation, recommended fertilizers, number of potato tuber per hole, spacing between holes and type of soil.

26- The family residence status was found to be having a significant association with adoption of recommended spacing between holes, recommended fertilizers and number of potato tubers per hole while there was no significant relation with adoption of recommended agricultural method, sowing date, type of recommended soil and type of irrigation.

5.2 Conclusions

The study revealed that there was positive relationship between personal characteristic (age, sex, education level, income and family size) and adoption of improved potato by small farmers in order to sustain their livelihoods and alleviate the poverty. The study also concluded that there was no significant relationship between social factors (social status, living standard, and marital status) and adoption of improved potato to sustain the livelihoods of the small farmers. According to the result, the study showed that there is a positive significant relationship between sex and adoption of recommended soil to grow improved potato. The study also detected that there was strong significant relation between agricultural extension methods used by agricultural extension agents to provide information on improved potato to the small famers and increasing productivity of improved potato during the farming season.

The result indicated that there was a significant association between obtaining training on improved potato and practicing and adoption of the recommended sowing date, type of soil, methods of improved potato and time of adding fertilizers,. However, there was no relationship between obtaining training and adoption of recommended number of tuber per hole.

The study concluded that there was a significant association between obtaining training on improved potato and high productivity of the improved potato. The result also indicated that there was relationship between possibility of getting improved potato and the adoption of the improved potato. The study also concluded that the availability of tools in local markets to grow improved potato has positive association with adoption of improved potato by small farmers.

Finally the study could be concluded that adoption of improved potato technical packages could sustain livelihoods and alleviate poverty.

5.3 Recommendations:

To Agricultural Extension Office in Central Darfur:

1- Improve skills of poor people by training them in income generating activities to increase their income sources.
2- Encourage the poor farmers to adopt improved potato to promote their income in order to alleviate their poverty.
3- Improve awareness of poor farmers on technical packages of improved potato through agricultural extension methods.
4- More information about agricultural technologies should be conveyed to the household, improve the rate of adoption and to boost the dissemination of improved potato.

To Ministry of Agriculture in central Darfur:

1- The agricultural extension program should be improved in all state including Jebel Marra areas and the program should be directed to bring about change in attitudes and practices among poor farmers to alleviate their poverty.
2- The results of study proved absence of agricultural extension services in some areas therefore; the Ministry of Agriculture should recruit more staff to be front-line extension workers in order to activate the agricultural extension work.

To Central Darfur Government:

1- According to the results, the insecurity is the main constraint facing the farmers to improve their livelihoods, therefore the Central Darfur Government should exert their efforts to promote peace among the tribes, between farmers and nomads and encourage the rebel movement to join peace process.
2- The agricultural development should be considered and have priority to alleviate poverty among the poor community since majority of the community are farmers.
3- Encourage the agricultural production in the area by establishment of markets and marketing system, prices system and policies.
4- Direct the policies3and role of the Agricultural Bank to support the most needy poor farmers in Central Darfur State.

To INGOs and UN agencies:

1- Develop the capacity of local organizations, community based organizations and government institutions to lead the change among vulnerable community.
2- Exert efforts by providing trainings and agricultural tools to the poor farmers in order to develop their livelihoods.

Future studies:

The future research could be on sustainable livelihoods using other cash crops in the same area.

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Appendix

A questionnaire for collecting information required for PhD. In agricultural extension and rural development

Title of the study: Sustaining livelihood to alleviate poverty through planting improved potato in small farms in Central Darfur State- Sudan

1- Name……

2- Sex: Male ( ) Female ( )

3- Age: 20- 29 ( ) 30- 39 ( ) 40- 49 ( )

50- 59 ( ) Above 60 ( )

4- Social status: Single ( ) Married ( ) Separated ( ) Divorced ( ) abandoned( )

5- Career: Farmer ( ) Trader ( ) Labour ( ) Employer ( ) Other( )

6- Do you read and write? Yes ( ) No ( ) Some how ( )

7- Family size (individuals): 2-3 ( ) 4-6 ( )

7- 10 ( ) Above 10 ( )

8- What is the residence status of the household?

IDPs in camps ( ) IDPs outside camps ( ) Resident ( ) Returnees ( ) Nomads( )

9- What housing structure does the household live in at present?

- Hut (Structure made at least in part with mud/ or bricks) ( )
- Hut (structure made from grasses or wood covered with plastic sheet) ( )
- Hut made from grass and wood only ( )

10- What are your main income sources?

Agriculture only ( )

Trade ( )

Livestock only ( )

Agriculture and livestock ( )

Agriculture and trade ( )

Labour ( )

Others " specify" ( )

11- For the income sources mentioned what is the relative contribution of each activity to total income of the household during the year?

- Sale of cereals, sorghum, millet…… etc ( )
- Sale of other crops and products (vegetables, groundnuts, tobacco, watermelon….. etc) ( )
- Sale of livestock and animal products ( )
- Agricultural wage labour ( )
- Non- agricultural work (casual, skilled…….etc) ( )
- Sales of handicrafts ( )
- Sale of fire wood, charcoal or grass ( )
- Petty trader, including bricks making ( )
- Remittances ( )
- Gifts from families and relatives ( )
- Sale of food aid ( )

12- Do you face constraints currently for your sources of income?

Yes ( ) No ( ) Sometimes ( )

13- If yes, tick () for constraints that you are facing currently

1- Insecurity to move to the farm ( )

2- Lack of manpower in the household. ( )

3- Closure of the markets ( )

4- Low prices or demand of agricultural, animal or other produce sold by the household. ( )

5- Limited employment/ labour opportunities/ lack of jobs ( )

6- Low agricultural production ( )

7- Low animal production ( )

8- Disability or health problems ( )

14- Did you cultivate potato crop this year?

Yes ( ) No ( )

15- If yes, what type of soil you grow in?

Heavy clay soil ( ) Light clay soil ( ) Sandy soil ( ) Sand and clay soil( )

16- How many Fedans did you plant with potato?

Less than one ( ) 1-2 ( ) 3- 4 ( ) Above 5( )

17- What kind of land ownership?

Own land ( ) Land rent ( ) partnership ( )

18- When did you grow potato?

October ( ) November ( ) December ( ) January ( ) other "specify" ( )

19- What kind of irrigation sources that you are using for planting?

Rain ( ) Rain supplemented by irrigation from valleys ( ) irrigation from valleys( )

20- What method you used for cultivating potato?

Ridges ( ) Plots ( ) Others "specify" ( )

21- What is the spacing between holes you used for planting potato?

10-19cm ( ) 20- 29cm ( ) 30- 39cm ( )

40- 49cm ( ) Above 50 ( )

22- How many tubers you used per hole?

Half tuber ( ) One tuber ( )Two tuber ( ) More than two ( )

23- Did you use fertilizers for cultivation?

Yes ( ) No ( ) Sometimes ( )

24- When did you add fertilizers in the last season?

Before planting ( ) duringplanting ( )

After planting ( ) before and during planting ( )

25- Did you use pesticides for potato?

Yes ( ) No ( )

26- Was it easy to get improved potatoes?

Very easy ( ) easy ( )very difficult ( ) difficult to get ( )

27- If you plant improved potato, what was the difference in productivity between local and improved variety?

Very high ( ) high ( ) Medium ( ) Little

Very little ( ) None ( )

28- Was the improved potato expensive?

Very expensive ( ) expensive ( ) reasonable ( )

29- Do you want to grow improved variety of potato in the next year?

I want strongly ( )I want ( ) I don't want strongly ( )

I don't want ( ) I don't know ( )

30- What about the availability of labour during cultivation of improved potato in the last season?

Abundant ( ) Very abundant ( ) Sometimes not abundant ( ) Not abundant at all( )

31- Is the cost of labour for growing potato cheap compared to the other cash crops?

Very cheap ( ) Cheap ( )Very expensive ( ) Expensive ( )

32- How did you describe the length of growing season of improved potato compared to the local one?

Short time ( )Medium ( )Very long time ( ) Long time ( )

33- How did you get the agricultural tools for cultivating improved potato?

Tool	**Available and cheap to buy**	**Available and expensive to buy**	**Not available**
Big hoe			
Small hoe			
Weeder			
Donkey plough			
Tridle pump			
Watering can			
Spray tools			
Fertilizer tools			
Harvest tools			

34- Did you thin potatoes this year?

Yes ( ) No ( )

35- What was the date of thinning that you have done?

1-2weeks after planting ( ) 3-4 weeks ( ) 5- 6 weeks ( )

36- Are the improved potatoes easy in marketing?

Very easy ( ) Easy ( ) Very difficult ( ) Difficult( )

37- Did you have any training about cultivation of potato?

Yes ( ) No ( )

38- If yes, who trained you ?

Jebel Marra Scheme ( ) Ministry of Agriculture ( )

Through agricultural Extension Division ( )

Governmental Organizations () Non Governmental Organizations ( )
Local organizations ( )

39- Which of the following sources, you got agricultural information?

- Extension leaflets ( )
- Posters ( )
- Training courses ( )
- Radio ( )
- TV ( )
- Agricultural extension n Agents ( )
- Neighboring famers and relatives ( )
- Field visits ( )
- office visits ( )
- field days ( )

40- Do you communicate the agricultural Extension Agent to receive agricultural information?

Yes I do always () Sometimes ( )Rarely ( ) No I don't ( )

41- Are there any constraints facing you when cultivating improved potato?

Yes ( ) No ( ) Sometimes( )

42- If yes or sometimes tick the below mentioned answers:

- Shortage of local potato ( )
- Shortage of improved potato seeds ( )
- Poor soil fertility ( )
- Pests, weeds and crop diseases ( )
- Water shortage (poor rains, lack of irrigation ( )
- Lack of animal for traction ( )
- Lack of agricultural tools ( )
- Insecurity to go to the field, displacement or land disputes ( )
- Lack of access or shortage of land to cultivate ( )

43- What are the kinds of economic activities that you practice after the agricultural season?

- Petty trade ( )
- Sale of fire wood/ charcoal ( )
- Masonry labour ( )
- Sale of grasses/ fodders ( )
- Making bricks ( )
- Sewing works ( )
- Sales of handicrafts ( )
- Wood work ( )
- Remittances ( )