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Exploratory Survey on Climate Change Effects, Value Chain Processes and Supportive Services: Case Study from Potato Based Farming System of Awi-Zone, Ethiopia

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Abstract – **Exploratory field survey was conducted with the objective of to understand climate change effects, potato value chain actors, processes, activities and supportive services providers in 2013, Awi-Zone, Ethiopia. Expert and key informant interviews, focused group discussions and review of literature were used as study methodology. A total of 51 value chain actors composing farmers, traders, processors consumers and supportive service providers were involved. The survey result indicates that climate change affects the whole value chain of potato. Drought and erratic, delay and early cessation of rain- fall, heat wave, strong winds, and more flood and night frost were the observed effects of climate change in the study area. Heavy flood impeded input supply and transport services to farmers by damaging roads, while delayed and erratic rain fall reduced the yield of potato and enhanced more diseases and insect pest pressure, which in turn resulted in inconsistent supply of produce to the traders. Consumers were also affected by inconsistent potato market supply. Moreover, poor linkage among value chain actors and support service providers contributed for inadequate action on the use of adaptive measures. The sub sector in general faces a number of structural and technological challenges that need immediate attention to improve potato sector development. Hence, vertical and horizontal integration will be required among value chain actors, supportive service providers and private investors to enhance the sector.**

Keywords – **Climate Change, Climate Change Impacts, Irish Potato, Supportive Services and Value Chain.**

I. INTRODUCTION

Climate change impacts and associated vulnerability are of particular concern to developing countries, where large parts of the population depend on climate sensitive sectors like agriculture and forestry for livelihood (Dinar & Ariel, 2008). Ethiopian economy also heavily dependent on rain fed agriculture which is extremely vulnerable to drought and other natural calamities such as floods, heavy rains, frost and heat waves (Kelbore, Zerihun, & Getachew, 2012). These extreme weather events have a negative impact on the growth and productivity of plants and livestock, cropping and grazing seasons, and the spread of pests and diseases(Thornton & Cramer, 2012).

Similarly, irrespective of size, location, products, and services, all agricultural businesses depend on the influence of weather and climate conditions. Changing weather and climatic conditions can affect the whole value chain of crop production. This includes the supply of raw materials, interrupt transport and logistics, damage infrastructure and physical assets, reduce revenues, and create other direct and indirect impacts (Thornton & Cramer, 2012).

Potato as agricultural commodity is highly vulnerable to climate change (Aniek et al., 2013). Unpredictable change of rain fall pattern, change in temperature, precipitation and unusual storms have affected yield and total profit of potato producers and other stakeholders. Moreover, rising temperatures accelerate plant development and leaf senescence, and thereby higher temperatures during tuber bulking reduce translocation of carbohydrates from other plant part to the tubers (CIPC, 2007).

Moreover, all other non- production chains of potato sector also vulnerable to climate variability. Climate affects every link in the potato value chain system. It brings high transaction costs and uncertainty on input and product markets supply, high access barriers and costs of information, and other market imperfections that restrict market access (MacFadyen & Allison, 2009). Workings together on improvement of institutional relationships undoubtedly assist smallholder farmers and other value chain actors to develop a competitive advantage in local and international markets(MacFadyen & Allison, 2009) .

The value chain approach has been recommended as a useful tool to study specific challenges facing a sector due to various drivers of change, including climate change (MacFadyen & Allison, 2009). Such analyses can reveal context-specific response strategies to enhance the target sector from production to consumption level (Jacinto & Pomeroy, 2010). However such kind of information is not available in the study Zone. Hence, the objective of this research work was to understand the current and potential impacts of climate change on potato value chain actors, processes and functions, identify challenges and opportunities of potato value chain and to suggest climate change adaptive mechanisms.

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II. Materials and Methods

2.1 Description of the Study Area

Awi- Zone is one among ten Zones of Amhara Nation Regional State of Ethiopia. Its population is about 1,078,235 of which 86.5 % resides in rural areas. The land use of Awi-Zone is 17.3% swampy areas, 6.9% cultivated land, 4.4% grazing land, 35% natural forest and 36.4% others(ANRS-BoFED, 2006).

The altitude of the zone ranges from as low as 550 to 3100 masl while the minimum and maximum annual temperature ranges between 5°C and 25°C. Daily temperature becomes very high during the months of March to May. Average mean annual rainfall for the area is about 1700 mm. The area has a uni-modal rain-fall pattern. The rainy months extend from March to the end of November. Rainfall during these months is erratic and has distribution challenges. However, peak rainfall occurs during the months of July and August. The soils in the area are predominantly Nitosol and some are of vertic properties (ANRS-BoFED, 2006).

Administrative Map of Awi Zone

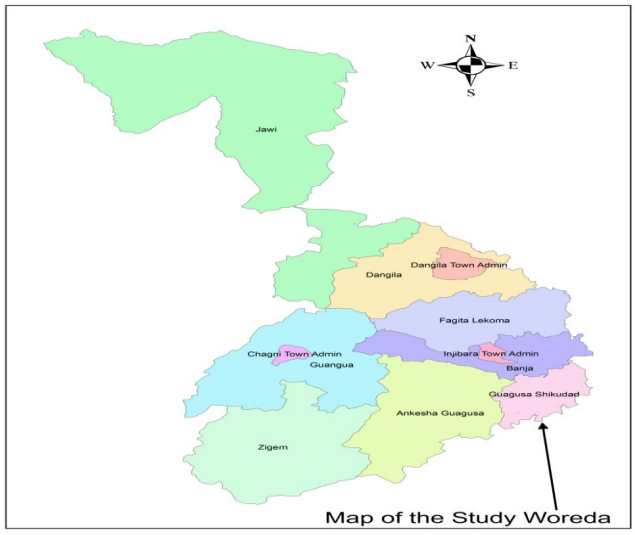

Fig.1. Geographical map of the study zone and locality
Source: Regional office of finance and economy

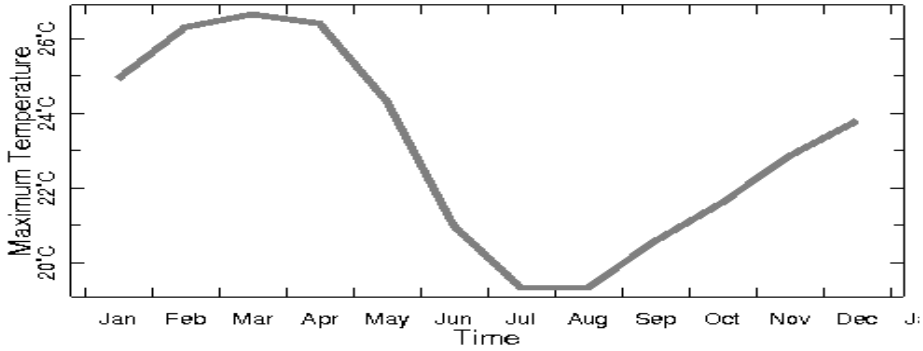

Fig.2. Monthly maximum for Awi, Amhara (Span Years from 1983 -2010)
Source: National metrology agency

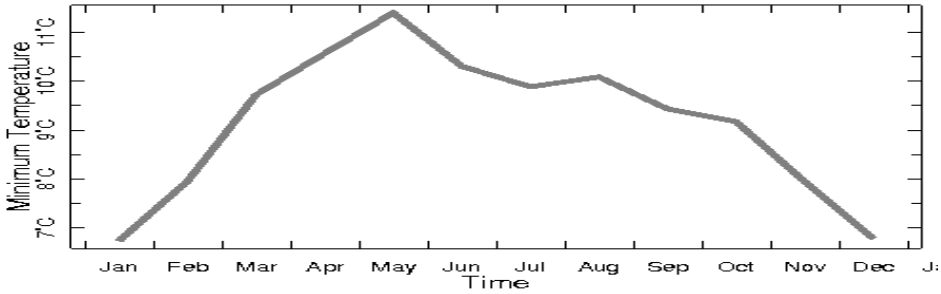

Fig3. Monthly minimium for Awi, Amhara (Span Years from 1983 -2010)
Source: National metrology agency

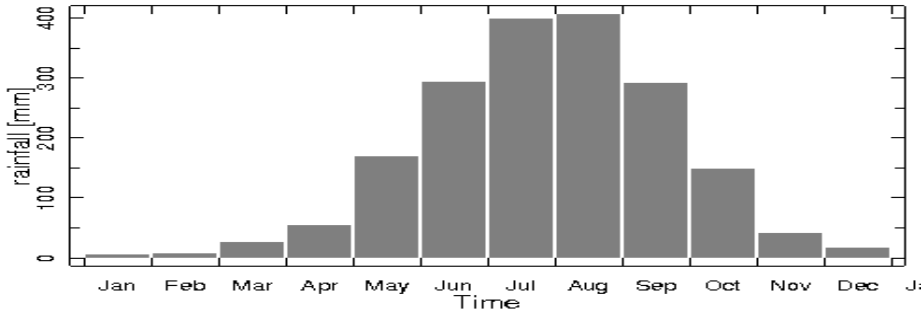

Fig.4. Monthly rain fall of Awi, Amhara (Span Years from 1983 -2010)
Source: National metrology agency

The area is characterized by mixed farming system. Potato, wheat, barley, maize, field pea and faba bean are the dominant crops grown in the area. These crops cover around 90% of the cultivated area. Livestock production is an integral part of production system of the area. Production of cattle, sheep, horse and mule and poultry is a common practice with an average 0.5 to 1.5 ha per house hold land holding size. Sheep and cattle are dominant live stock in the study zone.

2.2 Sampling procedure and data collection

The primary data were collected from three systematically selected districts and from sampled actors/stakeholders who are involved in input supply, production, marketing, post harvest processing, consumption and supportive services along the potato value chain in Awi-Zone. Both focus group discussions and key informant interviews were employed to gather the information.

Two focus group discussion in each district composed of men and women were held in study districts. Check list was used to guide the discussion and helped to balance information collected by key informant interview survey. The check list was designed to include relevant information on the effect of climate change on potato value chain. It included climate change perception and understanding, climate change manifestation and local climate change adaptation strategies and determinants.

Table1: The number and sex composition of participants in group interview

District	Peasant Association	Participant (Average)			
		Groups Number	Male	Female	Total
Guagusa Shikudad	Gusha	2	10	4	14
Banjja	Akayta	2	10	5	15
Fagita Lecoma	Amesha Shinkurie	2	11	5	16

Besides to group discussion, a total of 36 individuals, on average 12 individuals in each district, were used as key informant interviewees that including Kebele (village) administrative, successful farmers, religious leader, women and local experts. Wholesalers, retailers, consumers, and zonal and regional experts were also interviewed and discussed. Semi-structured questionnaires were used for interview various stakeholders involved in potato production.

Table 2: Number and sex composition of participants involved in the individual interview

District	Peasant association	Participant		
		Male	Female	Total
Guagusa Shikudad	Gusha	9	3	12
Banjja	Akayta	8	4	12
Fagita Lecoma	Amesha Shinkurie	8	4	12
Total		25	10	36

Besides collecting those primary data, the secondary data were also gathered from various sources including district ("woreda") and Zone offices of agriculture, farmers training centers, selected PAs, cooperatives and other NGOs who were involved in potato research and development activities. Moreover, relevant literature and official reports were also consulted as secondary data source. Data were analyzed with Simple descriptive statistics.

III. Results and Discussion

3.1: Potato value chain and climate change effects

The potato value chain actors that include primary actors and supportive service providers are found without strong interaction in the study districts (woreda). The primary actors are input suppliers, producers, traders, processors and consumers. Each of these actors adds value in the process of changing product from one step to another. According to (Zemede, Abebe , Mesfin , Alemayehu, & Assefa, 2007), the main processes of potato value chain in Ethiopia include input supply, production, processing, trading, and consumption. There are also supportive service providers that indirectly involve in financial or non-financial service provisions such as credit agencies, government, researchers and extension agents.

The processes of all agricultural value chain including potato depend on weather and climate conditions. Changing weather and climatic conditions can affect the whole chain of potato from farm to fork. It was supported by the research of which presented that climate change globally influenced potato production (Hijmans & Robert 2003).

Similarly, the cross-sectional survey data in the study also indicates that climate change affects potato value chain actors, processes and functions. Drought and erratic, delay and early with drawl of rain fall, heat wave, strong wind, and more flood and night frost was the observed effects of climate change in the study Zone.

The majority (88.7 %) of the respondent realizes that climate change is evident in the course of their potato production. Dawit and Habtamu (2011) also indicate that over 89.5% of Ethiopian farmers perceive that change in climate affect their produce. The increase in incidence of

observed extreme events such as floods and droughts in the study zone have caused extensive damage yield of potato and property of small holder farmers. Majority (94.4%) of the respondent explain that there has been delay at the beginning and early with drawl of rain falls than the past decades. Dawit and Habtamu (2011) also shows that rain fail start late and end earlier than the usual. Moreover, there has been frequent incidence of flood and heat wave occurring in present times.

Reduced yield and prevalence of more diseases and insect pest are the most obvious impacts for the effects of climate change (Watson, 1998). As much as 36 % of the respondent clearly understood with these two important events.

In response to these perceived changes in climate, almost all respondent are adopting some form of adaptation. Common adaptation measures include diversifying crops, planting different crops or crop varieties, changing planting and harvesting dates, increasing the use of irrigation, and increasing the use of water and soil conservation techniques. According to ADB (2009) climate change adaptation techniques involve changes in cropping patterns and cropping calendar, improved farm management, inclined to irrigation production seasons, and use of climate-resilient crop variety. Diversification and irrigation are the most important adaptation measure that farmers employed in Awi-administrative zones. About 100 and 44 % of farmers diversifying their crop and inclined to irrigated production crops respectively. (Haverkort et al., 2012) also indicate that there is a shift of production from main season to off season using irrigation to escape late blight infestation.

3.1.1 Inputs of the chain and climate change effects

The main inputs used in the study area include seeds, pesticides, and fertilizer. According toAlemayehu and Assefa (2011) fertilizer, fungicide, and improved seeds are most important input for Ethiopian potato growing farmers. Farmers in the study area use local potato varieties starting from a long period of time. It may be as long as following the introduction of potato to Ethiopia in 1858 by a German immigrant, Wilhelm Schimperes. Recycling of their local seed tuber is still the most important practice used in the study area and most farmers depend on their own seed partly preserved and stored from production used for consumption and sale. This seed system exists in all potato growing areas of Ethiopia. It is the major seed potato system. According to (Gildemacher et al., 2009), it supplies 98.7% of the seed tubers required in Ethiopia. The seed tubers supplied by this system have poor sanitary, physiological, physical and genetic qualities (Lemaga, Hailemariam, & Gebremedhin, 1994)

Improved varieties are not commonly found in the hands of the farmer's except Gusha area. Unavailability and high costs were the challenges of improved varieties. However, there are farmers acquires seed potato from different sources like from other farmers, Adet agricultural research center, NGOs and FRG member. Due to the establishment of some farmer groups in Akayta and Gusha, there are possibilities to obtain some improved varieties. The overall picture of seed supply indicates that over 48.8% of the farmers have at least one improved varieties like Jalene, Zengena,Gera ,Guassa and Belete in the farmers. However, the farmers are not ready to expand the improved varieties as the result of poor shelf life of the varieties. The rest of the farmers depend on local varieties only. The reason is that most farmers depend on local verities is that they produce for decades and it is stress tolerant.

Both Organic (compost and farm yard manure) and in organic mineral fertilizers are important sources of fertility potato production. Urea and DAP are the most important inorganic fertilizer and compost and farm yard manure are the most important organic fertilizer in all the study area. About 58.3% of the respondent use both organic and in organic fertilizer for potato production. Only 5.6% of the farmers depend on inorganic fertilizer. Farmers of Awi-Zone especially from Banja Woreda (district) said that "using organic fertilizer makes our soil poor". Of course, the surrounding soil is exposed for high rainfall and become acidic so that it is not responsive for commercial fertilizer. Hence, farmers commonly apply compost and manure to fertilize their land. About 50% of the farmers depend on organic fertilizer only. While the rest of the farmers used both inorganic and organic fertilizers depending on the land size allocated to potato.

Supply and markets of modern inputs such as seed and fertilizer suffer from lot of climate related uncertainties. Climate change driven road damage is one of the challenges of that affect the supply of seed and fertilizer (MacFadyen & Allison, 2009). Extreme events of climatic conditions like heavy rain fall and strong flood result in infrastructure destruction. Seed and fertilizer transport become blocked, especially for small scale farmers where year around transport service is a challenge at peasant administration level.

3.1.2 Potato produce and climate change effects

The next major potato value chain actors following input suppliers are potato growers. They are generally smallholder farmers allocate on average 0.25ha land size for potato production. Almost 100% of respondents were found potato growers. Main, residual and irrigation production seasons are important system in the study locality. As much as 69.4 % of the farmers produce potato three times annually and the rest 30.6 % of growers produce potato two times per year. Yazie (2009) also identified three production season that farmers adapted in the area.

Potato growers are the major actors who perform most of the value chain functions right from farm inputs preparation on their farms or procurement of the inputs from other sources to post harvest handling and marketing. The major value chain functions that potato growers perform include plowing, ridging, planting; fertilization, weeding, pest/disease control, harvesting and post harvest handling. The average plowing and earthings up frequency is 7 and 3 times respectively. Blanket application of soil fertilizer is common in each district. Only 50 kg of DAP and urea each were applied on potato as the field supplemented with organic fertilizer. Redomile were applied only once at 2 kg per hectare bases.

The effects of climate change on potato production can also be complex (Haverkort AJ & Verhagen, 2008). The potato crop is very sensitive to changes in temperature and relative humidity. Howden et al. (2007) indicates that climate change impact to the potato production would be clearer in non-irrigated area where crop growth would be depended on high rain fall. The response of the crop to changes in temperature is driven by changes in emergence, metabolic, photosynthesis and respiration rates, and total dry matter production (Hijmans & Robert 2003).

In addition to a direct physiological effect on potato yield, climate change may indirectly affect potato production and productivity through the negative impact of pest and diseases. Among them, potato late blight caused by the pathogen *Phytophtora infestans* is the most important disease affecting the crop worldwide (Hijmans & Robert 2003). Perversely, rain fall was common in April and May, which is important for early germination of potato plantings. This condition helps potato to bulk more before late blight appears (Chakraborty, Sukumar, Newton, & Adrian 2011). However, these days there is delay in raining at the beginning and plantings of potato are pushed to the month of June. These conditions coincide the growth stage of potato with aggressive periods of late blight infestation.Yazie (2009) noted that squeezing of rain fall from June to August threat potato production in Amhara region. However, chemical control is emerged as management option for late blight of potato. Only 13.9 % of the respondent depends on chemical control.

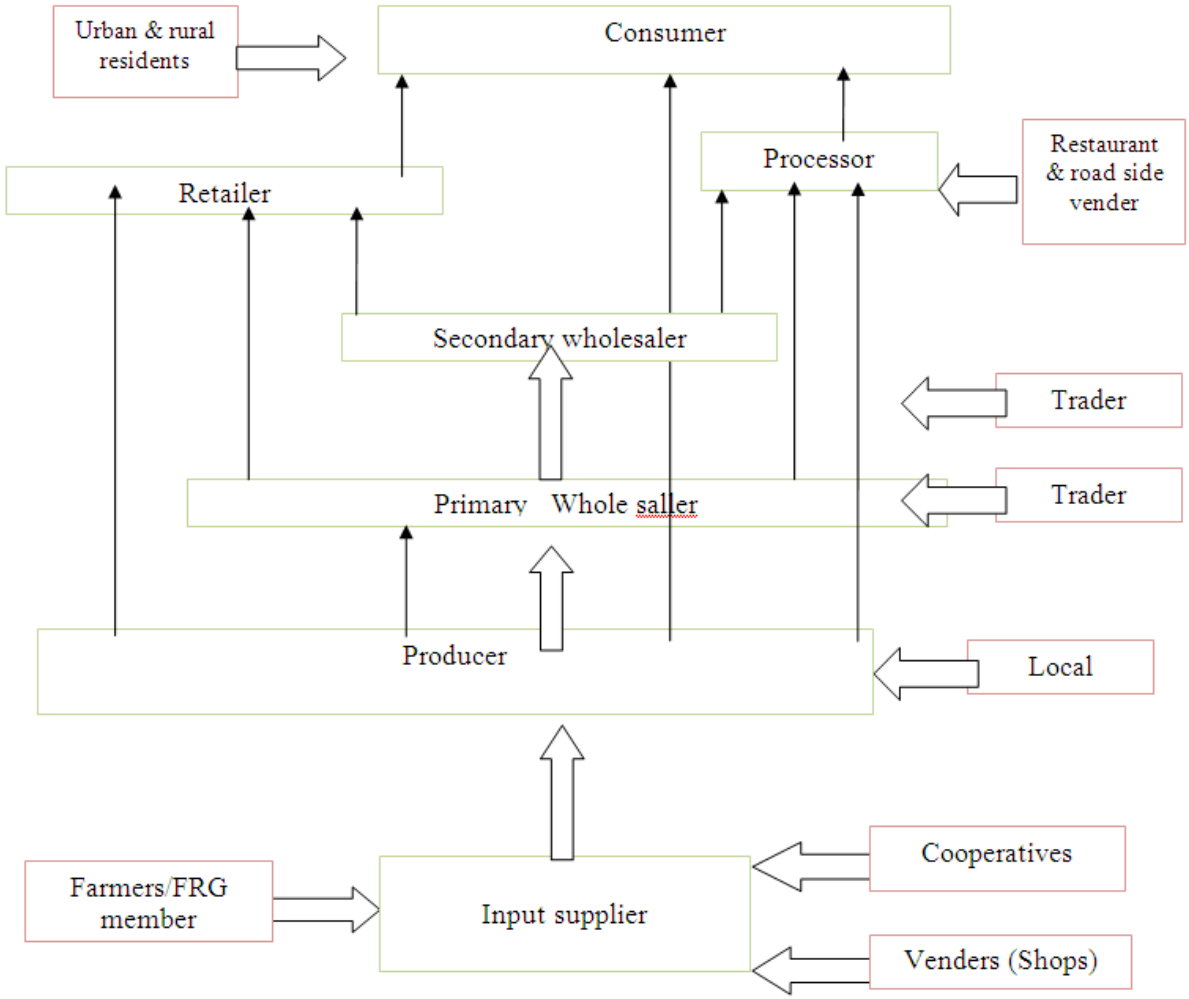

Fig.5. Diagrammatic representation of value chains of potato in Awi-zone

3.1.3 Potato marketing and climate change effect

The most important trading actors are wholesalers, brokers and retailers. They trade potato and potato recipes from producer to the consumer. In a value chain marketing system, traders are linked to consumers, producer and supportive service provider needs, working closely with suppliers and processors to supply the specific goods to consumers demand. In the traditional selling system of the study district, farmers produce commodities that are "pushed" into the market place. In selling systems formers/producers tend to receive minimal profit as they generally isolated from a majority of end-consumer and have little control over input costs or process received for their goods.

Wholesalers are those specialized potato traders dealing in big quantities of potato brought from farmers or brokers. The share of wholesaler is very significant in potato marketing. About 33% of the producer sells potato produces directly to wholesaler. Wholesale traders have three ways/options that they use to source potatoes for

their business. Some wholesalers buy directly from farmers, others use brokers and the rest acquire their ware potato from local collectors. They collect products and sell to other whole seller for the distant market and to retailers for local consumption (Zemede et al., 2007).

Retailers are key actors in potato value chain in the study Zone. They are the last link between producers and consumers. There are both urban and rural retailers involve in selling fresh potato. Over 36% of farmers' potato product goes to the retailer and the rest sold to whole seller and consumer.

Brokers also play crucial role in potato marketing system of Awi-Zone through facilitating potato transaction by linking producers with traders, a wholesaler with another wholesaler, and wholesalers with retailers. There role in potato marketing is low. Only 5.6% of the respondent goes to broker. The brokers sometimes go beyond facilitation of transaction and tend to control and fix potatoes price and make extra benefits from the process. The brokers in many parts of the district and here work in unregulated and informal way. According to (Bezabih and Mengistu. 2011) they do not follow proper business conduct and as a result they constraint the marketing system more than facilitation.

However, changing weather and climatic conditions can affect the marketing system like supply of raw materials, interrupt transport and logistics, damage infrastructure and physical assets, reduce revenues, and create other direct and indirect impacts (Haverkort et al., 2012). Traders need year round effective supply of potato produce. However, this is challenging particularly for small scale farmers who produce potato under uncontrolled environment. In the months of November to January potato availability is limited due to climate risks faced by the vulnerable small-scale producers. During, this scarce period's traders shift to other businesses and the link between traders and producer became broken (Yazie, 2009).

3.1.4 Potato consumptions and climate change effects

Potato is commonly consumed in the form of boiled and cooked meals in different traditional dishes like souse. Recently, there is an interest of consuming potato chips, crisps, and roasted potato. This is becoming more common practices especially in large cities. Other potatoes products such as potato flour, starch, wine etc. are not yet to be commercially processed.

Climate change has the most profound effect on consumption of potato. Year round supply of potato to the nearest market is challenging due to the effect of climate change. There has been variation access to potato from season to season. Similarly consumption of potato products like boiled potato and stews has varied accordingly. During the deficient times food habit is replaced with cereals.

3.2 Potato support service providers

Apart from main actors of value chain there are supportive services which facilitate role for the whole value chain. They include input and equipment providers, financial services, and technology supplier. Most service providers play roles in more than one function and others are limited to a specific function. ACSI, cooperatives and unions provide finical service especially give credit for input supply. Agricultural extension services were given by experts in the various process of the value chain at input, production, processing and consumption levels.

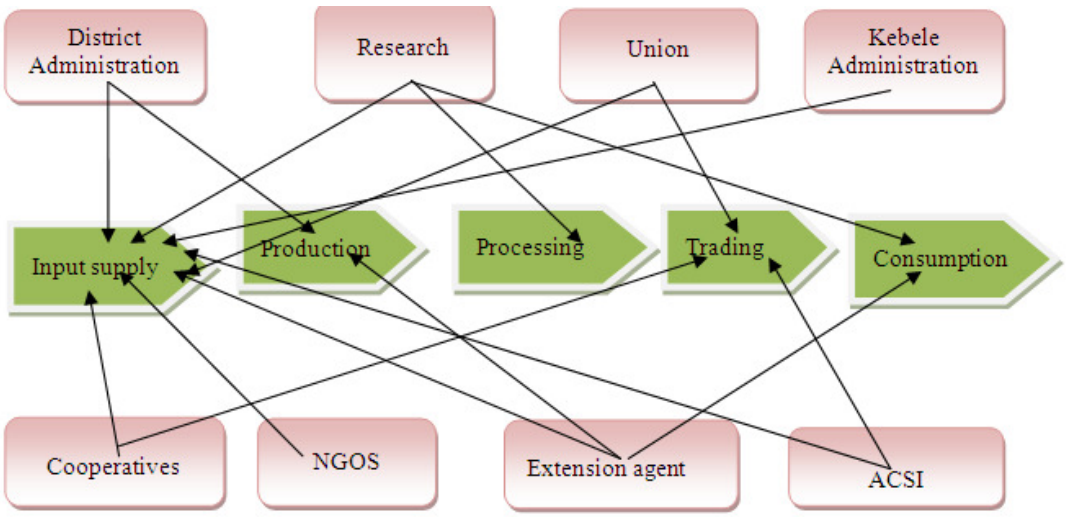

Fig.6. Summary of potato value chain support service providers for potato

However, the whole system of the value chain is none equally entertained. Many supportive services are focused only at inputs levels. The marketing and processing aspects of the value chain are neglected, even though they are crucial for production expansion. There are few trails by Adet Agricultural Research Center (AARC) in promoting the nutritional dimension of potato. Annual training on production and diseases management of potato were given by office of agriculture and AARC. However, it is not sufficient to improve the technical skill of the farmers. Adet Agricultural Research Center also involved in developing potato variety for wider adaptation, high yielding and resistant to biotic and a biotic stress. The center also tries to provide quality potato seed and technical support through capacity building.

IV. Conclusion and Recommendations

Climate change affects every link in potato value chain. Heavy flood impeded input supply and transport services by damaging roads, delayed and erratic rain fall reduced the yield of potato and enhanced more diseases and insect pest pressure. Hence, adaptive measures like expanding of irrigation, construction of all year round road , use of high yielder and diseases resistance variety, expansion of late blight control fungicide has to be adapted.

Moreover, low productivity, inefficient market linkage, poor infrastructure, inadequate input supply and absence modern processing unit are the challenges of potato value chain in Awi-zone. Hence, improving of infrastructure like defused light store and cold unit, advancement in improved seed supply system , Improving access for input like fertilizer, diseases free seed, and fungicide, expansion of processing unit, improving vertical and horizontal linkage among value chain actors and supportive services, will be required to enhance the sector.

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