Proceeding of the 2nd International Conference on Agriculture and Forestry, Vol. 1, 2015, pp. 68-76

ISSN: 2362 – 1036 online
DOI: 10.17501/icoaf2015-1109

PEASANT CLIMATE KNOWLEDGE, APPLICATION ON CROPS OF ONION BULB (*Allium cepa* L.)

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Abstract

In agricultural areas where there is no irrigation water, the farmers scheduled crops based on your climate knowledge, which plays a key role. This knowledge is only recorded in the memory and is transmitted from generation to generation orally. Although its utility is known, however are unknown, the factors influencing farmer's prediction skills and how this knowledge enables them to schedule crops. The present study was carried out in the province of Tungurahua, south western area, which is characterized by the practice of the rain fed agriculture and its tradition in the cultivation of bulb onion (Allium cepa L.) since 40 years ago. The objective was to analyze the peasant climate knowledge used in the cultivation of onion bulb. For which, 50 informants were selected using the methodology "snowball", who conducted semi-structured interviews. In addition there was geographic coordinates into 140 plots of onion. Data analysis was carried out with descriptive statistics and inferential. The results show that local knowledge is related to among other factors, the level of education and gender. Depending on the plantings and harvests, identified three groups of farmers, of which the largest considers the rainy periods to start planting, while the others consider the climatic cycles and market prices. The results can be useful in the development of agricultural climatic calendars. It is suggested to consider climatic particularities in technology transfer

Keywords: traditional knowledge, onion crop, climate change, peasants, climatology

Introduction

In vast areas of the Andean region, agriculture is based only on the rainfall, which requires a deep understanding of the local climate by the peasants. Agriculture based on climatic cycles, presents a high risk for the peasants who, to reduce applied strategies, such as the use of species that are resistant to drought or frost (onion bulb) (Riera & Graciela Pereira, 2013). According to Nara, Mao, and Yen (2014) climatic factors, are determinants for crop growth. The excess or shortage of rains, affect the prices of agricultural products and in the presence of diseases. Rainfall and temperatures, plays a key role in agricultural development by what their knowledge is very important. (Holzkämper, Calanca, & Fuhrer, 2011).

Given that the farmers to plan its cultivation, base in its personal experiences (Altieri, 1997), rather than in official climatic reports, the intuition of the peasant plays an important role to achieve good harvests (Kolawole, Wolski, Ngwenya, & Mmopelwa, 2014). On the other hand, farmers do not have the habit of recording in written form their ancestral knowledge, only do so in his memory and transmitted orally from generation to generation (Altieri, 1997). In addition, the low generational renewal in agriculture limits the transfer of local climate knowledge from adults to young farmers, while the changing climate environment constitutes a new learning scenario

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Despite the usefulness of climate knowledge in agricultural production, this has been rarely addressed in scientific research. In this regard are unknown factors that influence the abilities of the peasants for predicting the weather and how this knowledge allows them to plan their crops.

Preliminary investigations indicate that of onion crop is sensitive to brightness since its presence or absence affects the amount of quercetin (to sweeten) (Ko, Nile, Sharma, Li, & Park, 2015) and that the amount of water supplied to the crop, influences the quality of the bulbs and in the time of storage after harvest (Fan, Wang, & Nan, 2014). Which shows that the rainfall in one way or another affect the onion, so that their crop demand a broad knowledge of the local climate. On the other hand Kolawole *et al*. (2014) were identified that the peasants are experts in assessing seasonal weather patterns through their experience in the field. In the Province of Tungurahua (South-western area), the cultivation of onions from 40 years ago is one of the major items of the peasant economy. The research is based on the assumption that farmers in this region retain broad climate knowledge for the practice of seasonal agriculture. The objective of the research was to analyze the local climate knowledge related to the cultivation of bulb onion (Allium cepa), in the region south-west of the province. The information gathered contributes to the structuring of calendars agricultural climate, which can be supplemented by similar studies in other regions of the province of Tungurahua. The results also reflect the great contribution that can offer the peasant knowledge to understand climate cycles in agriculture. In a changing climate environment, this knowledge can contribute to reducing the vulnerability of the agricultural sector (Gunasekera, 2010) (Hiwasaki, Luna, Syamsidik, & Shaw, 2014).

Method

Description of the study area

The study area is located in the province of Tungurahua (South West), comprising the cantons of Quero and Mocha, located between the geographic coordinates of 01 ° 22´ 35´´ of South latitude and 78 ° 36´21´´ of length West, between altitudes of 2700 to 3600 meters above sea level. In this territory, information was collected in the following sectors: Yayurwi, Chocalo, Rumipamba, Pilco, Guangalo, Yanayacu (without irrigation areas) and the lower area of Mocha (Figure 1), which have in common the presence of crops of onion bulb (Banco Central del Ecuador, 2014). The climate of this region is temperate-cold (annual average 13ºC) with moderate rainfall (589.31 ml/year). The soils vary according to the altitude, in the lower part are sandy and in the upper parts are clayey loamy.

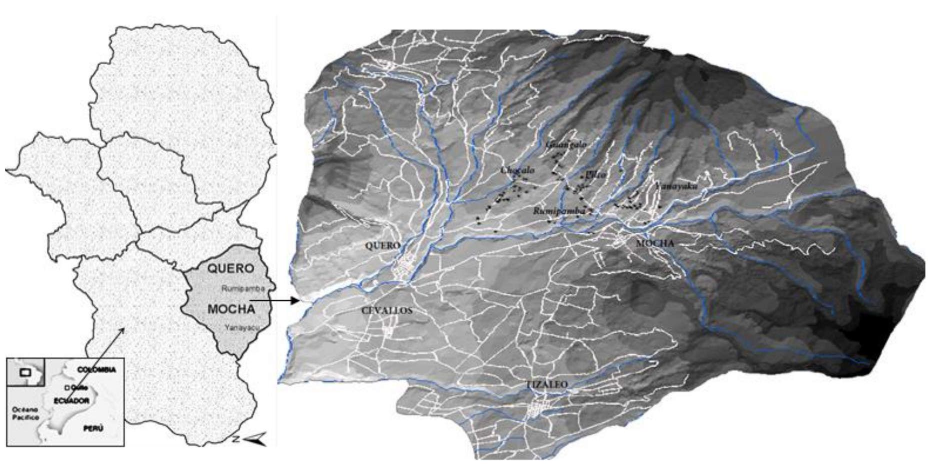

Figure 1: Location of the study area

Climate analysis of the area

This was done on the basis of two sources: (i) Climate information recorded between 1986 and 2014 by the weather station Quero-chaca (part of the network of the National Institute of Meteorology and Hydrology), average temperatures in degrees Celsius (ºC), precipitation (ml/year) and heliofania (light-hours a day) and (ii) field information collected through semi-structured interviews and in depth, according to the methodology suggested by Pedraz, Zarco, Ramasco, and Palmar (2014). The informants' selection was realized in base in the methodology "snowball" proposed for (Sandoval, 1996), for which were considered two criteria: (i) have crops of onions and (ii) be located in the delimited territory. Fifty peasants were interviewed, between April and May of 2015, the content of the interview treatment on: the experience of peasants to predict rain throughout the year, the use of bio-indicators for the prediction of rain, the transfer of knowledge and the skills of observation of clouds and stars to predict rainfall (Kolawole et al., 2014).

Market analysis,

Databases of the wholesale market of Ambato, of the years 2010 to 2014, and statistics of the Central Bank of Ecuador, were analyzed to find out the price fluctuations of the onion bulb of the province of Tungurahua. It is analyzed the movements of prices per month for four years expressed in dollars, for which the statistical program SPSS 19 was used.

Spatial analyses of crops

Geographical coordinates were recorded in 140 cultivated plots of onion, through travel on the territory selected. The selection of the plots was carried out considering the criteria of horizontal and vertical location of the crops in the territory, that according to Altieri and Nicholls (2009) in the Andean region vary according to the altitude. The data were processed by the ArcGIS program 10.1(Figure 1)

Results and discussion

Conditions of the farmers

The average age of farmers who are dedicated to the cultivation of onions is 45 years (standard deviation - DT - 11.09). Of the total (n = 50) of interviewees: 52% were women, who on average have 46.8 years and 48% men with an average of 43.2 years. The participation of women in agriculture is higher than the reported by FAO (2011) 43%. The presence of a higher number of women working in agriculture, confirms to Lastarria-Cornhiel (2008) who said that Latin America, presents a process of feminization of agriculture, among other things by the migration of the male population, the development of non-agricultural activities in the rural areas. The 64% of the farmers have between 32 and 50 years of age, only 8% are between the ages of 21 and 30 years of age. According to Zagata and Sutherland (2015,1) in developed countries where the farms are small, is also reported shortage of young people in the agricultural activity. These data show a low level of succession between the onion growers in the studied area.

The 16% of the farmers interviewed, reported not knowing how to read and write, this value is higher than the national rate (13.5%) (Instituto Nacional de Estadisticas y Censos, 2012).

Crop Conditions

In terms of varieties of onion bulb cultivated: The 90.3% corresponds to *Allium cepa* variety Agreggatum (spread by bulbs) and the 9.7% *Allium cepa* varieties Burguesa, Red Star y Perla (spread by seeds). The first crops of the variety Agreggatum, were established by 1975, while the first crops of seed varieties, by 1995. Despite the introduction of new varieties, the majority of farmers cultivate the variety Agreggatum, to which they attach greater resistance to rotting of the root caused by *Sclerotium cepivorum* Berk, which contradicts to Granados (2005) who stated that there are no varieties of onion bulb resistant to this fungus. The first crops of onions propagated by seeds produce good yields, however in the following years decrease because of the root rot. The development of rot, according to Walker 1969, referred to in Granados (2005) is favored by soil moisture. In the rainy months this disease can be more aggressive than in the dry months. From there, the knowledge of the cycles of rainfall can help reduce risks and to select the most suitable varieties.

As regards the irrigation system, 96.8% of plots are cultivated in grounds without irrigation water, this indicates that the agriculture of this area is highly determined by the rains cycles.

Use of peasant climate knowledge

The development of agriculture in this region, demand a broad knowledge of the climatic cycles to schedule agricultural activities during the year. The 63% of the farmers interviewed mentioned that the rainiest month is May, and between the 36 and 46% believe that the rainy months are also: March, April and June. And the months more dry are November and December (30%), August (28%) and September (26%). While that for 50% of interviewed the coldest month is August, for the 8 and 10 per cent are also very cold July and September, based on this information, the farmers scheduled sowings. Three groups of farmers have been identified in this respect: A first group (G1) (21 %) than planting between September and November; a second group (G2) (49.4 %) than planting between December and January and a third group (G3) (26 %) than planting between February and mid-March, it is clear that the times of planting influence in the months of harvests. Even though all farmers know the traditional climate calendar, among them there are three groups of farmers, which reflects a more climatic cycles, is also considered the market prices (Retnowati, Anantasari, Marfai, & Dittmann, 2014).

The knowledge also depends on the skills of the peasants for forecasting the weather; in this respect it was found that 70% are able to predict rainfall through the observation of groups of clouds (Table 1). In applying the Chi square test to the variables: ability to predict rainfall by observation of clouds and levels of education was obtained a high significance (0.826) which suggests that there is a strong relationship between these variables. For the prediction of rainfall the farmers also based on observation of bio-indicators such as the flight of swallows (Hirundo rustica) and the sound of the Toad (Chaunus spinulosa) which is also reported by Gómez (2014).

On the other hand the gender analysis revealed that the women are able to predict the presence of rain through the clouds (80%) more than men (58%). Which can be attributed to the intuition, which according to Sadler-Smith (2011) in women is more developed than in men, this capability would also associated with the ability of women in the observation.

Table 1: Climatic knowledge of the peasants

Preguntas	Totally agree (%)	Agreed! (%)	indeciso (%)	In disagreement (%)
Based on personal experience, you can predict if there will be enough rain or not in agricultural year?	6,0	44,0	46,0	4,0
Through the songs of some birds and toads sounds, can predict whether it will rain or not?	12,0	66,0	18,0	4,0
It takes decisions necessary for overcoming any problem of the time required and appropriate?	14,0	66,0	18,0	2,0
A través de ciertas plantas, puede predecir si va a llover o no?	14,0	22,0	58,0	6,0
Their ancestors of those who acquired the agricultural knowledge had broad and proven experience to predict the time from which you learned?	18,0	36,0	42,0	4,0

Can you through the observation of groups of clouds in a certain direction in the sky predict whether it will rain or not?	22,0	48,0	28,0	2,0
Can you predict the abundance or scarcity of rainfall based on the pattern of early rain in agricultural year?	10,0	28,0	60,0	2,0
Through the observation of star constellations and/or the moon, you can predict whether it will rain or not?	10,0	44,0	42,0	4,0

Cultivation of onion, rainfall and temperatures

According to reports from the meteorological station of Quero-Chaca, the months of highest precipitation are: April, May and June (66.5; 57.6; 62.8 ml) respectively. While the driest months are: January, September and December (35.8; 35.3; 39.8 ml) respectively (Figure 2a). To compare this information with the appreciation of the peasants there is match both in the dry and the rainy months. According to Estudios e Investigaciónes Meteorológicas (2014), in November in Quero-chaca and Riobamba was presented a water deficit, which affected the development of agriculture and livestock due to their water needs were not met.

As the G1 begins between September-November sowings, the crop cycle in this case extends to February, March and April. According to Schwartz and Cramer (2011) the onion bulb presents two defined phases: the first that starts with the growth of root and stem and ends with the growth of the prebulbo (90 and 110 days after planting); the second phase begins with the development of the bulb (2.5 to 4.0 cm) and ends with the formation of the bulb (over 170 dds), considering these phases, the crops of the G1 traverse two critical months of rainfall (December and January) and benefit from the light showers (October and November), however the restriction of irrigation for long periods can have negative effects on the conservation of the onion bulbs stored (Rattin, Assuero, Sasso, & Tognetti, 2011). While the crops grown by the G2 (December and January), ending its cycle between May and June, in this case the crop takes advantage of high precipitation and the final phase of the culture coincides with the decline of rainfall, however, this may cause increased incidence and severity of diseases to foliage, such as the macha purple (Alternaria porri), or more attack of pathogenic fungi to the bulb, due to the high humidity of the soil (Osuna-Canizales & Ramírez-Rojas, 2013). And finally the crops grown by the G3 (February and March) are harvested between July and August, in this case the first phase of the crop benefits from the rainy months and in the final stage coincides with the reduction of precipitation, this enhances the quality of the bulb. According to Martín de Santa Olalla, Domínguez-Padilla, and López (2004) crops exposed to high volumes of water in the stages of growth and maturation, produce larger bulbs. While that the scarcity of water in the time of bulb formation, it leads to a greater number of small bulbs.

Since in the area, drops heavy rainfall in the months of April, May and June, it is necessary to implement systems to capture rain-water, to reduce soil erosion, store and use in precision irrigation, for which there is a need for climate information in real-time (Leite, Martínez-Romero, Tarjuelo, & Domínguez, 2015).

On the other hand, the lowest temperatures according to the weather statistics are recorded in July and August (11.5 oC) and the highest in November, December and January (13.8 oC) (Figure 2b).

The appreciation of the peasants on the colder months, agrees with data from the weather station. However the presence of frost is not a limiting factor for the crop. In the months of frost most of onion crops are in the final stage.

While the information of the weather station of Quero-chaca, reveals that between the years 1986 and 2014 there was an increase of the temperature (Figure 2c), which can have a positive or negative effect on the crops (Ashardiono & Cassim, 2014). To raise the temperature there is most likely to increase the onion crops and other crops to higher altitude, which would adversely affect the paramo ecosystem. According to Bobojonov and Aw-Hassan (2014) in a scenario of climate change, the effects depend on agro-ecological zones as well as the social conditions of the population. As well in the medium term some farmers may benefit by the more favorable conditions for the growth of the crops, however, in the long run these expectations can be unfavorable due to scarcity of water for irrigation. A strategy for mitigating climate change may be to introduce new crops better suited to warmer climates as proposed Dosery, Mathew, Suresh, and Al-Menaie (2012).

The months of more light-hours are October, November, December and January. According to Ko et al. (2015), the light influences the amount of quercitina (glucose) that is one of the major flavonoids present in the onion. Given that the onion plants only receive natural light, the months most appropriate for the final stage of the crop would be January, October and November however, in these months the majority of crops are in the early stages.

Onion crops and height above the sea level

Crops of onion bulb in this region, were found from 3052 meters above sea level, up to the 3526 meters above sea level, the greater amount of plots (75.7%) were located between 3200 and 3400 meters above sea level (Figure 2d). According to Bach *et al*. (2003) the evapotranspiration decreases at higher altitudes, and when the evapotranspiration is low, affects the dynamics of water in the soil and the infiltration increases. On the other hand, each species grows in certain climatic conditions, so that its spatial location of the crops, also serves as a baseline for tracking of the species in the future (Holzkämper *et al*., 2011). The expansion of agricultural areas, is explained by the advance of urbanization in the lowland areas, a phenomenon that also occurs in other regions of the world (Lin, Huang, & Budd, 2013).

Periods of crop and market prices

As mentioned before, the time of the harvest depend on the time of planting. In this context was found: the G1 sells their crops between February and April, when the average price on the wholesale market of Ambato is between 19.3 and 25.2 USD; the G2 sold between May and June (27.7 and 23.2 USD) and the G3 sold between July and September (30.3; 31, 28.2 USD) (Figure 3a), these costs relate to a package of 45 kg. It is clear that the G3 sells in the best prices, while the G1 sells at lower prices; this suggests that farmers decide when to plant based on market prices and rainy seasons. While prices (2013) highest at the national level, were reported between April and May (Ministerio de Agricultura Ganaderia y Pesca, 2013). Although prices in the wholesale market of Ambato presnted a common pattern during the year (Figure 3b), these vary from one year to another. The prices in this market in addition to the climate, depends on other factors such as: the commercial opening of the Ecuador with neighbor countries and the increase in consumption of onions in certain months of the year. In this regard, the peasants are dissatisfied with the imports of onion that affects the prices of the national onion. In areas traditionally of onion crops as Yanayacu, it was noted that little plots of this crop (10). In the Canton of Mocha considered as an area of high production of onion found little plots of the crop. According to the peasants, the cultivation of onions is ceasing to be profitable, this indicates that the trade agreements for the import of onion affect domestic production (Jayne, Chamberlin, & Headey, 2014).

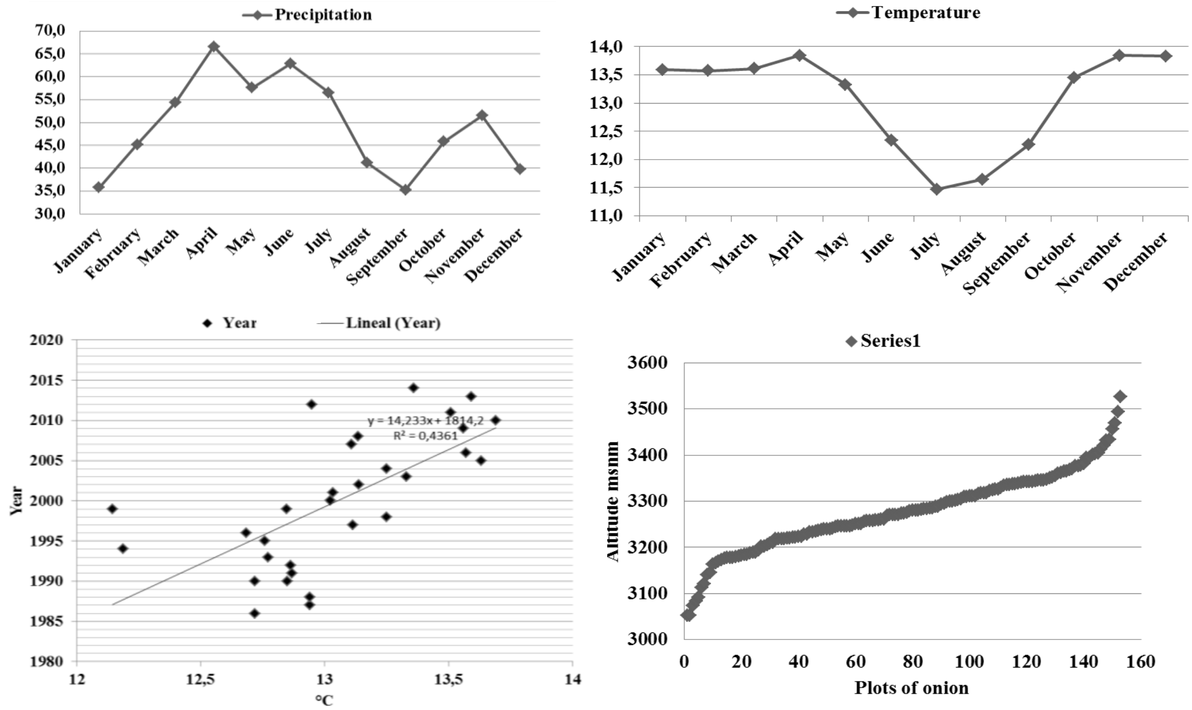

Figure 2: a) Precipitation overage 1986-2014; b) Temperature overage 1986-2014; c) Temperature rise 1986-2014; d) Plots of onion and altitude

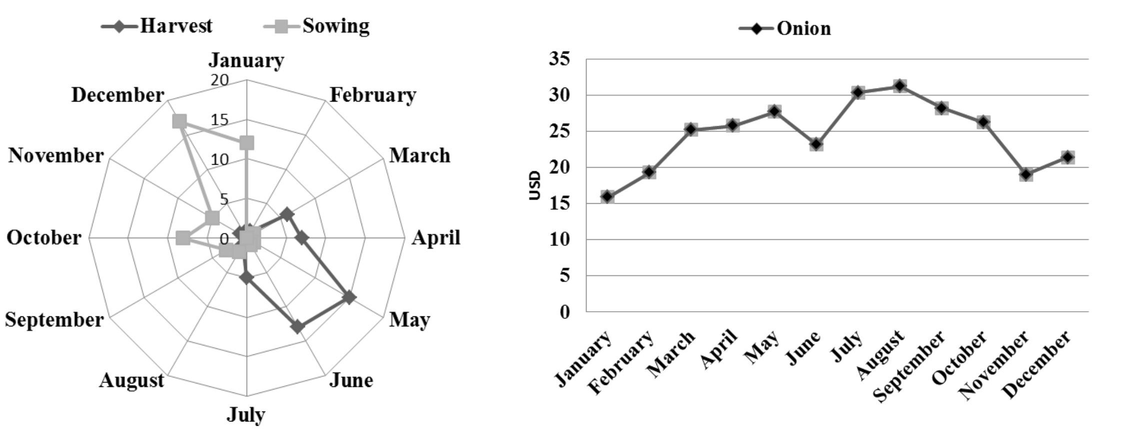

Figure 3: a) Cycles of sowing and harvests of Onion; b) Average prices of onion (variety agreggatum) 2010-2014, in the wholesale market of Ambato.

Conclusions

The local climate knowledge in this region is the basis for the establishment of the crop (onion), which depends on the skills of the farmers who have acquired through experience and by oral transmission of their ancestors. Among the peasants this knowledge is related to the level of education and gender. The peasant knowledge compared to meteorological statistics has high coincidence in relation to the periods of rainfall, drought and frost. Farmers take advantage of the dry months (November December) to start the plantings of onion, which enables them to take advantage of the rains in April, May, June, when the majority of crops are in full development. Times of crops of the majority of lots do not coincide with the months of high onion prices, which show that crop planning is not only depending on the market, but rainfall cycles.

Acknowledgement

Thanks to the Faculty of Agricultural Sciences and the authorities of the Technical University of Ambato

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