Selected Presentation at the 2020 Agricultural & Applied Economics Association Annual Meeting, Kansas City, Missouri, July 26-28

Aspiration formation and ecological shocks in rural Kenya

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Abstract

As a new strand in the theory of economic behaviour, the concept of aspiration and its relationship with future-oriented outcomes is receiving both theoretical and empirical investigation. While it is increasingly recognized that aspirations can lead households to undertake productive investments, it is still not well established how aspirations are formed (or eroded) especially in the face of ecological shocks. We refer to ecological shocks as the spread of three invasive species: fall armyworm (FAW), Parthenium, and Prosopis. While rural households may aspire for different aspirational dimensions, we sought to understand and predict the formation of aspirations under five dimensions: income, assets, livestock, social status and education as well as a standardized and aggregated aspiration index to obtain an overall impression of the aspirational mind set of households. Estimating regression models with instrumental variables, we show that ecological shocks have a differential negative effect on the aspiration dimensions as well as on the aspiration index. In this regard, understanding how aspirations are formed or shaped should be an issue of every governmental policy.

Keywords: Aspirations, ecological shocks, invasive species, aspiration index, Kenya

1. Introduction

High aspirations may navigate the poor through misfortune and difficulties in their quest towards better livelihoods. Many policy interventions and programs in rural areas have not been very successful and effective because of the lack of a perfect understanding of the desires, expectations, and aspirations of the rural people. A point in case is the low adoption of the highly tested and proven improved farm inputs, techniques and innovations in developing countries (Mausch et al. 2018). Inspired by its direct link to poverty and relevance in policy development in the light of specific agricultural interventions especially in rural areas, economists are increasingly getting on board in studying aspirations. Aspirations are crucial in explaining and predicting household goals and end behavior. Moreover, as individual behavior is actually less rational than the predictions of standard economic theory, it is even more worthwhile paying attention to the study of aspirations, its formation and its role in the forward-looking behavior of individuals.

Households, in a bid to improve their livelihoods and increase farm production and productivity, are usually faced with a plethora of shocks. These shocks can be idiosyncratic or systemic, and can cause reduced yields, pasture degradation, low productivity and the loss of productive farm assets and income. In Kenya, households are increasingly challenged with the spread and incidence of invasive (alien) species like *Prosopis juliflora, Parthenium hysterophorus* and recently the insect invasive, fall armyworm (FAW). Pratt et al. (2017) examine the economic impacts of parthenium on smallholder farmers in East Africa and estimated a current annual economic loss of $0.9 to $1.1 billion as well as a future loss of $1.0 to $1.2 billion. In Kenya particularly, current annual losses stemming from parthenium invasion range from $3.8 to $7.7 million while the predicted future loss range from $19.1 to $28.7 million. While this threat calls for a coordinated urgent response at all levels to manage these species, it is also important to fully understand household behavior and aspirations in the face of these invasive shocks.

We test the hypothesis that households form or adapt their aspirations based on an ecological threat. We see several possible mechanisms: Firstly, since ecological shocks affect individual productive activities and thereby economic outcomes, previously viewed achievable goals may seem unachievable making individuals to aspire for less. Secondly, severe ecological shocks may increase fatalism in plain sight of the related, emerging risks or reduce aspirations in order to minimize risks associated with investments triggered by high aspirations. Lastly, ecological shocks may also impact on the community's social and communication structure, which in turn may affect individual aspirations. For instance, approximately 30 years after the introduction of Prosopis in the Baringo county of Kenya by the Food and Agriculture organization (FAO) with the consent of the government, the rural population filed a lawsuit against the government for introducing this plant despite the original positive benefit it had at the time of its introduction. The communities were dissatisfied with its degree of invasion and its negative impacts on both livestock and human livelihoods. Such community efforts can strengthen community bonds and social networks which can positively affect aspirations.

Kosec and Mo (2017) provide a first attempt to answer whether environmental shocks affect aspirations analyzing floods in rural Pakistan. They report a negative effect of floods on the aspiration of households, with the greatest effect being felt by poor and agriculture-dependent households. We build on their analysis by examining the formation of aspirations under an ecological shock; specifically invasive species. Using invasive species as an ecological shock enables us to worry less about endogeneity issues as our invasive species pressure can be considered relatively exogenous to the determinants of rural aspirations. However, to address any residual endogeneity between ecological shocks and the aspiration measures, we employ instrumental variable regressions.

Rural Kenya serves as an ideal laboratory in studying the formation of aspirations under an ecological shock. As an agrarian economy, Kenya is a bright shadow of many other developing countries that are pruned to numerous ecological shocks common in agriculture with little or very rudimentary ways of mitigating them. Its young population also makes it a relevant environment to gauge aspiration formation as it will guide developing policies in creating an enabling environment where the aspirations and future-oriented outcomes of its citizens can be met. Despite tailoring our study to Kenya, the findings will have broader implications for most smallholder agrarian nations who suffer from numerous farming constraints especially in the face of ecological threats.

The study offers the following contributions. Firstly, it adds to the aspiration literature by providing empirical evidence on the formation of aspirations under an ecological threat using 5 dimensions of rural aspirations, income, assets, livestock, status and education. We also use an aggregated and standardized measure of all the different aspiration dimensions to give us an overall impression of the households. Secondly, it follows the well tested instrument on aspiration measurements designed by Bernard and Taffesse (2014), but adds livestock as an additional dimension of aspiration to fully capture the rural wealth level of households. As the study area is a pastoral community, livestock represents rural wealth to a considerable extent. To the best of our knowledge, this study is the first to investigate what drives aspiration formation in each of the quantitative dimensions of aspirations. Most previous studies (Stutzer 2004; Knight and Gunatilaka 2012; Janzen et al. 2017; Kosec and Mo 2017) only analyze the formation of aggregate aspirations (index approach) or look at the dimensions separately, in which case they focus on at most two dimensions.

The rest of the study is organized as follows: Section two provides a background into ecological shocks and invasive species in Kenya. Section three presents the farm household survey, data collection, and measurement of variables. Section four contains the empirical strategy while section five offers both descriptive and regression results. The paper ends with a conclusion in section 6.

2. Ecological shock - Invasive species in rural Kenya

The concept of alien species and invasive plants is becoming increasingly relevant in smallholder agriculture as they are a threat to agricultural production, reducing the yields of crops and causing numerous untold damages to rural populations. They also present a threat to ecosystem functioning, biodiversity and habitat loss as they out-compete both planted and natural vegetation. While they are non-native to Africa, their spread and incidence is increasingly reported in many African countries, in some cases with visible environmental and livelihood impacts. Their high spread and impact mechanism can be attributed to allelopathy and competition, allergic stimulating response, hypersensitivity inducement, rapid growth, pollen swamping and easy mode of transportation (CABI 2019). The incidence of these invasive species often than not result to livelihood changes beyond crop production losses with effects on the future prospects of households (Pratt et al. 2017). For instance, it may be the case that school-age children instead of going to school, spend considerable amount of days managing these invasive species through methods like weeding, cutting, pruning, and spraying. As highlighted above, we consider three invasive species currently impacting the livelihoods of farmers in Kenya: prosopis, parthenium and fall armyworm.

Prosopis, a shrubby woody plant native to South America was among one of the woody plant species introduced by the Food and Agriculture Organization (FAO) in Kenya in 1983 to rehabilitate the Arid and Semi-Arid Areas (ASALs) due to increasing deforestation, desertification, soil erosion and salinization as well as protecting households from whirlwinds and dust storms. The plant was also introduced for fodder, honey production, shades, windbreaks, fuelwood, firewood, and construction materials with a general objective of improving the livelihood options of households. Over time, its pods have been used as feed to livestock and occasionally by humans. However, after establishment, the trees quickly invaded all of the rangeland areas, manifesting negative impacts on humans, livestock and the rural landscape. Specifically, the tree has negative human and environmental impacts such as colonization and invasion of grazing lands, farmlands, roads, human settlement, ephemeral wetlands, irrigation canals, leading to death of livestock, causing floods and reducing livestock (meat) quality.

In Kenya, these species were specifically introduced in the Marigat division of the Baringo county stretching from Lake Baringo towards Lake Bogoria. Marigat is essentially a low land area where the invasion progress of prosopis can easily be observed. Using Landsat satellite data, Mbaabu et al. (2019) report an increase in prosopis coverage from 882 hectares in 1988 to 18,792 hectares in 2016 and found prosopis invasion to directly account for over 30% in the reduction of land use and land cover changes in grasslands, irrigated croplands, rainfed croplands and vegetations. This is suggestive of the fact that prosopis invasion is a key driver of the observed land use and land cover changes in the Marigat division of Kenya. In 2005, the rural population, very frustrated with dwindling grazing lands stemming from the prosopis invasion, filed a lawsuit against the national government of Kenya for the introduction of prosopis in the area.

Households with the support of both national and international non-governmental organizations (NGOs) have tried to manage prosopis through a system of management by utilization. This involves using the trees for enhancing livelihoods such as for charcoal production and apiculture. Nevertheless, the spread of prosopis has not reduced or slowed down (Mbaabu et al. 2019). This is probably because of its prolific production of fruits leading to its fast and easy propagation and its ability to form very dense and impenetrable thickets. It is also allelopathic with the ability to suppress the growth of other plant species. Moreover, unlike other invasive plants, it has no natural enemies like insects and plant pathogens that can feed it to death. As households only cut the tree above the soil, the stump is still left underneath and immediately regrows after a short while. This, therefore, makes the spread and management of prosopis a key pre-occupation to most rural households in Marigat.

Parthenium is an annual herb native to Central and South America, Mexico and the Southern United States which has increasingly become a rangeland weed in Asia and Africa (CABI 2019). It is a noxious weed that affects crops, livestock and biodiversity with effects on animal health and human livelihoods. The effect of parthenium on crops and forage plants is due to its highly competitive and allelopathic nature which inhibits the growth of a wide variety of crops. Moreover, it also acts as a secondary host for other crop pests that attack arable crops. It negatively affects livestock production by reducing grazing land as it encroaches and replaces forage plants, reducing the forage intake of livestock. This leads to poor tasting meat and low milk quality as well as intestinal damage, anorexia and dermatitis to animals feeding on it (CABI 2019). From an environmental perspective, parthenium leads to a loss of biodiversity through a disturbed food chain. Coupled with the fact that parthenium has no natural killers and predators, they are also hardly fed on by cattle and livestock. This leads to significant habitat changes since it suppresses the growth of natural vegetation.

Fall armyworm (*Spodoptera frugiperda* J: E Smith*)* is a crop pest first reported in Africa in 2016 which has quickly spread to virtually all of sub-Saharan Africa (SSA) (FAO 2018). Native to the Americas, the pest preferably feeds on staple crops like maize, but also wheat, sorghum, and millet as well as rice and vegetable crops. It damages plants by attacking their vegetative growing areas and burrowing into the cobs of older plants reducing both the quality and quantity of the harvested plants. FAW is a migratory pest with a high dispersal capacity which spreads rapidly along its host plants. It has a varying life cycle of 30-80 days depending on the season of the year. The warmer the season, the lesser it takes to complete its life cycle. As Kenya is semi-arid, with an extended dry season, its high incidence can be attributed to this suitable climatic condition.

For an agrarian economy like Kenya where maize is an important staple crop providing food, feed, and income to the rural households, the invasion of FAW can be considered a threat to food security and detrimental to rural livelihoods. From a household level perspective, FAW directly affects the income level of households through yield losses and increased cost of production. It also increases farm efforts and the labour costs needed to additionally deal with the pest, making it a threat to maize production with a substantive negative impact on food security and welfare in Kenya.

3. Farm Household Survey

3.1 Survey design and data collection

A farm household survey was conducted between July and August 2019 in the Marigat division of the Baringo county of Kenya. Marigat was purposely selected because of the presence and rapid spread of the invasive *Prosopis juliflora* and *Parthenium hysterophorus* coupled with the incidence of fall armyworm (FAW). Figure 1 shows the reported infestation levels of the invasive species in Marigat. 530 households were interviewed from the Ilchamus, Marigat and Mochongoi wards of the Marigat division. The sampling procedure involved a two-stage sampling procedure wherein we used villages as the primary sampling unit. In the first stage, villages were selected using probability proportional to size sampling (PPS). In the selected villages, a household listing exercise was undertaken where we listed all the households in the various villages. In the second stage, 530 households were randomly selected and interviewed using a well-structured questionnaire. The survey questionnaire was designed using the World Bank's computer-assisted personal interviewing (CAPI) free software, Survey Solutions. It was administered through personal interviews by a group of research assistants who were trained and supervised by the researchers. Interviews were carried out usually with the household head or the spouse in their local language.

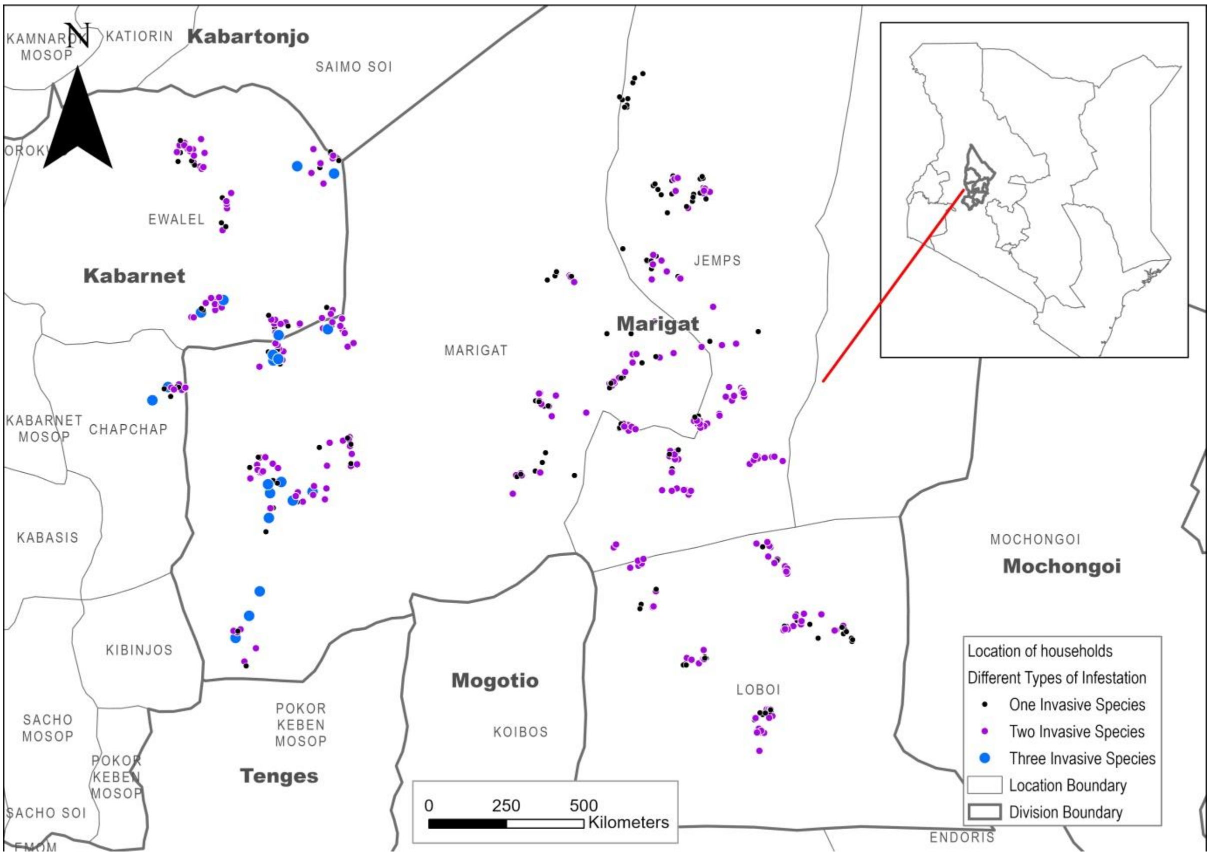

Figure 1. Infestation levels of invasive species in Marigat, Kenya

The survey gathered information on the aspirations, hopes and ecological shocks affecting pastoral farmers. Household-level data were garnered on invasive plant species like *Prosopis juliflora* and *Parthenium hysterophorus* as well as the insect invasive, fall armyworm. Data was also collected on key socio-economic variables, institutional characteristics, shocks, and coping strategies, land and livestock ownership, income and expenditure as well as the household asset structure. Table 1 provides a description of the main variables used in the analysis.

Table 1. Definition of variables

Variable	Definition
Household Income	Total household income (Ksh)
Asset ownership	Total value of all assets (Ksh)
Livestock ownership	Tropical livestock units
Flock size	Total number of livestock owned
Age of the household head	Age of the household head in years

Household head is male	=1 if household head is male, 0 otherwise
Education	Number of years in school
Household size	Total number of household members
Dependency ratio	Number of dependents over the active population
Total cultivated land	Total cropland in acres
Marital status	Marital status of the household head
Labour	Total labour of all household members (person-days)
Hired labour	Total person-days of labour hired
Village responsibility	Household head has a responsibility in the village
Crop experience	Number of years in crop cultivation
Livestock experience	Number of years of in livestock keeping
Extension contact	Number of interactions with an extension agent
Distance to market	Walking distance to the main market (km)
Credit access	=1 if household has access to credit facilities, 0 otherwise
Mobile money	=1 if the household uses mobile money services, 0 otherwise
Faw infestation	=1 if the household's fields are affected by fall armyworm
Parthenium infestation	=1 if the household's fields are affected by parthenium
Prosopis infestation	=1 if the household's neighbourhood is infested by parthenium

Source: Author's computation from field survey, 2019

3.2 Measuring Ecological shocks

We measure ecological shocks based on the infestation of prosopis, parthenium and FAW over the last calendar year. We used a dummy variable to represent this dichotomous relationship where a value of 1 represents infestation and zero otherwise. In the case of FAW, 1 represents FAW infestation while in the case of parthenium, a value of 1 signifies that fields are infested with parthenium. As prosopis is a rangeland invasive, we rather considered infestation based on the neighbourhood of the household. We define the neighbourhood of a household on a 10metres radius and considered it as a binary variable where 1 refers to a prosopis infestation and 0 otherwise.

3.3 Measuring Aspirations

Because of its multidimensional nature, aspirations have been measured differently using different measurement scales. This makes comparison and interpretation of results seemingly difficult. Its attitudinal nature further makes it challenging to effectively capture it for empirical analysis. The use of different wordings, measurement scales, and the dynamic nature of respondents who may interpret wordings differently may considerably induce measurement errors. To level this, we used the Bernard and Taffesse (2014) aspiration framework which measures aspirations on four key dimensions: income, education, social status and wealth. As our study area is a pastoral community, we add a livestock asset dimension to more fully capture rural wealth aspirations. As recommended by Bernard and Taffesse (2014), we used well-trained and experienced research assistants not to jeopardize the quality of the aspiration data.

We relied on the self-reporting of aspirations based on 5 quantitative dimensions of aspiration (*a*); asset aspiration, livestock aspiration, social status aspiration, educational aspiration, and income aspiration. The choice of the above dimensions are based on previous studies (Kosec and Mo 2017; Macours and Vakis 2014; Bernard and Taffesse 2014). We asked the following questions (in this order) to control for plausible anchoring effects and set a reliable range for reporting household aspirations.

Based on dimension *a*:

i What is the maximum level of (*a*) that an individual can attain in your neighbourhood?

ii What is the minimum level of (*a)* that an individual can attain in your neighbourhood?

iii What is your present level of dimension (*a*)?

iv What level of dimension (*a*) would you like to achieve?

One particular issue we concentrated on in training the research assistants is the difference between aspirations and expectations. While aspirations are future-oriented, idealistic and consider one's life goals, expectations are more limited, realistic and refer to what an individual thinks is more likely about his life after considering potential constraints. A household with a low-income status may likely not expect to increase its income after observing the income of others and considering their income activity generating potential. However, this household may aspire to increase its income. We made this difference very clear and quite understandable to the assistants so that they will in turn capture aspirations other than expectations.

Intuitively, all five measures of aspirations are highly interrelated, making it important to aggregate them as one aspirational index. We test this correlation (table 5) and show that all the correlation signs are expected and highly significant at different levels of probability. Despite reducing information on each dimension of aspiration, aggregation controls for measurement error common in attitudinal variables by reducing stochastic noise. Aggregation is carried out at the ward level by first subtracting the sample mean from the present level of each individual in a particular ward and then dividing by the standard deviation. Representing an individual's actual aspiration level for dimension a as x_i^a with A as the total number of dimensions (5), the aspiration index is expressed as

$$A_i = \frac{1}{A}\sum_a \frac{x_i^a - \mu^a}{\sigma^a} \qquad (1)$$

μ^a and σ^a are the sample mean and standard deviation respectively for the actual level of an individual's aspiration.

Individuals value the different dimensions of aspiration on a varying basis. While some individuals may value educational aspiration, others may simply value their social status or asset level. Since aspirations are motivators requiring the investment of some level of resources (effort), it becomes important to record how individuals regard the different aspiration dimensions by weighting. To do this, we play a simple game by giving out 20 maize seeds to households asking them to distribute the seeds based on how they value a particular aspiration dimension. Mathematically, this is represented as

$$A_i = \sum_a \left(\frac{x_i^a - \mu^a}{\sigma^a}\right) w_i^a \qquad (2)$$

Where w_i^a is the assigned weight to dimension a

4. Estimation strategy

To determine the effect of ecological shocks on the aspirations of rural households, we estimate the following regression:

$$A_i = \beta_0 + \beta_1 \boldsymbol{ES}_i + \beta_2 \boldsymbol{X_i} + \beta_3 W_{\boldsymbol{i}} + \varepsilon_i, \quad (3)$$

Where A_i represents the different aspiration dimensions (income, assets, livestock, social status, education) and the aspiration index for household *i*, ES_i is a vector of the invasive species (prosopis, parthenium, and FAW), $\boldsymbol{X_i}$ is the vector of explanatory variables and ε_i is the stochastic error term. For estimation, the standard errors are clustered at the household level. $W_{\boldsymbol{i}}$ represents the ward level dummies that capture ward heterogeneities.

Our interest lies in the estimation of β_1 which measures the impact of ecological shocks on the income, asset, livestock, social status, and educational aspirations as well as the aspiration index. We hypothesize a differential effect on the different aspiration dimensions and the index. Of course, ecological shocks should affect the different dimensions in a distinct manner but as they are correlated, a uniform relationship is expected *a priori.* We consider the spread of ecological shocks as a natural experiment with no household influence. For the income and asset aspiration model, the dependent variable is log-transformed because of its skewed distribution. For the other models, we estimate equation (3) in a linear form.

As the incidence of ecological shocks is quite a random and stochastic event, with very little control from households, we worry less about endogeneity issues. Moreover, our ecological shocks are quite independent of the different aspiration measures with no dependence on some unmodeled factors in our aspiration model. While this may be true for parthenium and FAW which are recent ecological shocks in the study area, one could argue that the case of prosopis may be different, especially as it was introduced in the area. Since its introduction, prosopis has quickly spread to new areas while it has been less successful in some of the introduced areas. Thus, there may be some unobserved heterogeneity between prosopis invasion and the aspiration dimensions. Not controlling for this could lead to biased estimates in β_1. Including a wide range of explanatory variables could cater for this bias arising from omitted variables and reduce unobserved heterogeneity. We thus include a wide range of control variables as well as controlling for location heterogeneity with the inclusion of village fixed effects in our structural model to control for unobserved heterogeneity at the village level.

Additionally, we also employ an instrumental variable (IV) approach to control for this endogeneity. Essentially, this entails getting one exogenous variable that determines prosopis infestation but has no effect on the outcome variables. As the growth and spread of prosopis depends on the soil condition, we exploit the soil type where prosopis infestation is observed as the instrument. Prosopis thrives best on almost all but rocky soils. It survives by extending its trunk very deep to obtain water, which is seemingly impossible in rocky soils. Our data show us a positive and highly significant correlation between soil type and prosopis infestation (Table A1). We, of course, attribute this strong relationship to the mechanism described above. Our instrument can now be described as relevant. However, soil type is also expected to be uncorrelated with household level time varying factors to meet the exogeneity condition. We argue that our instrument influences aspirations only through its effect on prosopis infestation and maintain instrument admissibility.

5. Results and Discussion

5.1 Descriptive statistics

We present the descriptive statistics of some of the important variables used in the empirical model. While Table 2 presents the means, standard deviation, 10th percentile and the 90th percentile of the continuous variables, Table 3 presents the frequencies and percentages of the indicator variables. For the continuous variables, we begin with household income which refers to all the income sources of the households. It includes crop income, livestock income and other income sources such as salaries, remittances, pension, compensation income as well as business income. The average household income is approximately 10890Ksh[1]. In terms of household assets, we have three main groups: total household assets which comprise non-productive assets like television, furniture, buildings, radios; productive assets like farm implements, ox and donkey carts, ploughs, tractors, and other rudimentary tools; and livestock assets which include cattle, goats, sheep, donkeys, camel and poultry. The average value of the asset holding of households is approximately 171532Ksh while the productive assets are valued averagely at 73913Ksh. Livestock ownership is measured as the herd size and converted to the tropical livestock units (TLU) to ease comparability and ensure

[1] [1] 1Ksh= $0.0096 (06.07.2019)

consistency. TLU was obtained using the Food and agricultural organization (FAO) conversion unit where a cow is equivalent to 0.8TLU, a goat 0.2TLU, a sheep 0.2TLU and poultry 0.02TLU. The mean herd size is estimated at 25 with an average TLU of 3.18.

Household demographic characteristics are captured with variables like age, education, household size, area of cultivated land, off-farm income, labour, and farming experience. The average age of the household head is 45years and ranges from 18 to 104years. While almost a fifth of the sampled households have undergone no level of education, the average number of years spent in formal educational training is approximately 8years. Household size ranged from 1 to 15 members with an average of 5.94 members per household. The dependency ratio measured as the ratio of the number of dependents (<15 and >65) to the number of the actively working population (15-64) is also computed with a mean value of approximately 1. A great majority of the households are either crop farmers or livestock keepers. The average farm size is 1.29 acres, suggesting that most of the households are smallholders with small farm sizes. Apart from cultivating crops and rearing livestock, households participate in other employment activities to which they earn an average off-farm income of 2083.11Ksh.

Farming experience was also captured with an average crop experience of 13.4 years and an average livestock experience of 17.06 years. Agricultural extension services are not well developed in the study area. Most of the farmers (26%) are not aware of who/what extension services are. The few who are aware of extension services have only interacted with extension agents on a single basis, on average.

Table 2. Summary statistics of continuous variables

Variable	Mean	SD	10th percentile	90th percentile
Household Income (Ksh)	10887.65	13330.24	2000	22500
Asset ownership (Ksh)	171532.50	1055138	7976.50	247975
Productive asset ownership (Ksh)	73913.8	879858	1000	89700
Livestock ownership (TLU)	3.18	5.07	0	7.85

Flock size (number)	24.74	35.16	0	57
Age of the household head (years)	45.15	15.62	26	70
Education of head (number)	7.89	4.86	0	13
Household size (number)	5.94	2.83	2	10
Dependency ratio	1.17	1.17	0	2.5
Total cultivated land (acres)	1.29	1.79	0	3
Off-farm income (Ksh)	2083.11	10143.93	0	4000
Years in village (number)	24.46	18.68	4	54
Labour (person days)	51.32	61.62	0	136.5
Crop experience (years)	13.4	13.02	1	30
Livestock experience (years)	17.06	16.14	1	40
Distance to market (Km)	9.50	7.79	2	20

Source: Author's calculation from field survey, 2019

Table 3. Summary statistics of indicator variables

Variable	Yes (1)		No (0)	
	Frequency	Percentage	Frequency	Percentage
Household head is male	393	74.15	137	25.85
Marital status	412	77.73	118	22.27
Village responsibility	89	16.79	441	83.21
Credit access	228	43.02	302	56.98
Mobile money	438	82.64	92	17.36
Faw infestation	390	73.58	140	26.42
Parthenium infestation	211	39.81	319	60.19
Prosopis infestation	386	65.28	184	34.72
Irrigation	128	24.15	402	75.85
Improved seeds	333	62.83	197	37.17

Source: Author's calculation from field survey, 2019

With regards to ecological shocks, about 74% of the sampled households reported an incidence of FAW in their fields, with about 50% of crops being damaged by FAW. For the plant invasive species, parthenium was reported to be new and was described as an ‘ambassador’. Its infestation rate was about 40% with less than 10% severity with low damage to crops. This can be attributed to the fact that parthenium only thrives well on plots not extensively managed and along irrigation canals. Though it gets propagated easily because of its tiny seeds, it is easily managed by hand weeding. Prosopis which is mostly found in the lowlands has an infestation rate of about 65.28%.

Turning to the descriptive results on aspirations, we are confident about our aspiration dimensions as the household’s aspiration responses are multiples of their current dimensional level. On average, the income aspiration of households is 45484.15Ksh which is 4.2 times their current income level (10887.65Ksh). In a similar vein, households aspired for assets of approximately 894600Ksh which is 5.2 times their current level of assets. The livestock aspiration of households in terms of TLU is 61.34 while the aspired herd size is approximately 510. Social status aspiration has a mean level of 9 and ranges between 4 and 10. While most of the household heads have little or no level of formal education, their aspired educational level for their children is high. Among households with children less than 10 years, irrespective of whether the child is currently enrolled in any formal education or not, the mean aspired education for both boys and girls is 18 years which is equivalent to obtaining an undergraduate degree. Table 4 presents the mean, percentiles and standard deviation of our five measures of aspiration.

Table 4. Summary statistics of aspiration dimensions

Variable	**Mean**	**SD**	**10th percentile**	**90th percentile**
Income aspiration	45484.15	60864.41	10000	100000
Asset aspiration	894611.3	6220386	47500	1000000
Livestock aspiration (TLU)	61.34	613.19	4.5	50
Livestock aspiration (flock size)	511.18	6131.27	35	270
Social status aspiration	9.00	1.11	8	10
Educational aspiration for male child	18.10	2.45	17	23
Educational aspiration for	18.12	2.48	17	23

female child

Source: Author's calculation from field survey, 2019

We also established pairwise correlations between the different aspiration measures to enable us clearly understand the interrelationship between the aspiration measures. Table 5 presents the pairwise correlations with their significance level. From the table, there exists some significant positive correlation between the different aspiration dimensions, despite the magnitudes being very small. This, of course, justifies our use of an aspiration index.

Table 5. Pairwise correlations between aspiration measures

	Income	Assets	Status	Livestock	Male education	Female education
Income	1.00					
Assets	0.35***	1.00				
Status	0.15***	0.04	1.00			
Livestock	-0.01	0.01	-0.10***	1.00		
Male education	0.11**	0.14***	0.07*	0.13***	1.00	
Female education	0.15***	0.14***	0.05	0.12***	0.76***	1.00

Notes ***p below 0.01, ***p below 0.05, *p below 0.1. Author's computation from field survey, 2019

5.2 Mean comparison of aspirations by ecological shocks

The household survey revealed the existence of significant differences between households that face ecological shocks and households that do not. Particularly, households whose fields are infested with prosopis have lower income aspirations than households that are not affected. Similarly, they also have a lower social status than the unaffected households. Furthermore, farmers that experience FAW in their fields have greater contact with extension agents, participate more in cooperative societies and have larger fields than households who report no incidence of FAW in their fields. This is shown in table 6 below. With regards to parthenium, the income, asset, livestock, status and educational aspirations of households that suffer from parthenium infestation are higher than the aspirations of households that do not face this shock.

Summarily, there exist significant socio-economic, farm level and aspirational differences between households that are faced with ecological shocks and households that are not. We can already confirm based on the associations between aspirations and ecological shocks that the understanding of aspiration formation will be understated if ecological shocks are not considered. That notwithstanding, it may be inconclusive to rely on these without subjecting it to more standard empirical analyses and controlling for confounding factors. This is the basis of the following section where we include a range of controls in a regression setting.

Table 6. Mean comparison of aspiration and other variables by ecological shocks

Variable	Fall armyworm		t-test	Parthenium		t-test	Prosopis		t-test
	Infestation	Non-infestation		Infestation	Non-infestation		Infestation	Non-infestation	
Income Aspiration	47314.36	40385.71		52000	41174.29	**	33519.57	51846.82	***
Asset aspiration	837394.9	1054000		1494664	497711.6	*	372663	1172179	*
Status aspiration	9.07	8.8	**	9.17	8.89	***	8.88	9.06	**
Livestock aspiration	76.19	19.96		121.72	21.40	**	17.10	84.86	
Male education	18.30	17.53	***	18.39	17.90	**	17.95	18.17	
Female education	18.23	17.80	*	18.28	18.01		18.08	18.14	
Age of household head	43.72	49.13	***	41.20	47.76	***	50.58	42.26	***
Education of the household head	8.24	6.94	***	8.32	7.61		7.55	8.08	
Household head is male	0.78	0.62	***	0.77	0.71		0.70	0.76	
Radio ownership	0.67	0.49	***	0.70	0.57	***	0.03	0.02	*
Mobile phone ownership	0.88	0.62	***	0.88	0.76	***	0.80	0.81	
Household size	6.42	4.6	***	6.46	5.58	***	5.42	6.20	***
Crop experience	14.16	11.26	**	11.79	14.46	**	17.49	11.22	***
Extension contact	0.32	0.10	***	0.34	0.21	***	0.15	0.32	***
Contact times	0.67	0.21	***	0.84	0.36	***	0.27	0.70	***

Cooperative membership	0.30	0.10	***	0.41	0.14	***	0.08	0.34	***
Credit access	0.50	0.22	***	0.55	0.34	***	0.38	0.45	*
Mobile money use	0.87	0.69	***	0.91	0.76	***	0.79	0.84	
Animal manure	0.20	0.10	**	0.18	0.17		0.23	0.14	***
Green manure	0.15	0.035	***	0.14	0.10		0.02	0.17	***
Soil and water conservation	0.27	0.19	**	0.27	0.24		0.17	0.29	***
Area of cultivation	1.58	0.48	***	1.73	1.00	***	0.88	1.51	***
Improved seeds	13.11	5.24	***	18.96	5.78	***	11.80	10.41	

Notes: ***p below 0.01, **p below 0.05, *p below 0.1

Estimation results

Both ordinary least squares (OLS) and IV estimations are carried out to establish the role of ecological shocks on rural aspirations. Tables 7 and 8 below present the effects of ecological shocks on the income, asset, livestock, education, social status and aspiration index of the households. We begin by looking at the ecological effects on the index. From the table, prosopis infestation has a negative impact on the aspiration index both for the OLS and the IV specification. Also, households who are aware of FAW and their devastating effects on crops have lower aspirations. This is in line with Kosec and Mo (2017) who found the incidence of floods to have a negative effect on the aspirations of households in Pakistan. This is somewhat expected as invasive species can have a direct impact on households by affecting livelihoods and creating numerous constraints to their aspirations. As most households are into livestock keeping, prosopis infestation can directly affect this activity either by reducing pasture land or by forming huge thickets making it hard for the livestock in accessing common water and feeding points. In the face of this, households may become fatalistic and only aspire for less. Furthermore, related to the first and in the light of Kosec and Mo (2017), these shocks may have annulling effects on the welfare and well-being of households. Households may only visualize a bleak future in the face of these ecological shocks, as guided by their current investment losses. These effects may even be self-reinforcing and rebound, making households to always aspire for less even when the shocks are post-existent. In line with this, Jensen (2000) found households who previously experienced an adverse weather shock to have a lower investment in the education and health of their children.

Going beyond the index effect, and looking specifically into all the five aspiration dimensions, we find prosopis infestation to have a negative effect on income, asset and livestock aspirations of households. As our income and asset outcomes are log-transformed, households that suffer the threat of prosopis infestation have income and asset aspirations higher than households with no prosopis infestation by 33 percent and 30 percent respectively. As the spread of prosopis can decimate household assets, these results are in order. In the case of livestock, aspiring for many livestock in the future may seem lofty in the face of prosopis which has harmful effects on livestock, leading to poor and bad quality meat. While we expected prosopis infestation to have a negative effect on the educational aspirations of parents for their children through the prosopis management pathway, no statistically significant relationship is established.

From the other control variables, education was found to be a significant determinant in the formation of aspirations. Its positive significance in all the outcome models but livestock aspirations underscores the role of learning in aspiration formation. Of course, aspirations are a social construct formed from the personal experiences and the experiences of others. In a similar vein, an institutional characteristic like access to extension contact has a positive and significant relationship with the income and status aspirations of households. Extension agents provide a form of informal education to farmers increasing their informational base. Households who have contacts with extension agents have higher aspirations. Perhaps, their regular contacts with these agents make them aspire for more in a bid to being like them or reaching their own status. The ownership of mobile phones also increases the educational aspirations of parents towards children. All these go to strengthen the role of information access in reducing informational barriers to aspiration formation (La Ferrara 2019).

The current income and asset level of households also matter in understanding how aspirations are formed. This goes back to the concept of 'capacity to aspire'. Low-income households usually aspire for less owing to their present conditions which makes them fatalistic. Similar results have been reported by Stutzer (2004), Janzen et al. (2017), Knight and Gunatilaka (2012), and Kosec and Mo (2017) in their various attempts to understand aspiration formation. Specifically looking at livestock ownership, we find positive and significant effects on the aspiration index, asset aspiration, livestock aspiration and status aspiration. In most rural settings like in the study region, livestock ownership represents rural wealth. They also signify social status, little wonder livestock ownership increases the status aspirations of rural households. Households who own livestock have a high social status aspiration.

Table 7. Effect of ecological shocks on aspiration index, income aspiration, and asset aspiration

Variable	Aspiration index		Income aspiration		Asset aspiration	
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	IV	OLS	IV	OLS	IV
Prosopis infestation	-3.790**	-9.322***	-0.330***	-0.342	-0.304**	-0.976***
	(1.623)	(4.366)	(0.101)	(0.285)	(0.133)	(0.328)
Parthenium infestation	-0.782	-0.807	0.038	0.038	0.011	0.008
	(1.240)	(1.212)	(0.080)	(0.070)	(0.119)	(0.105)
FAW infestation	-0.362	-0.641	-0.153	-0.154	-0.067	-0.102
	(1.795)	(1.633)	(0.110)	(0.094	(0.172)	(0.140)
FAW knowledge	-6.768**	-6.842**	-0.391**	-0.391**	-0.180	-0.184
	(2.825)	(3.013)	(0.189)	(0.174)	(0.237)	(0.259)
FAW neighbour infestation	5.523**	5.419**	0.109	0.108	0.026	0.007
	(2.670)	(2.344)	(0.137)	(0.135)	(0.203)	(0.202)
Age of the household head	-0.059	-0.058	-0.004	-0.004	-0.004	-0.004
	(0.050)	(0.045)	(0.002)	(0.002)	(0.003)	(0.003)
Education of the household	0.393**	0.399***	0.038***	0.038***	0.034**	0.034***
head	(0.175)	(0.151)	(0.009)	(0.008)	(0.013)	(0.013)
Marital status	0.827*	0.828*	0.065**	0.065**	0.022	0.022
	(0.456)	(0.474)	(0.031)	(0.027)	(0.049)	(0.040)

LnHousehold income	1.472**	1.473***	0.350***	0.350***	0.196***	0.196***
	(0.585)	(0.533)	(0.069)	(0.030)	(0.068)	(0.046)
LnAsset	0.168	0.176	0.061**	0.061***	0.230***	0.231***
	(0.377)	(0.394)	(0.012)	(0.022)	(0.053)	(0.033)
Household size	0.050	0.035	0.005	0.005	0.053***	0.051***
	(0.218)	(0.215)	(0.012)	(0.012)	(0.019)	(0.202)
Access to credit	1.280	1.140	-0.017	-0.018	0.236**	0.228**
	(1.164)	(1.150)	(0.061)	(0.066)	(0.099)	(0.099)
Extension contact	0.968	0.897	0.157**	0.157**	0.143	0.133
	(1.295)	(1.262)	(0.071)	(0.072)	(0.112)	(0.109)
Area of cultivation	0.850	0.843**	0.019	0.019	0.022	0.020
	(0.549)	(0.341)	(0.023)	(0.019)	(0.028)	(0.029)
Livestock ownership	0.312**	0.304**	0.008	0.008	0.034***	0.033***
	(0.312)	(0.122)	(0.006)	(0.007)	(0.008)	(0.010)
Radio ownership	0.734	0.803	-0.012	-0.012	0.015	0.026
	(1.317)	(1.218)	(0.066)	(0.070)	(0.107)	(0.105)
Mobile phone ownership	1.541	1.555	0.009	0.009	-0.085	-0.087
	(1.387)	(1.524)	(0.098)	(0.088)	(0.135)	(0.131)
Constant	-32.64***	-30.499***	6.661***	6.666***	7.727***	
	(5.740)	(5.975)	(0.636)	(0.353)	(0.627)	
F-value	4.92***	5.98***	18.46***	22.53***	15.32***	15.63***

Village fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	530	530	530	530	530	530

Notes:***p below 0.01, **p below 0.05, *p below 0.1. standard errors are in parentheses.

Table 8. Effect of ecological shocks on livestock, status, and educational aspirations

	Livestock aspirations		**Status aspiration**		**Educational aspiration**	
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	OLS	**IV**	**OLS**	**IV**	**OLS**	**IV**
Prosopis infestation	-1.623	-22.01***	0.380	-0.074	-0.308	-1.012
	(1.277)	(1.936)	(0.259)	(1.298)	(0.310)	(1.105)
Parthenium infestation	-2.506	-1.400	-0.361*	-0.362*	0.183	0.180
	(1.541)	(1.287)	(0.201)	(0.191)	(0.222)	(0.233)
FAW infestation	-2.050	-0.783	-0.423**	-0.417*	0.277	0.239
	(2.800)	(1.476)	(0.216)	(0.235)	(0.263)	(0.393)
FAW knowlege	-2.994	-1.009	0.377	0.365	-0.324	-0.341
	(3.589)	(2.702)	(0.462)	(0.415)	(0.464)	(0.506)
Age of the household head	0.023	-0.023	0.026***	0.026***	-0.003	-0.002
	(0.060)	(0.047)	(0.007)	(0.007)	(0.008)	(0.008)

Education of the household head	0.101	0.061	0.050**	0.050**	0.064**	0.064**
	(0.158)	(0.159)	(0.024)	(0.023)	(0.030)	(0.029)
Marital status	-0.275	-0.251	0.053	0.053	0.093	0.093
	(0.569)	(0.495)	(0.078)	(0.074)	(0.097)	(0.091)
LnHousehold income	0.038	0.331	-0.004	-0.003	0.144**	0.144
	(0.773)	(0.542)	(0.090)	(0.084)	(0.082)	(0.102)
LnAsset	-0.123	-0.238	-0.004	-0.004	0.136	0.137*
	(0.707)	(0.422)	(0.068)	(0.062)	(0.083)	(0.076)
Household size	0.343	0.088	0.025	0.024	-0.032	-0.034
	(0.479)	(0.228)	(0.036)	(0.034)	(0.039)	(0.041)
Access to credit	-3.248**	-2.680**	-0.349*	-0.359**	0.301	0.284
	(1.277)	(1.218)	(0.184)	(0.182)	(0.220)	(0.222)
Extension contact	1.167	0.690	0.546***	0.541***	0.231	0.224
	(1.413)	(1.365)	(0.204)	(0.198)	(0.242)	(0.242)
Area of cultivation	0.873	0.472	0.031	0.030	0.031	0.030
	(0.861)	(0.316)	(0.051)	(0.053)	(0.079)	(0.065)
Livestock ownership	1.225***	1.165***	0.045***	0.045**	0.004	0.003
	(0.196)	(0.148)	(0.019)	(0.019)	(0.019)	(0.023)
Radio ownership	0.672	1.276	0.249	0.253	0.056	0.064
	(1.786)	(1.282)	(0.194)	(0.192)	(0.263)	(0.235)
Mobile phone ownership	0.919	-1.275	0.200	0.200	0.583*	0.584**

	(1.685)	(1.587)	(0.241)	(0.240)	(0.351)	(0.294)
F-value	5.43***	6.32***	4.35***	9.32	3.56***	7.68***
Village fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	530	530	530	530	530	530

Notes:***p below 0.01, **p below 0.05, *p below 0.1. standard errors are in parentheses.

Conclusion

In this article we sought to understand how households form their aspirations under an ecological shock. By ecological shocks, we refer to the incidence of FAW, parthenium and prosopis. We used five rural aspiration dimensions: income, asset, livestock, status and education as well as an aspiration index to capture the overall aspiration feeling of households. We employ a cross-sectional dataset of 530 households in the Marigat division of Kenya. Beginning with a classical means test to verify the existence of significant differences in aspirations between households that are affected by ecological shocks, we also extend the comparison to household socioeconomic variables and farm characteristics. The household survey reveals the existence of significant differences between households that are affected by ecological shocks and households that are not. These significant differences spread across a range of farm and household characteristics.

Employing regression approaches to identify the effect of ecological shocks on aspirations, we establish a negative relationship between ecological shocks and aspirations. Furthermore, different ecological shocks have varying effects on the different dimensions of aspirations. Households under Prosopis infestation have lower income, assets and livestock aspirations than households without infestation. Households who are aware of FAW have lower aspirations. This could be attributed to fatalism which is thought to increase in the plain sight and knowledge about these invasives.

From the analysis, we conclude that it may be inconclusive to understand aspiration formation without understanding the role of other determinants like the current wealth status of the household and institutional characteristics like education and access to extension services. By wealth, we refer to the income, assets and most importantly livestock assets, since they represent rural wealth in most pastoral settings. This study offers empirical support to the theoretical concept of 'capacity to aspire'. Institutional characteristics like education and access to extension services shape aspirations by reducing the informational barriers household face through the provision of learning and improved information access.

From a policy perspective, our study findings have important policy implications. Understanding how aspirations are formed or shaped should be an issue of every governmental policy. To the extent that current income and asset levels have an effect on aspirations, the role poverty reduction strategies like social safety nets and cash transfer interventions should be encouraged. While it was not in the scope of this study to establish how such relief social protection programs attenuate constraints to the formation of aspirations, we believe that a well-targeted program that seeks to increase the income of rural households will in a way increase their aspirations for the future. Finally, to further improve on rural aspirations, targeting institutional policies will be very essential. The provision of formal and informal education, as well as a well-established and functioning agricultural extension system, would reduce barriers to the formation of rural aspirations.

Two limitations of this study could be taken up in future research. Firstly, despite dealing with endogeneity by specifying IV regressions, we cannot claim to have fully identified causal impacts given the cross-sectional nature of the data making it hard to completely rule out all biases. The use of experimental approaches or panel data may offer better causal identification and should be explored. Moreover, as aspirations evolve over time, panel data offer additional advantages by controlling for unobserved heterogeneities. Secondly, we used five aspiration dimensions that pertain to most rural livelihoods. However, aspirations span through many more dimensions like health, security, and nutrition. Future research in this direction may want to address other dimensions of rural aspirations. That notwithstanding, this analysis is one of the first to quantify aspirations and establish the links between ecological shocks and aspiration based on five aspiration dimensions. As context matters, follow-up research is warranted to test these empirical findings and add to the literature on aspiration formation in rural communities.

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Appendix

Table A1. Correlation between Prosopis infestation and soil type

	Prosopis infestation	**Soil type**
Prosopis infestation	1.0000	

Soil type	0.2543***	1.0000

Notes:***p below 0.01, **p below 0.05, *p below 0.1

Table A2. Regression coefficient of soil type in outcome equations

Outcomes	Coefficient of soil type
Aspiration index	0.563
	(0.497)
Income aspiration	-0.004
	(0.031)
Asset aspiration	-0.022
	(0.048
Livestock aspirations	-7.373
	(7.212)
Status aspiration	-0.026
	(0.079)
Educational aspiration	-0.048
	(0.098)

Notes:***p below 0.01, **p below 0.05, *p below 0.1