

IMPLICATIONS OF DIVERSITY OF GROUPS OF INDIGENOUS BIRDS TO AGRICULTURAL OUTPUT IN ETHIOPIA

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Abstract

The value of birds for agriculture in Ethiopia was studied. Diversities of indigenous bird guilds namely granivores, frugivores, insectivores, and raptors that inhabit differently agro-climatic zones were used as predictors of percent agricultural outputs of the zones. This showed diversity of all the guilds did have significant positive explanatory value to agricultural output across agro-climatic zones. To explain such contribution of birds to agriculture their role in predicting forest cover the value of which was already verified should have been done. The diversities of all the four guilds significantly and positively explained patterns in forest cover across agro-climatic zones of Ethiopia. Thus birds are important for agriculture because of their roles both within pristine landscapes such as forests and also within the farmstead. The results may be indicative of past and present role of indigenous birds in the maintenance, spread and multiplication of crops and livestock in Ethiopia's wildernesses and farms. The evidence indicates birds may have significant economic value and money spent on the conservation of birds is money well spent.

Key Words: *Crop, Bird, Diversity, Forest, Agro-climate, Ethiopia*

Introduction

The usefulness of plants in boosting agricultural output was elucidated by Shimelis (2016) and Shimelis (2017). There has been evidence regarding the usefulness of birds to humans basing the argument on the role played by birds as parts of the natural process forces which determine the plant species composition and physiognomy of the vegetation in ecosystems such as forests. The argument for birds cites the roles they play in plant seed germination and dispersal which granivorous and frugivorous birds do; them being critical for successful

pollination of many plant species which is the role played by nectarivorous species and their ability to regulate the population sizes of herbivorous insect and other species which otherwise may turn in to pests and inhibit plant multiplication and growth if not for regulatory effects of insectivorous and other predatory birds (Bleher and Bohning-Gaese, 2006, Pejchar *et al.*, 2008 Shimelis, 2008, Shimelis *et al.*, 2014). Such roles explain the significant numerical and functional responses of birds both at the population and community scales to plant species

diversity and structural complexities of the vegetation (Shimelis, 2008, Gove *et al.*, 2008, Shimelis *et al.*, 2013, Shimelis *et al.*, 2014,. It is the dictation of mathematical functions that any unknown on both sides of an equation is derivable provided that on both sides of an equation the rest of the variables are known. This means what is a predictor in a certain equation can also be the response variable. This leads us to interpretation of results such as in Shimelis *et al.* (2013) in which bird diversity was a function of forest cover as the latter is also a result of bird diversity. Such responses can be taken as evidences of the regulatory effects of birds on various aspects of the vegetation in a given ecosystem.

If there are such interactive relationships between particularly indigenous birds and also the vegetation it is imperative to ask and answer the question whether some attribute of the indigenous bird community in Ethiopia also is responsible for variations in agricultural output.

The paper's objective is determining the functions and services of birds that are of values of great magnitude to humans. This I believe helps to convince policy makers and the wider public regarding the vital role of birds which is beneficial to humans to justify money spent on researching and conserving them.

The paper's focus is testing a hypothesis which asserts bird guilds with significant direct and indirect interactions with plants predict significantly and positively patterns in percent agricultural output across broadly different agro-climatic zones in Ethiopia and this is so because of their effects on forests. For this purpose published material was used

to glean meta data on agricultural output, forest cover and number of indigenous species in four important guilds namely granivores, frugivores, insectivores and raptors for a modeling exercise as part of the effort to explain agricultural productivity across the country.

Methods

Study Area

The whole country Ethiopia is the subject of this study. Ethiopia has diverse agro-climatic zones that are responsible for biodiversity assemblages with global (Williams *et al.*, 2004) and local conservation significance (Vergendhill *et al.*, 2012, Shimelis *et al.*, 1996, EWNHS, 2001). Meittemeir *et al.* (2004) recognize two broad concentrations of biota in Ethiopia on the basis of altitudinal divisions. This refers to two globally important hotspots within the confines of the highland and lowland ecological zones. Along these two divisions the current analyses proceeded.

Field notes on the distributions of the bird species in the guilds considered that was used in the two important bird area publications (Shimelis *et al.*, 1996, EWNHS, 2001) that included 73 sites were browsed for species that occurred at a minimum of 50 % of the IBAs surveyed through an extensive ornithological field work in most parts of Ethiopia and used to generate the total number of species that are found in various pristine ecosystems in the lowlands and highlands and also habitats where humans undergone modifications within the two categories. Data on forest cover was gleaned from what was published to delimit the area coverage of Important Bird Areas (Shimelis *et al.*, 1996, EWNHS, 2001). Percent agriculture output was extracted from Ehui *et al.*

(2001) and approximated for places in the two broad categories of agro-climatic zones. These two types of data were used in simple linear regression modeling activities by classifying birds in to the four guilds considered most directly important for agricultural production.

Results

Responses of Agriculture to Diversity of Indigenous Bird Guilds

Figure 1 depicts the significant positive ($P < 0.01$) relationship between the total number of granivore birds per agro-climatic zone and the percent agricultural output within such zones. The best fit line of the simple regression model explained 100 % of the variations observed in the response variable indicating that granivore birds may have a lot to do with agriculture in terms of positive role in Ethiopia.

Depicted in Figure 2 is the significant ($P < 0.01$) positive relationship of frugivore indigenous birds with agricultural output across agro-climatic

zones. As the best fit line of this particular simple regression model explained 100 % of the variations observed in agricultural output one can seriously consider frugivore birds as a collection of species that may have a significant role in boosting agricultural productivity.

As indicated in Figure 3, the indigenous insectivore bird guild also played a significant ($P < 0.01$) positive role in determining the magnitude of percent agricultural output across agro-climatic zones. This relationship is further verified by the fact that the best fit line of the simple regression model here explained 100 % of the variation in the observed data set of agricultural output.

Figure 4 shows that diversity of indigenous raptors does also affect percent productivity of agriculture significantly ($P < 0.01$) and positively. The best fit line of the simple regression model represented 100 % of the observations on agricultural output across the agro-climatic zones.

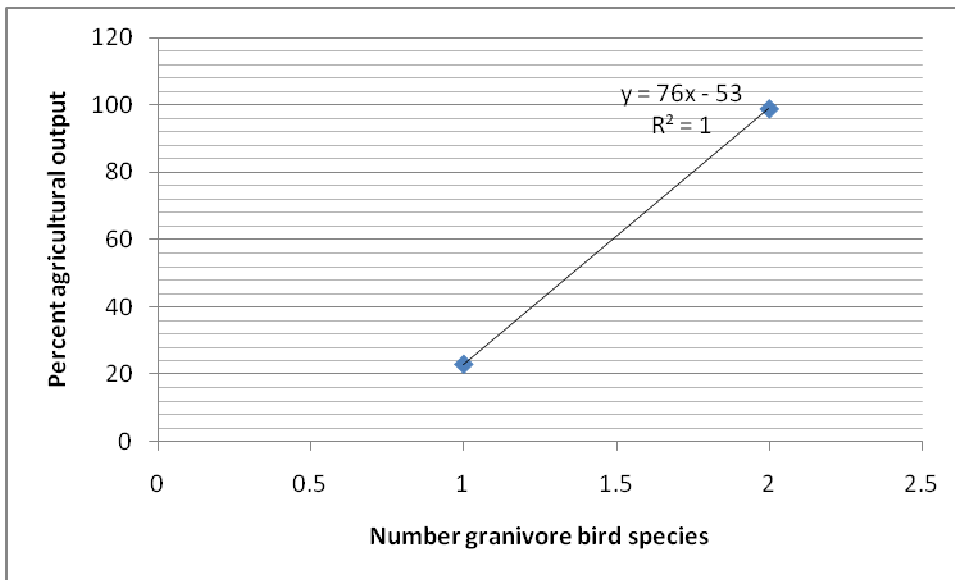


Figure 1: Relationship of percent agriculture output with the diversity of granivore birds across agro-ecological zones

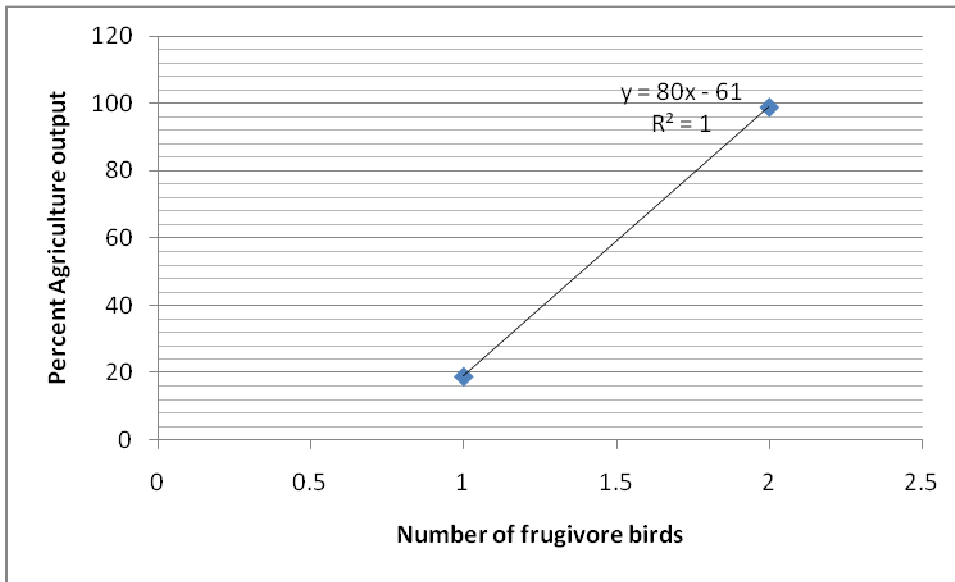


Figure 2: The explanatory value of diversity of frugivore birds to percent agricultural output across agro-ecological zones

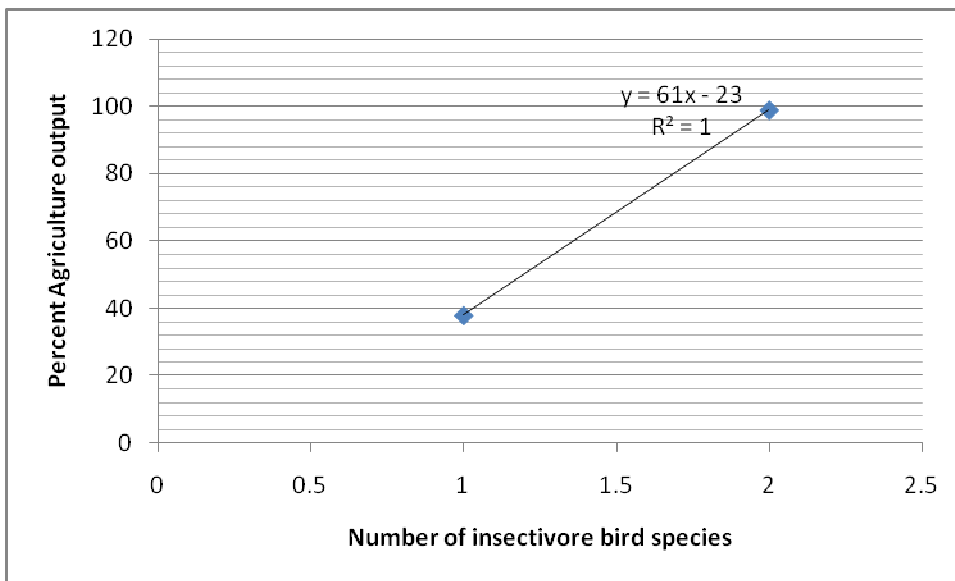


Figure 3: Linear relationship between the diversity of insectivore birds and agricultural output

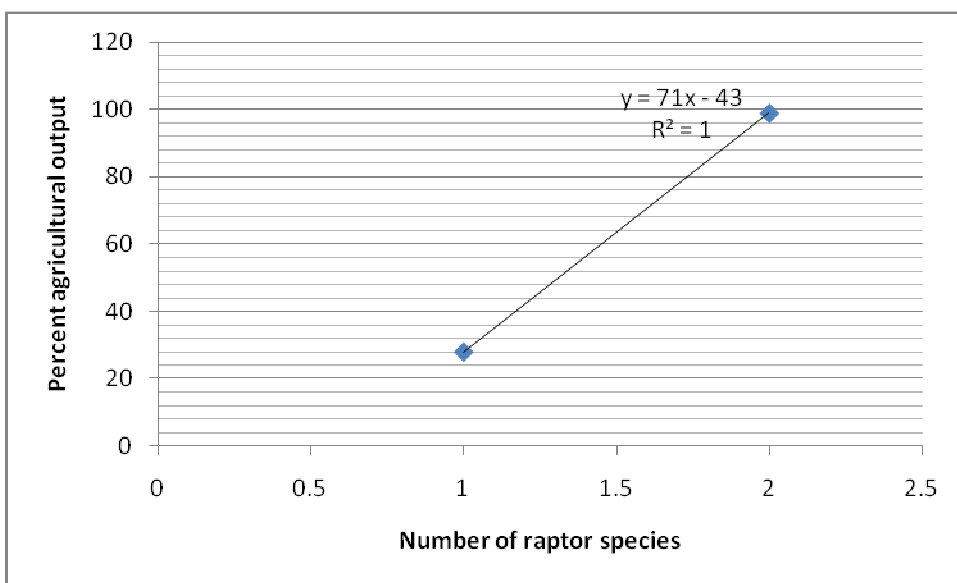


Figure 4: The effect of diversity of raptors on agricultural output across agro-climatic zones

Response of Percent Forest Cover to Diversities Indigenous Bird Guilds

As indicated in figure 5 the diversity of granivorous birds played a significant ($P < 0.01$) positive role in determining the spatial coverage of wet afro-montane forests across the agro-climatic zones of Ethiopia. The best fit line of the model explained 100% of the variations in forest extent.

Figure 6 also shows explanatory value of diversity of frugivore bird species to the spatial extent of forest cover across the agro-climatic zones. As the diversity of fruit eating birds increased there was also significant ($P < 0.01$) increase in forest cover. The

best fit line in the simple regression model explained 100% of the variations in the observed data set.

As depicted in Figure 7 the forest spatial cover in the agro-climatic zones increased along an increasing gradient of diversity of insectivore bird species. This relationship was statistically significant ($P < 0.01$). The model's best fit explained 100% of the variations in the data set.

Figure 8 shows raptors are also important predictors of forest cover across the agro-climatic zones of Ethiopia. As raptor species richness increased it had a significant ($P < 0.01$) increasing effect on percent forest cover.

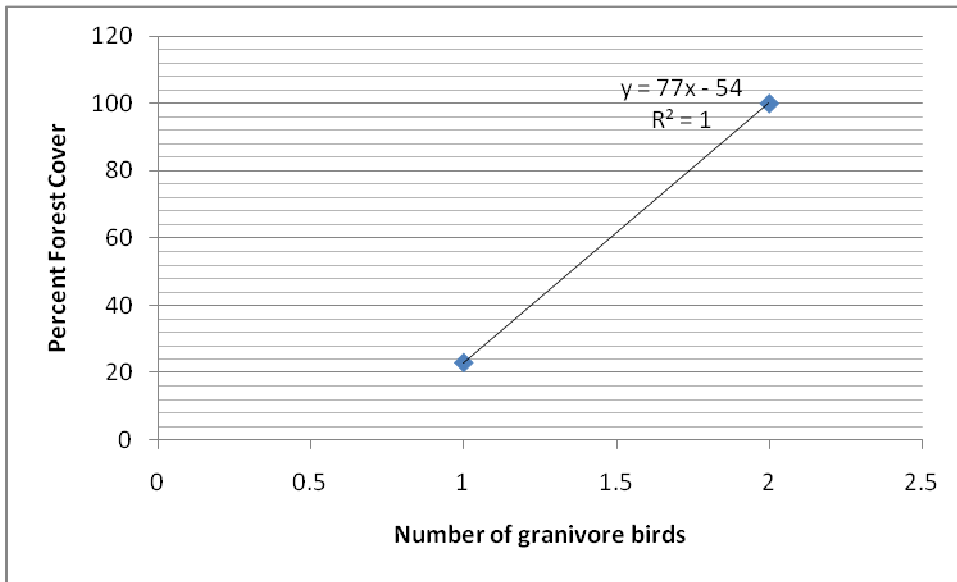


Figure 5: The positive effect of diversity of the granivore birds on percent forest cover

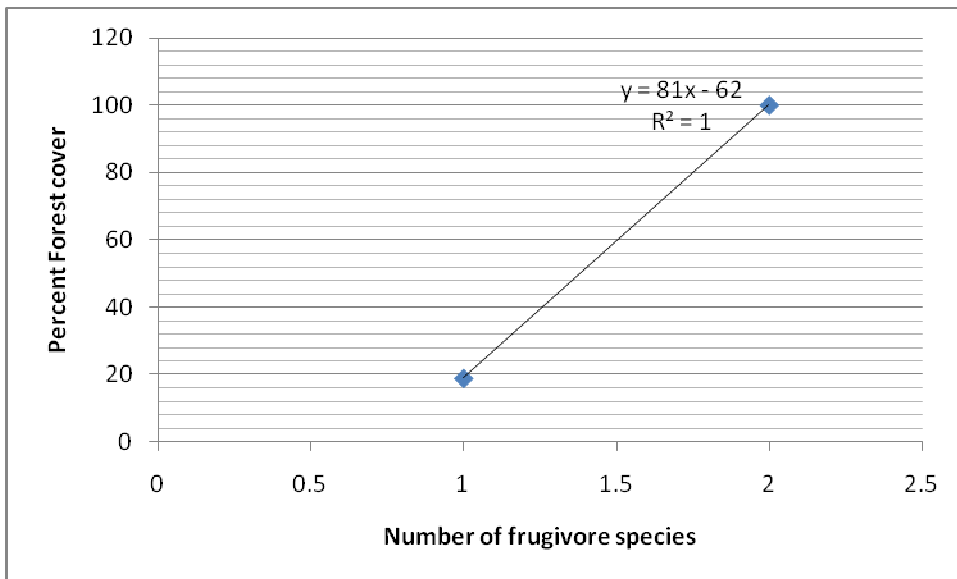


Figure 6: Positive relationship between diversity of frugivore bird species and percent forest cover

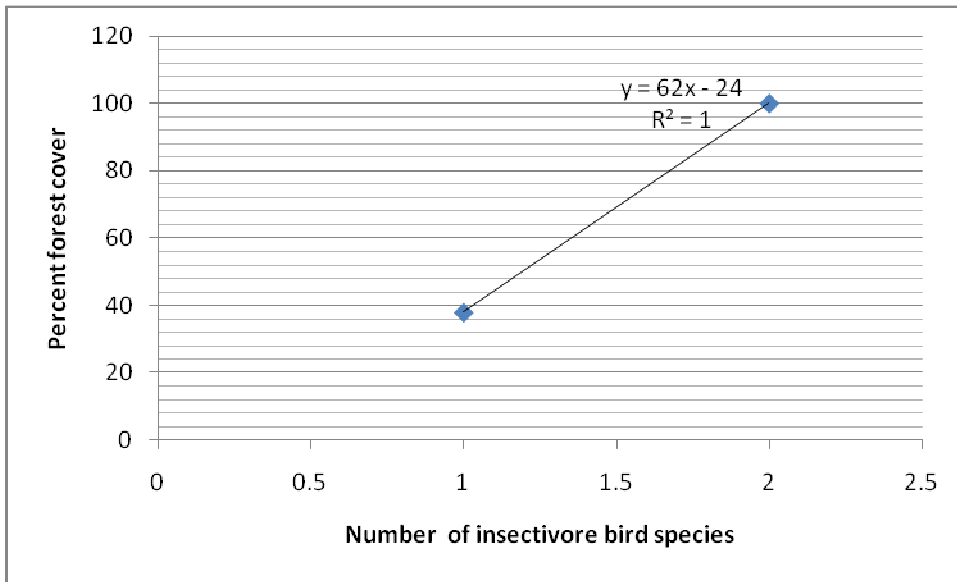


Figure 7: The response of percent forest cover to the diversity of insectivore birds

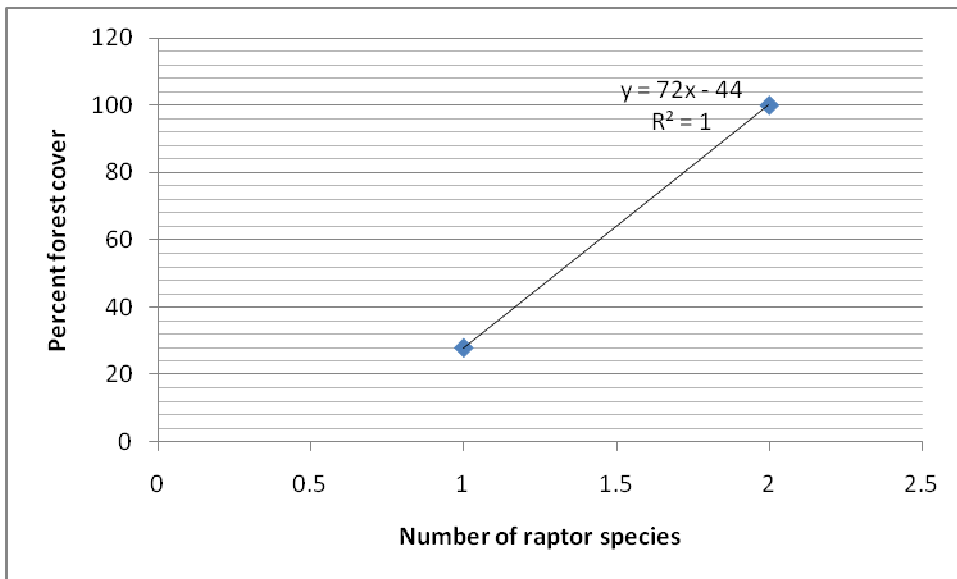


Figure 8: The effect of diversity of the indigenous raptor guild on forest cover

Discussion

Forest cover that is in fact to a large extent an attribute of the plant constituents was depicted as a very important predictor of agricultural productivity (Shimelis, 2016; Shimelis, 2017). Despite the fact that the role of plant constituents of forests in such models were indisputable it has been very

hard to ignore other components of such ecosystems such as birds about the role of which in shaping nature where they occur substantial evidence published in the ornithological literature (Bleher and Bohning-Gaese, 2006, Pejchar *et al.*, 2008; Shimelis 2008; Shimelis *et al.*, 2014). Birds are known to have very useful roles in plant seed germination,

seed dispersal, pollination and also regulation of insect and other prey populations that may inhibit plant growth and spatio-temporal expansions of plants would not have been possible if not for the population controlling role played by birds. Birds in fact responded both numerically and functionally to ecosystem constituents at lower trophic layers (Shimelis 2008, Shimelis *et al.* 2014_a where organisms that affect the vegetation are known to occur and also evidence at the community scale by way of depicting species richness responses (Shimelis *et al.*, 2013, Shimelis *et al.*, 2014_{b,c}, Gove *et al.*, 2008) which represented the number of consumers that determines the magnitude of consumption can be correctly taken as evidence of the regulatory role birds are playing in nature. More importantly birds were shown as a group or a single population significantly responsive to the floral composition and also structure (Shimelis and Assefa, 2007; Shimelis, 2015).

Such evidences led one to think that birds may also have significant positive relationship with agricultural productivity like the plant constituents of ecosystems such as forests. With such an idea in mind preliminary study on the relationship of indigenous bird guild diversity and agricultural productivity of agro-climatic zones of Ethiopia were explored and modeled and the results showed there is significant positive relationships with all the guilds considered. Such a result may indicate bird based processes are also with other factors are naturally important to boost agricultural productivity and also the fact that birds were and still are important players in the maintenance of wild populations of various plant and animal

inputs of agriculture through a complex web of interactions creating an enabling environment in which humans saw the direct consumptive values of a certain portion of biodiversity to domesticate and farm in Ethiopia as they were doing since time immemorial.

This in fact was proven by results in this paper which showed birds significantly and positively affect forests indicating there are very important ecological roles of birds beyond and equivalent to what they may do in farmsteads. Thus birds positively affect agriculture in to two broad ways. In what they do within the pristine landscapes such as forests and also their interactive roles in the farmsteads as well.

In any case the evidence evaluated and presented in this paper is indicative of one very important economic value of birds and it is useful to justify money spent on the conservation of birds which may boost productivity at least in one human economic sector if such a case is studied and applied carefully at appropriate spatial and temporal scenarios.

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