International Research Journal of Natural and Applied Sciences
Vol. 3, Issue 8, August 2016 IF- 3.827 ISSN: (2349-4077)
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Website: www.aarf.asia Email : editor@aarf.asia , editoraarf@gmail.com

ECONOMICS OF CLIMATE CHANGE PERCEPTION AND ADAPTATION AMONG CROP FARMERS IN OGUN STATE, NIGERIA

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ABSTRACT

Nigeria has been recognized as a country in Sub Saharan Africa which is very susceptible to climate change. It is possibly, the level of perception that determines the approaches to be engaged in abating the impacts of climate discrepancies.The study therefore examined the economics of climate change perception and adaptation among crop farmers in Ogun state, Nigeria. A multistage random sampling technique was employed in selecting 177 crop farmers. Data collected were analyzed using descriptive statistics and Heckman's two-step model.

The descriptive statistics was used to analyse the crop farmers' socio-economics characteristics in the study area, it was observed that 46% of the sampled respondents are still in their active working age. Majority of the respondents were married and crop production in the study area was dominated by men. However, greater share of the sampled households in the study area were educated. In order to adapt to climate change, the analysis of the Heckman's two-step model revealed that 9 variables (gender, education, farming experience, household size, farm size, access to extension services, awareness of climate change, access to adaptation measures and age) significantly determined whether crop farmers perceive climate change while7 variables (education, farming experience, farm size, access to extension services, awareness of climate change, average monthly farm income and age) were directly proportional to climate change adaptation level. The study therefore, recommends training of extension workers, awareness campaign, farmers' adult education programme and farm income expansion policy.

Keywords: climate change, Heckman, perception, adaptation strategies

INTRODUCTION

Climate change can be considered as one of the most serious threats to sustainable development, with adverse impacts expected particularly on human health, food security, economic activity, water resources and other natural variations, but scientists agree that increased anthropogenic greenhouse gas concentrations in the atmosphere are the causes (ECA, 2006; Huq et al., 2006; Adebayo et al. 2012; Adeloye and Sotomi, 2013).

Nigeria has been recognized as a country in Sub Saharan Africa which is very susceptible to climate change (IPCC, 2007; BNRCC, 2008). This is due to the fact that majority of the countries' population partake in agriculture as their primary occupation and agriculture in the country is mainly rain fed. The rain-fed agriculture practiced and fishing activities from which two -third of the Nigerian population depend primarily on foods and livelihoods are also under serious threat besides the high population pressures of 140 million people surviving on the physical environment through various activities within an area of 923,000 square kilometers (NEST 2004; IPCC 2007; Oluwatayo et al., 2008).

Food production will be adversely affected by the variability in timing and amount of rainfall and heat stress and the consequence is an increase in food shortages and many farmers could lose their sources of livelihood due to climate change. Benhin (2006); Mano and Nhemachena (2006); Seo and Mendelsohn (2006) observed that climate attributes (temperature and precipitation) affect net farm revenue and such impacts can be significantly reduced through adaptation. There are diverse methods of adapting to climate change in agriculture (Bradshaw et al., 2004; Mertz et al., 2009 cited in Fatuase and Ajibefun, 2013) and various agricultural adaptation alternatives have been recommended in literatures(Gbetibouo, 2009). Moreover, diverse issues affect the usage of any of these adaptation approaches (Nhemachena and Hassan, 2007; Hassan and Nhemachena, 2008 and Deressa et al., 2011). According to Bradshaw et al., (2004) it was noted that crop diversification, mixed crop-livestock farming systems, using different crop varieties, changing planting and harvesting dates,and mixing less productive, drought-resistant varieties and high-yield watersensitive crops are essential adaptation alternatives in the agricultural province.

Ajadi et al., 2011, reported that people make decisions in their environment not the way the environment is but the way they perceive it. He also noted that the perceptions of farmers have the tendency of inducing their coping strategies which eventually determine the

degree to which climate impacts agriculture. The issue of perception of climate change is particularly important considering the fact that agriculture constitutes the mainstay of about 60-70% of the Nigerian populace (Apata et al., 2009). It is perhaps, the level of perception that determines the approaches to be engaged in abating the impacts of climate discrepancies. This study therefore seeks to provide necessary information on theeconomics of climate change perception and adaptation as evident among farming households in Ogun state of Nigeria. The specific objectives are to: identify the socio-economic characteristics of crop farmers; evaluate the level of awareness and perception of crop farmers to climate change; identify various adaptation strategies adopted by farmers to climate change and examine the determinants of farmers' level of perception and adaptation to climate change.

METHODOLOGY

The study was carried out in Ogun State of Nigeria. Ogun State is located in the South Western part of Nigeria. It is bounded in the west by the Republic of Benin, in the east by Ondo State, in the south by Lagos State and in the north by Osun and Oyo States. It lies within latitude 6^{o}N and 8^{o}N and longitude 2^{o}E and 5^{o}E. It has a land area of about 16,762 square kilometers and a population of about 3,728,098 (NPC, 2006), which is approximately 2.70 percent of Nigeria's population (NBS, 2007). Farming is the major occupation of the people, particularly those living in the rural areas. The climate favours the production of arable crops such as maize, yam, cassava, rice, cocoyam and tree crops like kola nuts, cashew and oil-palm. Administratively, the state is divided into four divisions which include, Egba, Ijebu, Yewa and Remo. In all there are twenty local government areas in the state.

Method of data collection

Primary data were collected and used for analysis in this study. Structured questionnaire and oral interviews were used to obtain information on socio-economic characteristics of farmers, climate change variables and coping strategies adopted by households in the study area. A multi-stage random sampling technique was used for the study. The first stage involved the random selection of four (4) Local Government Areas. In each selected local Government Area, five (5) communities/villages were randomly selected. Lastly, ten (10) farmers involved in plantain production were randomly selected from each community. Thus a total of two hundred (200) respondents constituted the sample size for the study. Out of 200 questionnaires served to the selected households, a total of 177 questionnaires were retrieved and useful for analysis.

Methods of data analysis

The study makes use of descriptive statistics such as frequencies, percentage and mean in general description of respondents' socio-economic characteristics, perception of climate change and adaptation strategies adopted by the farmers. While Heckman's two-step procedure was used to identify and analyse the determinants of respondents' perception and adaptation to climate change.

Heckman Two Step Procedure

Adaptation to climate change is a two-stage process involving perception and adaptation stages. Following Tesso et al., (2012) two equations are involved. The first stage is whether the respondent perceive that there is climate change or not, and the second stage is whether the respondent adapt to climate change depending on the first stage that he/she has perceived climate change. Because the second stage of adaptation is a sub-sample of the first stage, it is likely that our second stage subsample is non-random and different from those who did not perceive climate change creating sample selection bias. This study, therefore, used the well-known maximum likelihood Heckman's two-step procedure (Heckman, 1976) to correct for this selectivity bias.

Tesso et al., (2012) also noted that the first stage is referred to as sample selection equation while the second one is the latent regression equation. In equation 1 perception is used as the dependent variable while the explanatory variables are socio-demographic and environmental factors based on a literature review of factors affecting the awareness of farmers to climate change or risk perceptions. These are; age, education, farming experience, access to adaptation measures, gender, marital status, household size, farm size, access to extension service, access to credit, awareness of climate change, average monthly farm income and off farm income. Respondents were grouped into two categories based on whether they perceive climate change in the right direction or not. Those that perceive climate change in the right direction (that is, those whose perceptions tally with records of weather monitoring stations in the study area) were grouped as 'perceived' and scored one (1) while those with wrong description and unable to perceive climate change were grouped as 'not-perceived' and awarded zero (0). Hence probit model stated below was used to analyse perception to climate change:

$\Pr(\varphi i = {}^{1}/_{T}, \alpha) = Ø\,[h(T_i, \alpha)] + U_{1i}$ ---------- eqn 1

Where;

φ_i is the latent level of utility an household i gets from the climate change perception.

T_i is the vector of independent variable.

α vector of coefficients to be estimated.

$U_1$is the error term.

Ø is standard normal cumulative distribution function

The latent regression equation which is referred to as adaptation to climate change model was conditioned on the sample selection equation to cater for the determinants of adaptation strategies to climate change. The model is stated as follows:

$$E(Y_i/_{\varphi i} = 1) = f(x_i, \beta) + \gamma i \frac{Ø(Ti\delta)}{Ø(Ti\delta)} \text{ ---------- eqn 2}$$

Where;

E= expectation of taking adaptive measures

Y_i = the (continuous) extent of adaptation to climate change

γ_i= extent to adaptation to climate change

x_i= vector of explanatory variables

β= vector of coefficient to be estimated

φ= normal probability density function

Other variables are earlier defined.

From equation 1, γ was estimated using φi and $T_i$from whole sample and the inverse mills ratio λ was computed using equation 3 below;

$$\frac{Ø(Ti\delta)}{Ø(Ti\delta)} = \lambda \text{ ---------- eqn 3}$$

$$\gamma_i = \lambda_i(\lambda_i - T_i\delta) \text{ ---------- eqn 4}$$

Substituting equation 3 into equation 2 we have;

$$Y_i^* = X'_j \beta + \gamma_i \lambda + U_{2j} \text{ ---------- eqn 5}$$

X'_j is K vector of independent variables (age, education, farming experience, access to adaptation measures, gender, marital status, household size, farm size, access to extension service, access to credit, awareness of climate change, average monthly farm income and off farm income.)

Y_i* is the dependent variable. This is the proportion of adaptation measures adopted by farmer i.

U_{2j} is the error term and other variables are as earlier defined.

In the study area eleven (11) different types of adaptation measures were adopted by respondents. Farmers were scored between 0 and 1 based on the proportion of measures

adopted. Using the Heckman procedure in STATA, full maximum likelihood method was used to estimate equations 1 and 5 jointly.

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

Table 1 shows the summary statistics of some socio-economic variables in the study area. The distribution of respondents by gender shows that about 67 percent of the household heads surveyed are males while about 33 percent are females. The dominance of the male counterparts may be attributed to the labourious nature of farming in the area whereby most of the farming operations are carried out manually using crude farm implements. In such condition, males may be more able to endure the hectic and energy dispelling nature of farming. However, about 88 percent of the respondents are between the ages of 41 and 60. 3 percent is less than 41 years while about 8 percent of them are over 60 years of age. This implies that about 46 percent of the sampled respondents are still in their active working age which is between 30 and 50 years. The mean age of the respondents is 52 years. The result further indicated that majority of the respondents (about 83 percent) were married. One of the most important factors affecting the level of production and productivity on peasant farms is the composition and size of farming family. Married farmers are likely to be under pressure to produce more, not for family consumption but also for sale. The desire to produce more could lead to agricultural information seeking and use. Respondents which are single, divorced and widowed constitute the remaining 17 percent.

A higher level of education is associated with greater access to information on climate change, improved technologies and higher productivity. The distribution of households by level of formal education reveals that over 92 percent of the household heads sampled are educated up to tertiary level while the remaining 8 percent had no formal education. Moreover, majority (about 56 percent) of the respondents had polytechnic. This shows that greater share of the sampled households in the study area were educated and would therefore be able to comprehend the complexities of farming and climate change better.Households having between 6 and 10 members take the greatest portion (48 percent) while households with 11-15 persons, 16-20 persons and 21 members and above represent 12%, 5% and 3% respectively. The mean household size is about 8 members with the number of adults in the farming households taking a greater proportion. It has however been noted that households with greater members are more likely to have available labour compared to households with

fewer members (Aigbogun, 2009). Hence, household size as a proxy tolabour availability reduces labour constraints.

The study further revealed that 77 percent of the respondents make use of hired labour while only 23 percent do not. A greater proportion of 84 percent is also discovered to be using family labour while only about 16 percent of sampled households do not make use of family labour. It was also revealed that about 76 percent of the farmers had access to extension facility while about 24 percent did not have access. This could imply that a greater proportion of the sampled respondents would have information as regards climate change measures to be taken to mitigate against its impacts on livelihood. As further revealed, about 57 percent of the respondents had access to credit facility while 43 percent did not have access. Access to credit is expected to enhance the farmers' capacities to effectively cope with climate change.

Table 1: Distribution of farmers' socioeconomic characteristics

Characteristics	Frequency	Percentage
Sex		
Male	118	66.67
Female	59	33.33
Age (Years)		
31-40	6	3.40
41-50	77	43.50
51-60	79	44.63
Above 60	15	8.47
Mean age 52, Std. dev. (6.34)	Min (32)	Max (68)
Maritalstatus		
Single	7	3.95
Married	147	83.05
Divorce/ separation	7	3.95
widowed	16	9.05
Educational level		
No formal education	14	7.91
Primary education	20	11.30
Secondary education	29	16.38
Polytechnic education	99	55.93
Tertiary education	15	8.48
Household size		
1-5 persons	55	31.07
6 – 10 persons	85	48.02
11- 15 persons	22	12.43
16 – 20 persons	9	5.08
21 and above	6	3.40
Other Socio-economic attributes	**Yes**	**No**
Use of hired labour	136 (76.84)	41 (23.16)
Use of family labour	149 (84.18)	28 (15.82)

Access to extension facility	134 (75.70)	43 (24.30)
Access to credit facility	101 (57.06)	76 (42.94)

Source: Field survey, 2015

Awareness and Perceptions of Climate Change by Respondents

Perceptions of Climate Change by Farmers

An essential criterion for adaptation is perception. Respondents were asked about their perception on climate change over the last five years. The elements of climate that farmers commented upon include humidity, temperature, rainfall, abnormal weather andundefined season.

As presentedin table 2, variations in rainfall were experienced by up to 21.49 percent of the sampled respondents.Extremely high temperature was perceived by 33.33 percent of the respondents while 3.95 percent noticed extremely low temperature. Also 7.34 percent noticed change in climatic condition as high humidity while 2.82 percent observed low humidity. 45 farmers constituting about 25.42 percent perceived undefined season and 5.65 percent of them perceived abnormal weather. As gathered from the respondents, delay in rainfall commencement and high temperatures result in stunted growth and eventual death of some young plants.

Table 2: Distribution of Farmers' perception of Climate Change

Variable	Frequency	Percentage
Increase in rainfall	12	6.78
Decrease in rainfall	20	11.33
Prolonged rainfall	3	1.69
Delayed rainfall commencement	3	1.69
Extremely high temperature	59	33.33
Extremely low temperature	7	3.95
High humidity	13	7.34
Low humidity	5	2.82
Abnormal weather	10	5.65
Undefined season	45	25.42

Source: Field survey, 2015

Awareness of Climate Change

Result on awareness of climate change by respondents as shown in Table 3 indicates that greater part (84.18%) of the respondents are aware of the threat, while 15.82% are not. This implies that majority of the respondents observed in one way or the other changes in the climatic variables which affect their agricultural activities. Farmer's awareness of changes in

climatic factors over time is important for adaptation decision making. It helps farmers reduce risk and uncertainty associated with the climate.

Table 3: Awareness of Climate Change by respondents

	Frequency	Percentage
Aware	149	84.18
Not Aware	28	15.82

Source: Field survey, 2015

Adaptation to climate change

Analysis in Table 4 presents changing of planting dates as the most adaptation strategies actually adopted by the respondents. Majority 77.40% adopted changing of planting dates followed by shading and shelter /mulching, mixed cropping, mixed farming, diversion to non-farm activities and diversion to other crops having 72.88%, 72.32%, 69.49%, 59.32% and 57.06% respectively. In addition, 48.02% and 37.29% of the respondents adopted Soil conservation techniques and irrigation as the strategies to mitigate effect of climate change. Table 4 further revealed that 22.03% adopted tree planting, 18.64% change use of chemicals, fertilizers and pesticides and the least adopted was government intervention having 12.43%.

Table 4: Distribution of respondents by adaptation strategies adopted

Adaptation Strategies	Frequency	Percentage
Diversion to other crops	101	57.06
Irrigation	66	37.29
Tree planting	39	22.03
Diversion to non-farm activities	105	59.32
Changing of planting dates	137	77.40
Mixed farming	123	69.49
Change use of chemicals, fertilizers and pesticides	33	18.64
Shading and shelter /Mulching	129	72.88
Soil conservation techniques	85	48.02
Government intervention	22	12.43
Mixed cropping	128	72.32

Source: Field survey, 2015

**Frequency based on multiple responses*

Determinants of the respondents' perception and adaptation to climate change

In the analysis using the Heckman probit model, the model was first run and tested for its appropriateness over the standard probit model. The outcome of this operation revealed the presence of a sample selection problem (that is dependence of the error terms on the outcome and selection models) hence, justifying the use of the Heckman probit model with

rho significantly different from zero (Wald= 14.72, with P = 0.001). Moreover, the likelihood function of the Heckman probit model was significant (Wald =81.44, with P<0.0001) showing a robust explanatory influence of the model. Moreover, results show that most of the explanatory variables and their marginal values are statistically significant at 1%, 5% and 10% and the signs on most variables are as expected, except for a few as explained in Table 5. The calculated marginal effects measure the expected changes in the probability of both perception of climate change and adaptation with respect to a unit change in an independent variable.

According to the result in Table 5, out of the 13 explanatory variables, 9 variables (gender, education, farming experience, household size, farm size, access to extension services, awareness of climate change, access to adaptation measures and age) significantly affected the perception status of farmers while 4 variables (marital status, access to credit, average monthly farm income and non-farm income) were not significant. Three variables (education, gender and access to adaptation measures), three variables (access to extension service, farming experience and household size) and three variables (age, farm size and awareness of climate change) influenced the farmers' perception status at 1%, 5% and 10% level of significances respectively.

Variables that positively and significantly influence perception status of the farmers to climate change include education, farming experience, household size, access to extension services, awareness of climate change, access to adaptation measures and age. On the other hand, gender and farm size were negative and significant related. The implications of this result is that higher likelihood of perceiving climate change with increasing age of the farmers are associated with experience which lets farmers observe changes over time and compare such changes with current climatic conditions. The marginal effect reveals that a year increase in farmers' age translates into an 11% increase in the probability of such household perception of climate change. According to Maddison, 2006; Ishaya and Abaje, 2008, Deressa et al., 2009 cited in Temidayo G. A. (2011), it was observed that experienced farmers have a higher probability of perceiving climate change as they are exposed to past and present climatic conditions. Thus, perception of climate change is directly proportional to the age of the farmers and that older respondents are more efficient in perceiving climate change than the younger respondents.

Gender result shows that the household head being male implies a 42% reduction in the probability of farming household perception of climate change. It was observed that

perception of climate change is indirectly proportional to gender. This implies that females perceive climate change more compared to males. Information on climate change through extension service and awareness of climate change increase the likelihood of climate change perception as they play an important role in the availability and flow of information.

Educational level of farmers also plays a good role in perceiving change in climatic conditions. It was indicated in Table 5that there is direct relationship between education and ability to know whether climate has changed or not. This implies that farmer's perception of climate change increases with more education. In addition, the positive coefficient of farming experience implies that experienced farmers perceive change in climate better than the inexperienced ones. Furthermore, increasing household size increases the likelihood of farmers' perception of climate change by 31%. Farm size had negative relationship to farmers' perception of climate change by 7% decrease. In other words, it is not the size of the farm, but the specific characteristics of the farm that dictate the way the farmers perceive climate change.

Table 5 also shows that out of the 13 explanatory variables, 7 variables (education, farming experience, farm size, access to extension services, awareness of climate change, average monthly farm income and age) were directly proportional to climate change adaptation level while 6 variables (household size, gender, marital status, access to credit, access to adaptation measures and non-farm income) were not significant. Three variables (farm size, access to extension service and average monthly farm income) and four variables (education, farming experience, age and awareness of climate change) influenced the farmers' adaptation to climate change at 1% and 10% level of significances respectively.

The determinants of adaption to climate change as shown in Table 5 implies that as a farmer grows older, his/her level of adaptation to change in climate improves. Farmers adopt more adaptation strategies as their age increases. The positive sign on the coefficient of education indicates that education encourages farmers to adopt measures that would allow them to adapt to changes in climatic conditions. The effect of experience on adoption of climate change adaptation strategies implies that the probability of adoption of climate change adaptation strategies increases with increase inlevel of farming experience. The result corroborates findings from Okpe B.E. and Aye G.C. (2015) which show that older farmers are more likely to adopt climate adoption strategies since age indexes experience. Increase in average income also encourages and empowers farmers to adopt more measures to curtail the menace of climate change. Moreover, Deressa (2009) reported that most of the problems or

constraints encountered by farmers in adaptation to climate change are associated with poverty. As expected, the likelihood of perception of climate change is positively related to age, farm income and information on climate. Increasing the age of household head by one unit increases the probability of perceiving change in climate by 0.4% whereas increasing farm income by one unit increases perception by 0.13% (Deressa, 2009). In addition, the result indicates that farmers with large farm size would take up more adaptation strategies when compared to farmers with small farm size. Access to information on farming and climate change through extension services would enhance farmers' adaptation to changes in climatic conditions.

Table 5: Heckman's results for determinants of the respondents' perception and adaptation to climate change

Explanatory Variables	Selection Model		Adaptation Model	
	Marginal values		Marginal values	
	Coefficients	Standard Error	Coefficients	Standard Error
Education	0.421***	0.103	0.203**	0.101
Gender	-0.387***	0.089	0.886	1.23
Marital status	-0.0954	0.059	0.153	0.114
Farming experience	1.653**	0.832	1.742**	0.810
Age	0.112*	0.066	0.203**	0.101
Household size	0.314**	0.133	0.130	0.156
Farm size	-0.074*	0.041	0.664***	0.204
Access to credit	1.336	1.357	0.599	1.273
Awareness of climate change	0.119*	0.070	2.532**	1.141
Access to adaptation measures	0.584***	0.117	0.293	0.123
Access to extension service	0.436**	0.156	0.397***	0.133
Average monthly farm income	0.760	0.931	0.427***	0.114
Average monthly off farm income	-0.197	0.296	0.725	2.44

Source: Field survey, 2014.

*** = Significant at p<0.01, ** = Significant at p<0.005, * Significant at p<0.001, Wald Chi square (zero slopes) 81.44*P* =0.0001,Wald Chi square (independent equations) 14.72*P* = 0.001.

Conclusion

From the overwhelming findings conveyed by the data in this study, it can be concluded that majority of the farmers are now aware of variations in the climatic conditions

and how it affects their farm produce. The study shows therefore, that the knowledge and perception of farmers about climate change influences their coping strategies. The strategies engaged by the farmers include; changing of planting dates, shading and shelter /mulching, mixed cropping, mixed farming, diversion to non-farm activities, diversion to other crops, soil conservation techniques, irrigation, tree planting, change use of chemicals, fertilizers and pesticides and government intervention. Heckman's two-step procedure was used to identify the determinants of respondents' perception and adaptation to climate change. The analysis revealed that 9 variables (gender, education, farming experience, household size, farm size, access to extension services, awareness of climate change, access to adaptation measures and age) significantly affected the perception status of the farmers while 7 variables (education, farming experience, farm size, access to extension services, awareness of climate change, average monthly farm income and age) were directly proportional to climate change adaptation level.

Furthermore, from the results of the descriptive statistics used to analyse the crop farmers' socio-economics characteristics in the study area, it was observed that 46 percent of the sampled respondents are still in their active working age which is between 30 and 50 years. Majority of the respondents were married and crop production in the study area was dominated by men. The meanhousehold size was 8 persons. However, greater share of the sampled households in the study area were educated and would therefore be able to comprehend the complexities of farming and climate change better. 84 percent is also discovered to be using family labour. In addition, 76 percent of the farmers had access to extension facility. This could imply that a greater proportion of the sampled respondents would have information as regards climate change measures to be taken to mitigate against its impacts on livelihood. As further revealed, about 57 percent of the respondents had access to credit facility. Access to credit is expected to enhance the farmers' capacities to effectively cope with climate change in the study area.

Recommendations

The following recommendations are proffered;

- ✓ Farmers' adult education / enlightenment workshops are needed to provide information on the adaptation strategies. This recommendation flows from the significance of the age which rules them out of regular schools, and from the positive effect of education and farming experience on adoption. The workshops should be

designed to sensitize the farmers on the effect of climatic changes and global warming and how it could affect food production.

- ✓ The extension workers should be trained on complexities of climate change and their services should be made available to farmers. In other words there is need to reinforce the extension service delivery towards climate change adaptation strategies rather than the usual role of extending information on the new varieties and technologies.
- ✓ Farm income expansion policy is required. Expansion in farm income will translate into increase adaptation level. This could have a multiplier effect especially on the output and subsequently on farm income.
- ✓ There is also need for severe awareness campaigns to enhance the adoption of the strategies since this variable has a direct relationship with climate change adaptation level.

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