Do Leader and Organizational Characteristics Affect Scientist's Productivity?

A Multilevel Analysis of Nigerian Agricultural Research System

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Poster prepared for presentation at the Agricultural & Applied Economics Association's 2011 AAEA & NAREA Joint Annual Meeting, Pittsburgh, Pennsylvania, July 24-26, 2011

Abstract

Organizations offer employees with opportunities to cultivate their innovativeness and facilitate greater productivity. In this paper we analyze preconditions for individual productivity of agricultural researchers in Nigeria, measured in terms of the self-reported number of scholarly publications and technologies produced; presence of external collaborators; number of dissemination events for publications produced; and perceived adoption level of technologies developed. It utilizes a multilevel analysis to systematically examine what characteristics of individual scientists and organizations promote greater individual productivity. The statistically significant random-effect estimates show that there is considerable variance across the 47 organizations after adjusting for the effects of differences in individual characteristics. Moreover, several measures of organizational characteristics are statistically significant in explaining variations in individual productivity. This paper contributes to limited studies that systematically analyze the influence of organizational factors and the organization head’s characteristics on individual researcher’s performance.

Keywords: organizational culture, multilevel analysis, poisson, productivity, research, motivation

1. Introduction

Improvement of agricultural productivity is crucial for food security and poverty reduction (World Bank 2007). Crop yields in many developing countries, especially in sub-Saharan Africa, remain a small fraction of what the rest of the world achieves, for example, maize and rice yields are less than 30 percent of average yields in the world (You and Johnson 2008). Both technical and institutional innovations in production, marketing, and policy processes are important to close the yield gap and achieve greater agricultural productivity. Agricultural researchers and their organizations play a vital role as innovators and partners of other key actors within the innovation systems. Despite various attempts by the Consultative Group for International Agricultural Research (CGIAR) and other international organizations to strengthen the capacity of researchers and their organizations in many developing countries, various studies find that their productivity and impact remain low (Eicher 2001, 2004; IAC 2004; Clark 2005). This paper aims to provide a better understanding of factors contributing to limited productivity and impact of agricultural researchers and research organizations.

In other sectors, various studies have analyzed the factors affecting researcher's outputs, productivity, and efficiency (see Gulbrandsen and Smeby 2005; Gonzalez-Brambila and Veloso 2007; Manjarres-Henriquez 2009; Abramo et al. 2009; Ponomariov and Boardman 2010; Costas, van Leeuwen, and Bordons 2010 for more recent studies). Commonly significant individual characteristics include age, square of age, gender, education, discipline, experience, square of experience, position or job classification, linkages and affiliations, and reputation. Female researchers tend to publish less than male researchers (Gonzalez-Brambila and Veloso 2007; Turner and Mairesse 2003; Xie and Shauman 1998; Long 1992; Cole and Zuckerman 1984). Only Ponomariov and Boardman (2010) find that gender is not significant in determining the research output. Gonzalez-Brambila and Veloso (2007) find a quadratic relationship between age and the number of publications of a researcher; while Costas and van Leeuwen (2010) shows that top-publishing scientists in the Spanish National Research Council are the youngest with each professional category. Gonzalez-Brambila and Veloso (2007) find that reputation (measured in terms of 10-year stock of publication and citations) has some impact on level of research output. Gulbrandsen and Smeby (2005) found that size, structure and source of funding receive by researchers are significant factors in explaining researchers' outputs.

Limited studies include organizational characteristics in analyzing individual productivity. Funding received by organization appears to be significant (see Gulbrandsen and Smeby 2005). Manjarres-Henriquez et al. (2009), in their study of researchers in two universities, find that the dummy for universities is not significant. Gonzalez-Brambila and Veloso (2007) use three different break points associated with three different cohorts (namely the early educated group of researchers, the middle years, and the latest educated set) and found no significant difference between the first and the latest educated and that the second cohort is slightly more productive than the latest educated. Bonaccorsi and Daraio (2003) performed an efficiency analysis using biometrics data as output and found that location and geographical agglomeration to be significant in determining research output in French institutes but not in Italian institutes. Lorenz and Lundvall (2010) show that creative employees are overpresented in business services and social and community services than in manufacturing, construction and utilities. The authors show that institutional and national context have a significant direct impact on the individual creativity at work across 27 European research organizations.

Another set of literature looks at organizational culture (OC) that affects employee satisfaction (Gregory et al. 2009); staff turnover (Stone et al. 2007); motivation of staff and managers (Moynihan and Pandey 2007); extent of knowledge sharing (Willem and Buelens 2007); organizational performance and effectiveness (Ogbonna and Harris 2000); and the diversity and nature of use of performance measure systems (Henri 2006). Various authors described and measure organizational culture or climate using slightly different categories. Marshall and McClean (1988) define it as "the collection of traditions, values, policies, beliefs and attitudes that constitute a pervasive context for everything we do and think in an organization." Quinn and Rohrbaugh (1983) developed the commonly-cited Competing Values Model, which incorporates two sets of competing values: (1) the control/flexibility dilemma which refers to preferences about structure, stability, and change; and (2) the people/organization dilemma which refers to differences in organizational focus. From these two sets emerge four combinations which reflect four types of culture (group, developmental, rational, and hierarchical) and a balanced culture, which is one where there is no dominant culture type (Henri 2006; Gregory et al. 2009) and well-favored by various authors (Quinn 1988; Yeung et al. 1991; Quinn and Spreitzer 1991; Ramanujam and Rousseau (2006); Gregory et al. 2009).

Authors such as Gregory et al. (2009), Stone et al. (2007), Moynihan and Pandey (2007), Willem and Buelens (2007), Ogbonna and Harris (2000), and Henri (2006) use a wider classification of OC combining measures of transparency, fairness, political autonomy, coherence, mobility, openness, responsiveness, flexibility, participatory leadership, adequacy of resources; and employee morale or satisfaction. Willem and Buelens (2007) use coordination mechanisms (i.e., formal systems, lateral coordination, and informal coordination), and contextual organizational variables (i.e., power games, trust, and identification). Biggs and Smith (2003) use two criteria (degree of group cohesion and degree of institutionalized rules and procedures), which yield to a stylized four-part classification of organizational cultures namely (1) hierarchical (high in group cohesiveness and high in predetermined rules); (2) fatalist (low in group cohesiveness and high in predetermined rules); (3) individualist (low in group cohesiveness and low in predetermined rules; and (4) egalitarian (high in group cohesiveness and low in predetermined rules). However, Biggs and Smith (2003) emphasize that these classifications are not to compare model or justify preferred models nor neatly put organizations into these boxes since organizations, projects or programs can contain multiple organizational culture.

Despite some differences, a common feature of studies on OC is the use individual's perceptions on OC as proxy measure for OC and authors find this perception variable as significant. Moreover, measures of OC are treated as an organizational- or institutional-level variable. While individual perception can be an indicator for organizational or institutional context, the dataset used in this paper suggest that individual perception vary within organizations and thus cannot be interpreted as "organizational- or institutional-level variable." This suggests that perception variable can be best treated as individual-level explanatory variable rather than a variable that represents organizational or institutional context. Moreover, perception On OC may be endogenous to the output or outcome model due to possible unobserved variables that affect individual's perception but not the dependent variable.

This paper aims to provide a better understanding of the systematic relationship between organizational characteristics and perception on organizational culture and that of individual researcher's productivity. This paper contributes to existing literature and fills some of the research gaps identified above through the following ways: (1) it employs a multi-level analysis that differentiates individual versus organization-level factors; (2) it differentiates proxies for capacity versus measures of motivation as explanatory variables; (3) it goes beyond usual measure of research output to include some proxies for research quality and effectiveness; (4) it uses individual's perception on organizational culture as individual-level explanatory variable rather than a variable that represents organizational- or institutional-level variable; and (5) it formally tests and models perception on organizational culture as endogenous to the research output model. A multilevel analysis applied to survey data on Nigerian agricultural researchers suggests that organizational characteristics systematically explain variance in individual productivity after adjusting for the effects of differences in individual characteristics.

2. Data and Methods

This paper uses survey data of 344 researchers in 47 organizations in the Nigerian agricultural research system. The survey was conducted jointly by International Food Policy Research Institute (IFPRI) and Agricultural Research Council of Nigeria (ARCN) in May to July 2010 and it covers public-sector agricultural organizations across Nigeria including research institutes (RIs); federal colleges of agriculture (FCAs), under the aegis of ARCN; and faculties of agriculture or veterinary medicine at federal universities (FUFs). Based on the 2010 ARCN records, there are 15 RIs, 11 FCAs, about 40 faculties of agriculture (FAs), and 8 faculties of veterinary medicine (FVMs) located across Nigeria's six agroecological zones (including the South-South political zone). All RIs and FCAs were included in the sample. Due to the far distances of some organizations and a limited time allowed for survey data collection, the team focused on 32 FUFs based on the organizations' geographic proximity. ARCN confirmed that representativeness of the sample FUFs among the population of FUFs.

Two sets of questionnaires were used— an organizational-level questionnaire administered to organization heads or a designated representative, and an individual-level questionnaire for individual researchers. The questionnaire for organizations included questions on the organization's mission; research management issues and training needs; scientific and technical training needs; the availability of physical and human resources; research outputs; management systems and procedures; partnerships and linkages; accountability and motivations; and funding sources. The questionnaire for individual researchers covered demographic and individual characteristics; research outputs; workload; linkages; research issues and training needs; motivation and incentives; and perception of the organization's culture.

This paper utilizes a multi-level analysis following a conceptual framework presented in Figure 1. Multi-level modeling allows one to model processes at multiple levels of the population hierarchy. By simultaneously modeling at multiple levels it is possible to determine where and how effects are occurring (Lorenz and Lundvall 2010; Rasbash et al. 2005; Goldstein 2003). Multilevel modeling also responds to the criticism often made of single-level models that too much emphasis is placed on individual's characteristics to the neglect of the social, institutional, or organizational context (Lorenz and Lundvall 2010; Rasbash et al. 2005; Goldstein 2003). Failure to take into account the hierarchically structured nature of the data may lead to serious technical problems, with standard errors of the regression coefficients being underestimated.

Our analysis of research productivity operates at two levels, with individual employees at level-1 being clustered within organization at level-2. Our variables characterizing employees at level-1 are derived from the individual responses to IFPRI-ARCN individual-level survey questionnaire, while our variables characterizing the organizational context at level-2 are derived from the IFPRI-ARCN organization-level survey questionnaire administered with heads or designated representative of organizations, completed by ASTI dataset.

In a simple two-level model, the linear predictor with random intercept and coefficient for organization *j* is given as

$$\eta_{ij} = \sum_{l=1}^{k} x_{ijl}\beta_{lj} + \upsilon_{lj} \qquad (1)$$

where η_{ij} is the linear predictor; x_{ijl} is the vector of covariates with fixed effects or the standard coefficient β and $\beta = (\beta_{1j}, \beta_{2j}, \ldots, \beta_{kj})$ are unknown k-dimensional column vector of coefficients; the subscript i represents the individual scientists (level-1 units), and subscript j represents organizations (level-2 units); and υ_{lj} is the random effect (one for each organization). These random effects represent the influence of organization j on individual i that is not captured by the observed covariates. These are treated as random effects because the sampled organizations represent a population of organizations, and they are assumed to be distributed as $\mathcal{N}(0, \sigma_v^2)$.

In the two-level model with random intercepts and coefficients, both the intercept and the coefficients vary randomly across the level-two units. Both the intercept term and coefficient consist of two terms: a fixed component β_{lj}, which is similar to standard single-level model, and a random effect υ_{lj} due to the fact that the level-2 units are treated as a random sample from a population of organizations. For example, the random effect υ_{1j} measures the departure of the j-th unit's intercept from the average or summary intercept across all level-2 units predicted by the fixed parameter, β_1. Similarly, the random effect υ_{2j} measures the departure of the j-th organization's slope from the average slope across all level-2 units predicted by the regression coefficient β_2. Level-2 context variables can be included directly as covariates in order to estimate the direct effect of differences in organizational context variables on the dependent variable. Such direct effects modify the intercept and slopes and reduce the variability in the intercept and slopes across level-2 units.

$$\begin{aligned} \beta_{1j} &= \beta_1 + \upsilon_{1j} \\ \beta_{2j} &= \beta_2 + \upsilon_{2j} \\ &\vdots \\ \beta_{kj} &= \beta_k + \upsilon_{kj} \end{aligned} \tag{2}$$

A link function $G(\cdot)$ to convert the expected value μ_{ij} (i.e., $\mu_{ij} = E[y_{ij} \mid \upsilon_j, x_{ij}]$ of the outcome variable y_{ij} to the linear predictor η_{ij} need to be specified based on the nature of the dependent variable and is given as

$$g(\mu_{ij}) = \eta_{ij} \tag{3}$$

Since several measures of research output y_{ijl} is being used with varying structure and nature of the data, we employ different models in this paper. Table 1 presents the measures and descriptive analysis of research outputs; while table 2 presents some indicators of the quality and effectiveness of these research outputs. For the number of publication and number of dissemination events for publications, characterized as overdispersed count data variables, this paper uses the generalized poisson regression (GPR).[1] The generalized Poisson regression (GPR) model $f(\mu_i, \alpha; y_i)$ is adopted from Famoye and Singh (2006) and is given by

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[1] An alternative is negative binomial regression (NBR) model which assumes that $\sigma^2 > 1$, so that there cannot be underdispersion. Generalized Poisson Regression (GPR) allows for all types of dispersion. GPR has been a good competitor of NBR and in some instances, it may also have some advantages (Famoye and Singh 2006). In the Famoye and Singh (2006) paper, they successfully fitted the ZIGP regression model to all datasets, but in a few cases, the iterative technique to estimate the parameters of ZINB regression model did not converge. Moreover, GPR has an edge over NBR for estimating parameters of the conditional mean (Wooldridge 2002).

$$f(u_{ij}, \propto; y_{ij}) = \left(\frac{\mu_{ij}}{1+\propto\mu_{ij}}\right)^{y_{ij}} \frac{(1+\propto y_{ij})^{y_{ij}-1}}{y_{ij}!} exp\left[\frac{-\mu_{ij}(1+\alpha y_{ij})}{1+\alpha\mu_{ij}}\right] \quad (1)$$

where the mean of y_{ij} is given by $\mu_{ij}(x_{ij}, \upsilon_j)$ and the variance of y_{ij} is given by $V(y_{ij} \mid x_{ij}, \upsilon_j) = \mu_{ij}(1 + \alpha\mu_{ij})^2$; and α is the dispersion parameter. When $\alpha = 0$, the probability model in equation (1) reduces to the Poisson regression model and this is a case of equi-dispersion. When $\alpha > 0$, the GPR model in equation 1 represents count data with over-dispersion. When $\alpha < 0$, the GPR model represents count data with under-dispersion. The non-negative function μ_{ij} is modeled via a log link function given as

$$\eta_{ij} = \log(\mu_{ij}) = \sum_{l=1}^{k} x_{ijl}\beta_{lj} + \upsilon_{lj} \quad (2)$$

The regression coefficient β_l represents the expected change in the log of the mean per unit change in the regressor x_l. In other words increasing x_l by one unit is associated with an increase of β_l in the log of the mean.

For the number of technologies produced (y_{ijl} = TECHNO), count data with excess zeros, this paper uses a zero-inflated generalized poisson (ZIGP) model adopted from Famoye and Singh (2006) and is given by

$$P(Y = y_{ij} | \upsilon_i, x_{ij}, z_{ij}) = \varphi_{ij} + (1 - \varphi_{ij}) f(\mu_{ij}, \alpha; 0), \quad y_{ij} = 0$$

$$= (1 - \varphi_{ij}) f(\mu_{ij}, \alpha; 0), \quad y_{ij} > 0 \quad (3)$$

where $f(\mu_{ij}, \alpha; y_{ij})$, $y_{ij} = 0, 1, 2, \ldots$ is the GPR model in equation (1); $0 < \varphi_{ij} < 1$; x_{ij} represents the set of covariates affecting μ_{ij}; and z_{ij} represents the set of covariates affecting φ_{ij}. The model in equation (3) reduces to the GPR model when $\varphi_{ij} = 0$. For positive values of φ_{ij}, it represents the zero-inflated generalized Poisson regression model. In this set up, the non-negative functions μ_{ij} and φ_{ij} are, respectively, modeled via log and logit link functions given as

$$\eta_{ij} = \log(\mu_{ij}) = \sum_{l=1}^{k} x_{ijl}\beta_{lj} + \upsilon_{lj} \text{ and } \eta_{ij} = logit(\varphi_{ij}) = log\left(\frac{\varphi_{ij}}{1-\varphi_{ij}}\right) = -\tau \sum_{l=1}^{k} z_{ijl}\beta_{lj} + \nu_{lj} \quad (4)$$

Were υ_{ij} and ν_{ij} are random intercepts and coefficients of the log link and logit link functions, respectively. The ZIGP regression model with logit link for φ_{ij} and log link for μ_{ij} as defined in equation (4) will be denoted by ZIGP(τ). When $\tau > 0$, the zero state becomes less likely and when $\tau < 0$, excess zeros become more likely.

For the dummy variables representing presence of at least one international or national research collaborator (y_{ijl} = TECHINTL, TECHNATL, PUBINTL, and PUBNTL), binary response variables, the paper uses logit regression model with response probability (equation 5) and logit link (equation 6) given as

$$p(x_{ijl}) \equiv P(y_{ij} = 1 | \upsilon_{il}; x_{ijl}) = P(y_{ij}^{*} > 0 | x_{ijl}) = \frac{\exp(\sum_{l=1}^{k} x_{ijl}\beta_{lj} + \upsilon_{lj})}{1 + \exp(\sum_{l=1}^{k} x_{ijl}\beta_{lj+\upsilon_{lj}})} \quad (5)$$

$$\eta_{ij} = \Lambda(\sum_{l=1}^{k} x_{ijl}\beta_{lj}) = logit(\pi_{ij}) = log\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \sum_{l=1}^{k} x_{ijl}\beta_{lj} + \upsilon_{lj} \quad (6)$$

where y^* is a latent variable determined by $y^* = \sum_{l=1}^{k} x_{ijl}\beta_{lj} + e, y = 1[y^* > 0]$, e is the disturbance term; π_{ij} is the underlying probability that $y=1$; and Λ is the logit model.

For the level of technology adoption (y_{ijl} = TECHADOPT), ordered response, this paper uses ordered logit regression model with response probabilities (equation 7) and logit link function (equation 8) given as

$$P(y_{ij} = 0 | \upsilon_{il}; x_{ijl}) = P(y_{ij}^* \le \alpha_1 | \upsilon_{il}; x_{ijl}) = \Lambda(\alpha_1 - \sum_{l=1}^{k} x_{ijl}\beta_{lj} + \upsilon_{lj})$$

$$P(y_{ij} = 1 | \upsilon_{il}; x_{ijl}) = P(\alpha_1 < y_{ij}^* \le \alpha_2 | \upsilon_{il}; x_{ijl}) = \Lambda(\alpha_2 - \sum_{l=1}^{k} x_{ijl}\beta_{lj} + \upsilon_{lj}) - \Lambda(\alpha_1 - l=1kxijl\beta lj+\upsilon lj$$

$$\vdots$$

$$P(y_{ij} = J-1 | \upsilon_{il}; x_{ijl}) = P(\alpha_{J-1} < y_{ij}^* \le \alpha_j | \upsilon_{il}; x_{ijl}) = \Lambda(\alpha_j - \sum_{l=1}^{k} x_{ijl}\beta_{lj} + \upsilon_{lj}) - \Lambda(\alpha_{j-1} - l=1kxijl\beta lj+\upsilon lj$$

$$P(y_{ij} = J | \upsilon_{il}; x_{ijl}) = P(y_{ij}^* > \alpha_J | \upsilon_{il}; x_{ijl}) = 1 - \Lambda(\alpha_J - \sum_{l=1}^{k} x_{ijl}\beta_{lj} + \upsilon_{lj}) \quad (7)$$

$$logit(\pi_{ij}) = log\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \sum_{l=1}^{k} x_{ijl}\beta_{lj} + \upsilon_{lj} \quad (8)$$

where $\alpha_1 < \alpha_2 < \ldots < \alpha_J$ are unknown cut points and defined as $y = 0$ if $y^* \le \alpha_1$, $y = 1$ if $\alpha_1 < y^* \le \alpha_2, \ldots, y = 0$ if $y^* > \alpha_J$.

The dependent variables, y_{ijl} , are modeled using covariates that represent individual characteristics, individual perceptions on organizations, and organizational characteristics. The types of organizations and the agroecological zones, where the headquarters or main campus of the organizations are located, are controlled for. The list of covariates and their descriptions are given tables 3 and 4. Perceptions on organizational culture by individual scientists are hypothesized and tested to be endogenous in the model.[2] The inverse mills ratios (IMR) are used the second-stage regression. The GLLAMM command in STATA was used in modeling and adaptive quadrature was utilized to perform the integration over random-effects distribution.

3. Results

Both individual and organizational characteristics are significant in explaining variations in publications produced (table 5). Education level is strongly and positively significant in explaining variations in the number of publications produced, external collaboration, and the number of dissemination events for these publications. Advancement of education level (e.g., from BSs to MSc or from MSc to PhD) increases the expected number of publication by about 42 to 114 percent. Female researchers seem to have less expected number of publications than male researchers in most models. Females have 3 percent

[2] Instruments include the agroecological zone where the organization's headquarters is located, whether the organization us officially under the ministry of agriculture or education, reasons why the individual staff chose the job, and the individual's perception on the central goal of the organization. Other variables appear to be correlated to OC. The more experience the sample researchers have, the lower is the score on organizational culture. The more PhD-level employees in the organization (the more available and quality human resources the organization have), the better score is given to OC. The gender of the leader is also significant in most models. Organizations with female heads have been rated more favorably than those with male heads.

less number of publications than males. Researchers with more time allocation for research appear to have more expected publications than those that have less time allocated for research. One percent more time allocated to research increases number of publication by 1 percent.

In model 1, all individual characteristics are highly significant in explaining variations in the number of publications produced. The random intercept of organizations is highly significant, which means that variation in the number of publication of scientists can be explained by variations in organizations. In models 2 and 3, we added organizational characteristics and random effects on slopes. Many of the individual characteristics are still significant (i.e. square of age, education, length of stay in current organization, and gender). The random effects in intercept become insignificant; some organizational characteristics (i.e., WEB, MEPLAN, LFEMALE, OC, IMR, and RI) are significant; and the random effects in terms of slope of most of the variables are significant (except for age). Researchers in organizations with website and M&E plan have more publications. If the organizations have a website, which indicates advancement in technology and information, the more publications researchers in that organization have. The difference is about thrice. If organizations has M&E plan, which indicates the strength of management systems, the more publications that researchers have. The difference is more than twice higher in organizations with M&E plan. Researchers in organizations with female head have less publication by fourfold. Researchers in organizations with perceived favorable OC have more publications. Researchers in research institutes have statistically higher expected publications than those in FCAs and FUFs.

Researchers with external collaborators (international or national) have higher education level (models 4 and 5). Female researchers have less probability of having international collaborators while researchers with greater time allocated to research have more probability of having national collaborators. Researchers in organizations with more MS-level scientists have more probability of having national collaborators. Researchers in organizations with formal linkages with relevant organizations have more probability of having national and international collaborators. This suggests that researchers often need institutional initiative and support to start and maintain their linkages.

The number of dissemination events for these publications are significantly explained by education level, experience, length of stay on organization, research time allocation, and perception on OC. Organizational characteristics are not significant in explaining variations in the number of dissemination events for research findings. However, the random intercept is highly significant which suggest that other organizational factors still matter and they help explain the variations in the number of dissemination events.

In terms of number of technologies produced, both individual and organizational characteristics are significant factors explaining variations in the number of technologies produced (Models 1 and 2) (table 5). Education level is positively correlated with the number of technology produced, which is consistently with what was initially hypothesized. An advancement of one education level (e.g., from BSs to MSs or from MSs to PhD) increases the expected technology produced by 20 to 27 percent. However, the length of stay in the organization (EXPORG) is negatively correlated with technology produced. An advancement to one category level (e.g., from 2-3 years to 4-5 years) in terms of length of stay in the organization decreases the expected technology produced by 31 to 34 percent.

Several organizational characteristics are significant (table 6). Measure of human resource availability in the organization, proxied by number of researchers (FTE) with MSc degree, is positively correlated with the number of technology produced. However, the number of researchers with PhD did not appear to be significant. Measures of availability and adequacy of physical resources and organizational management systems are positively significant in affecting number of technologies produced. If organizations have website (a measure of physical resources and strength of information systems), the expected number of technologies produced that researchers are involved in increases by 78 to 122 percent. If organizations have M&E plan (a measure of adequacy of organizational management system), the expected number of technologies that researchers are involved in increases by 42 to 54 percent. An increase in the satisfaction level of organization heads on the adequacy of laboratory and research facilities corresponds to an increase in expected number of technologies that researchers are involved in by 22 to 29 percent.

Researchers in older organizations have higher expected number of technologies. If the organization head is female, the lower is the number of technologies (although it was not significant in one of the models). Results on the significance of perception on organizational culture are mixed (significant and negative in model 1 and negative but not significant in model 2). Results on the significance of types of organization are also mixed. The random effect in terms of intercept is not significant.

In the model explaining having at least one external collaborator of developing technologies (Model 3), individual characteristics were not significant, while an organizational characteristic appear to be significant. Only the gender of the organization head is significant in the model explaining having at least one external collaborator of developing technologies. Researchers in organizations with female heads have lower probability to have external collaborators in developing technologies than those in organizations with male heads.

In terms of indicators of adoption of these technologies, both individual and organizational characteristics matter (Model 4). Education is negatively correlated with adoption level, which is the opposite of the results using number of technologies as the dependent variable. These results suggest that the higher the education level of researchers, the more technologies they produce; while as the education level of researchers becomes more advanced, they perceive less adoption level of their technologies than the ones with male heads. Female researchers observe lower adoption levels of the technologies they produced. Researchers with female heads perceive less adoption level of their technologies. Perception on organizational culture is significant. As the probability of researchers strongly agreeing to favorable work environment increases, they perceive higher adoption rate of their technologies.

4. Discussions

Results are similarities and differences between the models using publications and the models using technologies as measures of researcher outputs. The positive significance of education is consistent in both models explaining number of publications and technologies. The effect of education on number of publications is higher than in number of technologies. Advancement in one education level increases the expected number publication by 42 to 114 percent. Female researchers produce less publication, while there is no difference between male and female researchers in terms of the number of technologies produced. There is no statistical difference in number of publications produced by researchers in organizations with more number of scientists than those in organizations with less number of scientists. However, there is statistical difference in the number of technologies produced by researchers in organizations with more MS-level scientists than those in organizations with less MS-level scientists (although no statistical significance in terms of number of PhD-level scientists). This suggests that some organizations may be severely constrained by limited research support to their senior scientists and heads of programs, which in term restricts the number of technologies being produced by their researchers.

Researchers in organizations with website have more number of publications and more number of technologies produced. Researchers in organizations with female heads have less number of publications and less number of technologies produced. Researchers in older organizations have higher number of technologies produced than those in more recently established organization but there is no statistical difference in terms of number of publications produced. This suggests the importance of organization's experience in developing technologies. Researchers in researcher institutes have more publications than those in FCA and FUF, while there is no evidence on statistical difference among organization types in terms of technologies produced by researchers. The most striking difference is on the perception of organizational culture. Researchers in organizations with perceived more favorable work environment produced more publications than those in organizations with perceived less favorable work environment but it is quite the opposite in terms of number of technologies produced. Both random intercepts are not significant. Most random coefficients are statistically significant which suggest that organizations vary in terms of the quadratic effect of age, effects of education, experience, length of stay in the organization, gender, and research and teaching time allocation on the number of publications. Due to smaller variability across organizations, we were not able to estimate the random coefficients of the model on number of technologies.

There are very different results from the models explaining presence of external collaborators in producing publications and in developing technologies. Educational level seems to matter more in having external collaborators in producing publications than in developing technologies. Female researchers have less probability of working with international collaborators in producing publications than male researchers. Researchers with more time allocation for research have greater probability of having national collaborators than those with less time allocation for research. Gender of research does not seem to matter in terms of the number of technologies produced. Researchers in organizations with formal linkages with relevant organizations have higher probability of having external collaborators in producing publications, while this did not seem to matter in terms of external collaborators in developing technologies.

All the models consistently suggest that organizational characteristics are significant. Measures of availability and adequacy of physical resources seem to be the more consistently significant ones than measures of availability of human resources and organizational management systems. The gender of the organization head is also significant in most models.

5. Conclusions, Limitation of the Study, and Policy implications

Most studies on individual research productivity focus on individual characteristics, and this paper is among the first set of papers that models systematic variation in individual research productivity across organizations. Results of this study show that organizational characteristics matters (both in terms of fixed, direct effects and in terms of unobserved, random effects on coefficients) in explaining variations in individual research productivity (measures in terms of quantity and quality of publications and technologies produced). Limited human capacity has been a major concern in African agricultural development. Researchers have called for increasing human capacity for agricultural research in order to increase the productivity of African agriculture. While it is true that human capacity needs to be increased, utilization of existing capacity depends on the incentives, motivation and optimal working conditions that bring the best in people. In addition, provisions of research infrastructure and adequate funding could enhance the effective use of existing capacity. Results of this study reinforces that improving organizational effectiveness can contribute to increased productivity of individual researchers. This in turn implies that attention must be paid to improve leadership and organizational skills of the existing managers and directors of research organizations. Thus, measures of availability and adequacy of physical resources and organizational management systems seem to be the more consistently significant ones than measures of availability of human resources. The gender of the organization head is also significant in most models.

Organizations with female heads seem to have better organizational culture – partly due to women's organized way of handling challenges. This result adds support to the argument that more women should be encouraged to lead institutions including research organizations. Research institutions and the federal colleges specifically teaching agriculture have better organizational culture than the agriculture facilities that are embedded in general federal universities. This is expected because of the homogeneity of purpose in the first two sets of organizations. A mixed organizational setup such as the federal universities does not promote agricultural research culture.

External collaborations help to bring in new ideas, methods and skills. While it can help in improving local individuals who collaborate, it can also help in increasing the organizational productivity by cross pollination of ideas with other researchers and learning of new work ethic from the collaborator. Also external collaboration generally brings in additional resources which helps to explore new avenues of research and thereby increases research productivity. However, a major policy challenge at the institutional and national levels is the restrictions placed on external collaboration both in terms of institutional regulations that are stringent in allowing external collaboration. More importantly financial accounting systems of the organizations which cannot accept the funds directly pose a major challenge for such collaboration.

Results of the models estimated on organizational culture indicate that the quality of human resource increases the organizational culture. This is partly due to the individual self-motivation of the researchers with PhDs who are in most cases lead researchers. As their number increases organization shows better work culture. However, organizations with lesser number of PhDs can compensate this by increasing other factors such as performance monitoring and improved institutional regulations.

Results suggest the need to strengthen and invest in organizations if the Nigerian government aims to increase the research productivity of its agricultural research system. In 2010, only 30 of organizations have M&E plans and a majority does not have IPR policy. In the context of Nigeria, in terms of prioritization, human resources development seem to be the least of the problems compared to the serious deficiencies in laboratory and research facilities and infrastructure and in poor implementation of management systems and organizational procedures. Investing in physical resources and better understanding employees' incentives and motivations to better enforce organizational management systems seem to be the more important factors that would increase the likelihood of increasing individual and organizational research productivity.

While this paper provides useful insights and policy implications, it is constrained by several limitations of data. First, the dataset used in this study include small number of observations per organization (3 to 15 researchers per organization) although they were selected randomly and experts' opinion suggests that the sample are representative. Any discrepancy of the sample and the observed characteristics of a larger sample dataset (ASTI 2009) were adjusted using sampling weights in the modeling.

Second, measures of research output are based on self-reported values. Anonymity of the responses was important to the research design due to the possible sensitivities of the responses in perceptions. For this reason, this paper used self-reporting rather than bibliometrics data. To minimize the bias in self-reporting, the questionnaires were kept anonymous and confidential, which was emphasized to the respondents. It was emphasized by the organization heads and ARCN representative to answer the questions as honest and accurately as possible to help analyze important factors on how productivity and performance can be improved. In most cases, CVs were requested to be printed, so that respondents will find it easier in answering the questionnaires and minimize errors in self-reporting.

Third, variables on quality of publications and technologies produced have been included, but alternative measures can be explored. While this study measures presence of external collaborator and extent of dissemination, it is not include measures of impact of these publications due to the inherent difficulty of measuring of research. While this study is innovative in including a measure of perceived adoption levels of technologies produced, it does not include a more objective and actual adoption rates of these technologies.

As a future research agenda, better methods of collecting information as well as better indicators of adoption and impact of publications and technologies can be explored. A future line of inquiry will be to build up indicators of individual productivity of scientists and explore the relationship between individual and organizational productivity. It will also be useful to investigate further why female researchers and researchers in organizations with female heads have lower indicators of research output. It might be that the gender effects in variations in productivity are due to gender differentials in access to opportunities and resources for research, collaboration, or dissemination. Lastly, cross-sectoral or cross-national comparison can be explored to determine whether institutional or national context matter in explaining scientists' productivity.

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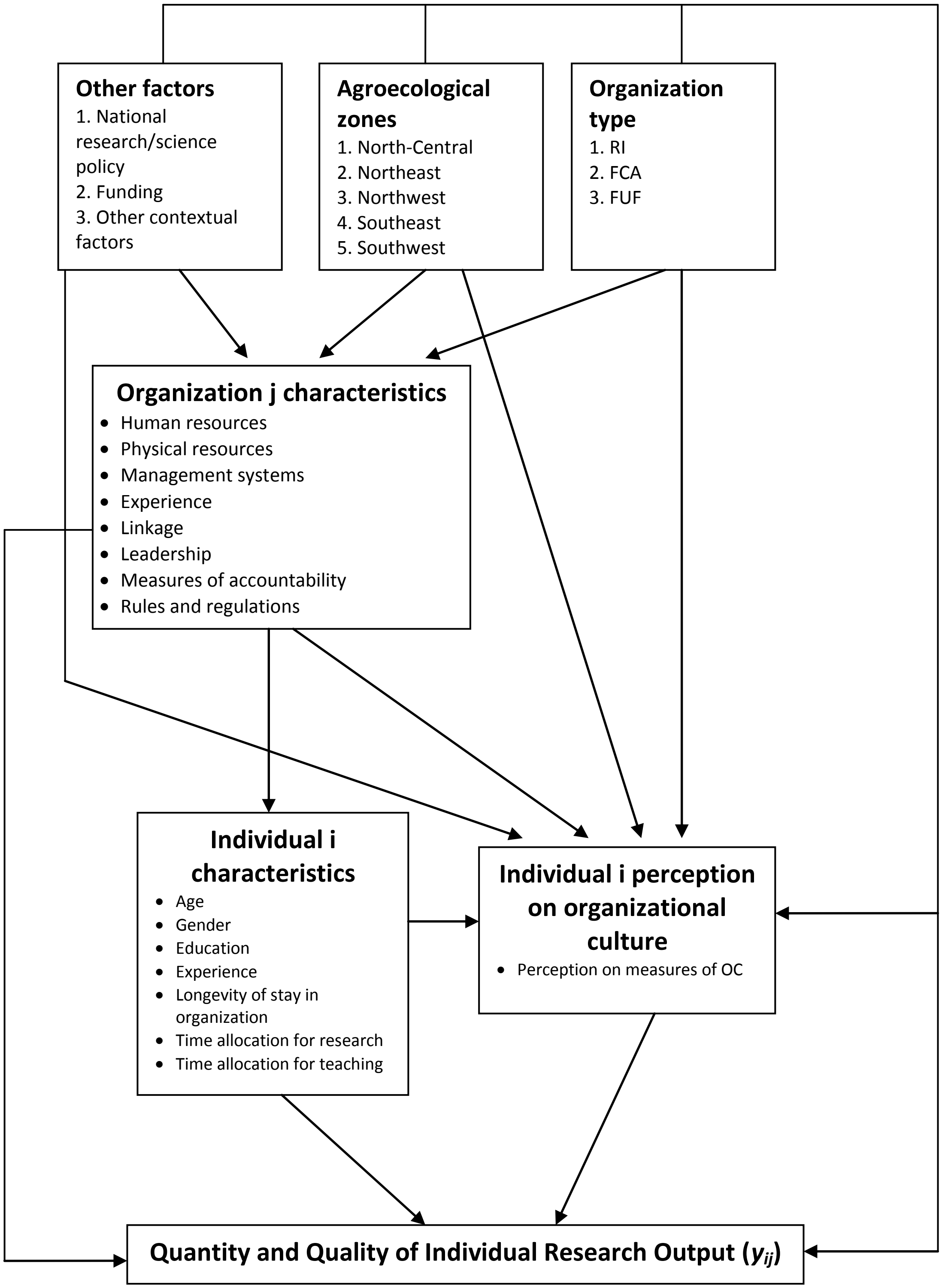
Figure 1. Framework for Modeling Individual and Organizational Characteristics.



Source: Authors.

Table 1. Distribution and descriptive statistics of agricultural researcher's output, Nigeria, 2010.

Number	Technology (2005-2009)		Publication (2007-2009)					
			Total		First Authorship		Co-authorship	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
0	257	*74.7*	64	*18.6*	105	*30.5*	90	*26.2*
1	35	*10.2*	19	*5.5*	39	*11.3*	44	*12.8*
2	21	*6.1*	27	*7.9*	32	*9.3*	37	*10.8*
3	8	*2.3*	18	*5.2*	25	*7.3*	23	*6.7*
4	6	*1.7*	17	*4.9*	16	*4.7*	30	*8.7*
5	6	*1.7*	25	*7.3*	23	*6.7*	18	*5.2*
6	3	*0.9*	18	*5.2*	15	*4.4*	21	*6.1*
7	0	*0.0*	18	*5.2*	16	*4.7*	13	*3.8*
8	3	*0.9*	25	*7.3*	9	*2.6*	13	*3.8*
9	1	*0.3*	12	*3.5*	12	*3.5*	11	*3.2*
10	0	*0.0*	14	*4.1*	3	*0.9*	3	*0.9*
11-20	3	*0.9*	51	*14.8*	30	*8.7*	33	*9.6*
21-30	1	*0.3*	18	*5.2*	15	*4.4*	6	*1.7*
31-40	0	*0.0*	9	*2.6*	4	*1.2*	2	*0.6*
41-50	0	*0.0*	5	*1.5*	0	*0.0*	0	*0.0*
51-60	0	*0.0*	4	*1.2*	0	*0.0*	0	*0.0*
Mean	0.76		8.28		4.84		4.37	
Std. Dev.	2.22		10.09		6.83		5.67	
Variance	5.1		104.1		47.8		32.8	
F-statistics from ANOVA (between organizations)	2.30***		2.11***		1.34*		2.90***	
F-statistics from ANOVA (between org. types)	1.06		11.00***		4.00**		15.43***	

*Note: *Significant at 0.10 level; ** Significant at 0.05 level; *** Significant at 0.01 level. Source: IFPRI-ARCN survey (May-July 2010).*

Table 2. Distribution and descriptive statistics of measures of the quality and effectiveness of technologies and publications produced, Nigeria, 2010.

(a) Quality of technologies produced

Measures of quality of technologies produced	**% of total respondents with >= 1 technology produced**
• With international collaborator in developing technology (binary)	29
• With national collaborator in developing technology (binary)	51
• Perceived adoption level of technologies produced (Likert scale)	
○ no information	38
○ no adoption (0 adoption)	33
○ limited adoption (< 20%)	15
○ moderate adoption (21-40%)	8
○ wide adoption (> 40%)	6

(b) Quality of publications produced

Measures of quality of publications produced	**% of total respondents with >=1 publication produced**
• With international collaborator in producing publications (binary)	37
• With national collaborator in producing publications (binary)	78
• Number of dissemination events for publications produced (count)	
0	23
1	24
3	9
4	9
5	6
6	5
7	1
8	2
9	4
10	1
11-20	12
21-30	1
41-50	1
51-60	1

Source: IFPRI-ARCN survey (May-July 2010).

Table 3. Descriptive statistics of individual characteristics of sample agricultural researchers, Nigeria, 2010.

Variable	Total	Organization type: RI	FCA	FUF	F-statistics from ANOVA: Between org. types	Between org.
Dummy for gender (1=FEMALE)	**0.31 (0.46)** /a	**0.33 (0.47)**	**0.28 (0.45)**	**0.30 (0.46)**	**0.22**	**0.89**
AGE	**3.60 (0.94)** /a	**3.70 (1.00)**	**3.31 (1.00)**	**3.73 (0.78)**	**6.85** ***	**3.89** ***
≤ 20	3 /b	1	8	0		
21-30	5	43	5	3		
31-40	38	22	40	37		
41-50	37	18	40	42		
≥ 51	17	16	6	17		
Highest level of education (EDUC)	**3.77 (1.33)** /a	**4.01 (1.15)**	**2.80 (1.38)**	**4.29 (1.02)**	**46.91** **	**5.50** ***
BSc	11 /b	6	31	2		
MSc	40	40	51	33		
PhD	49	54	19	66		
Number of years after last degree (POSTDEGREE)	**4.94 (1.63)** /a	**5.02 (1.65)**	**4.98 (1.53)**	**4.91 (1.70)**	**0.19**	**1.78** ***
< 6 months	3 /b	3	2	5		
6-11 months	2	2	2	3		
1- <2 years	13	14	16	11		
2-4 years	21	22	19	22		
5-7 years	22	17	28	22		
8-10 years	12	13	11	11		
> 10 years	26	29	22	26		
Number of years in the organization (EXPORG)	**4.90 (1.29)** /a	**5.31 (0.94)**	**4.56 (1.51)**	**4.74 (1.30)**	**11.30** ***	**4.96** ***
< 6 months	3 /b	0	6	3		
6-11 months	2	0	2	3		
1-2 years	10	6	19	8		
3-5 years	18	17	13	24		
6-10 years	22	19	22	24		
> 10 years	45	59	38	37		
Percentage of time allocated to research (RESEARCH)	**39.76 (21.80)** /a	**59.80 (19.71)**	**23.29 (11.31)**	**31.93 (12.33)**	**181.00** ***	**9.28** ***
Percentage of time allocated to teaching (TEACH)	**34.12 (24.30)** /a	**6.93 (8.88)**	**54.00 (15.43)**	**46.61 (12.93)**	**485.65** ***	**23.72** ***

Source: IFPRI-ARCN survey (May-July 2010).
*Note: /a Figures represent the mean and the ones in parentheses are the standard deviation. /b Percentage to total respondents per category; *Significant at 0.10 level; ** Significant at 0.05 level; *** Significant at 0.01 level.*

Table 4. Descriptive statistics of characteristics of sample agricultural research organizations, Nigeria, 2010.

Categories	Variable Name	All organizations		Organization type			
				RI (15)	FCA (10)	FUF (22)	
		Ave.	SD	Ave.	Ave.	Ave.	
Human resources							
Total number of research staff	FTETOTAL	32.28	29.45	58.87	7.60	25.38	***
Total number of staff with PhD	FTEPHD	11.84	9.07	16.33	1.20	13.62	***
Total number of staff with MS	FTEMS	12.03	13.15	24.24	3.38	7.63	***
Total number of staff with BS	FTEBS	8.38	14.12	18.28	3.01	4.08	***
Satisfaction [1] with human resources	HUMAN	2.81	0.97	2.67	3.00	2.82	
Physical resources							
Dummy for the presence of website (1=with website)	WEB	0.74	0.44	0.73	0.30	0.95	***
Satisfaction[1] with the adequacy of laboratory facilities	LAB	2.30	1.08	2.40	2.20	2.27	
Satisfaction[1] with the adequacy of ICT	COMM	2.28	0.99	2.53	2.20	2.14	
Satisfaction[1] with the adequacy of computers	COMPUTER	1.70	0.69	1.73	1.30	1.86	*
Satisfaction[1] with the adequacy of libraries	LIBRARY	1.87	0.80	2.13	1.30	1.95	**
Management systems							
With M&E plan (1dummy)	MEPLAN	0.62	0.49	0.47	0.70	0.68	
With strategic plan (dummy)	STRAPLAN	0.62	0.49	0.53	0.50	0.73	
With training plan (dummy)	TRAINPLAN	0.70	0.46	0.80	0.60	0.73	
Satisfaction[1] with M&E plan	MESATIS	1.98	1.84	1.67	2.70	1.86	
Satisfaction[1] with the strategic plan	STRASATIS	1.85	1.77	1.40	1.80	2.18	
Satisfaction[1] with training plan	TRAINSATIS	2.62	1.88	2.20	3.50	2.50	
Experience							
Year of organization's establishment	YEARESTAB	1968	20	1954	1972	1975	***
Leadership							
Gender of head (1=female)	LFEMALE	0.09	0.28	0.13	0.20	0.00	
Dummy for central goal of organization[1]							
(1=research; 0=otherwise)	GOAL1	0.19	0.40	0.33	0.00	0.18	
(1=to help farmers; 0=otherwise)	GOAL2	0.21	0.41	0.67	0.00	0.00	***
(1=teaching; 0=otherwise)	GOAL3	0.60	0.50	0.00	100.00	82.00	***
Linkages							
With international linkages (dummy)	LINTL	0.32	0.47	0.47	0.20	0.27	
With linkages with training institute (dummy)	LLTRAIN	0.38	0.49	0.47	0.30	0.36	
With linkages with research institute (dummy)	LRES	0.66	0.48	0.73	0.60	0.64	
With linkages with universities or colleges (dummy)	LEDUC	0.40	0.50	0.60	0.40	0.27	
With linkages with private sector (dummy)	LPRIV	0.17	0.38	0.27	0.10	0.14	
Organizational culture							
Perception on organization culture	OC	2.20	0.45	2.20	2.10	2.40	
Performance							
With award (dummy)	AWARD	0.17	0.38	0.20	0.10	0.18	
Number of times the organization was considered top 3 good–performing organizations by survey respondents	GOODCOUNT	3.98	4.12	4.93	4.80	2.95	

*Note: *,*,*** are the significance levels based on the F-statistics from ANOVA. *Significant at 0.10 level; **Significant at 0.05 level; ***Significant at 0.01 level. Source: IFPRI-ARCN survey (May-July 2010).* [1] As perceived by the head or representative of the organization interviewed.

Table 5. Results of different models explaining the number, presence of external collaborators, and dissemination events of publications produced, Nigeria, 2010.

	Model 1		**Model 2**		**Model 3**		**Model 4**		**Model 5**		**Model 6**	
Dependent variable	**Number of Publications (count data)**						**Presence of international research collaborator (dummy)** [/a]		**Presence of national research collaborator (dummy)** [/a]		**Number of dissemination events for research outputs (count data)**	
Individual characteristics (fixed effects)												
AGE	0.42 (0.14)	*** [/b]	0.52 (0.35)		0.06 (0.49)		0.16 (0.88)		1.01 (1.05)		0.23 (1.10)	
AGESQ	-0.08 (0.02)	***	-0.99 (0.05)	**	-0.03 (0.06)		-0.03 (0.13)		-0.14 (0.14)		-0.04 (0.03)	
EDUC	0.42 (0.03)	***	0.61 (0.94)	***	1.14 (0.27)	***	0.53 (0.15)	***	0.73 (0.17)	***	0.45 (0.04)	***
POSTDEGREE	0.06 (0.01)	***	-1.99 (0.17)		-0.25 (0.11)	**	-0.39 (0.44)		-0.20 (0.42)		-0.38 (0.11)	***
POSTSQ					0.01 (0.09)		0.04 (0.05)		0.03 (0.04)		0.04 (0.01)	***
EXPORG	0.07 (0.03)	***	0.02 (0.02)		0.11 (0.08)		0.15 (0.14)		-0.02 (0.15)		0.10 (0.04)	***
FEMALE	-0.34 (0.05)	***	-0.39 (0.16)	**	-0.49 (0.134)	***	-0.50 (0.29)	*	-0.20 (0.32)		-0.20 (0.08)	
RESEARCH	0.00 (0.00)	***	0.01 (0.01)	*	0.01 (0.01)		0.00 (0.01)		0.02 (0.01)	*	-0.00 (0.00)	*
TEACH	-0.01 (0.00)	***	-0.01 (0.01)		-0.01 (0.01)		-0.02 (0.01)		0.00 (0.01)			
Organizational characteristics (fixed effects)												
FTETOTAL											-0.00 (0.00)	
FTEPHD			-0.04 (0.05)		-0.08 (0.07)		-0.02 (0.03)		-0.01 (0.02)			
FTEMS			-0.09 (0.03)		-0.03 (0.04)		-0.00 (0.02)		0.04 (0.01)	**		
WEB			1.82 (0.87)	**	2.23 (1.00)	**	-0.11 (0.42)		0.19 (0.40)			
COMM			0.33 (0.36)				-0.04 (0.17)		0.20 (0.15)			
LAB					-0.07 (0.38)						-0.03 (0.10)	
LIBRARY					0.75 (0.58)							
MEPLAN			0.51 (0.74)		1.13 (0.78)		0.35 (0.32)		0.21 (0.31)		0.04 (0.21)	
LINTL			1.30 (0.71)	*	1.36 (0.84)		0.86 (0.37)	**	0.59 (0.33)	*	-0.11 (0.23)	
LFEMALE			-1.77 (1.26)		-2.49 (1.37)	*	-0.19 (0.62)		-0.56 (0.62)		-0.08 (0.41)	
YEAREST			-0.03 (0.02)		-0.02 (0.02)		-0.01 (0.01)					
OC			0.13 (0.09)									
IMR1					44.72 (11.62)	***	12.83 (16.36)		-0.74 (16.92)		7.93 (3.94)	**
IMR2					43.50 (10.57)	***	14.11 (14.83)		-4.29 (15.29)		9.92 (3.38)	***
IMR3					46.39 (10.67)	***	12.56 (15.91)		-3.66 (16.43)		11.05 (3.54)	***
RI			1.39 (0.44)	***	0.11 (0.56)	*	-0.98 (0.68)		-1.00 (0.67)			
FCA			-0.96 (0.92)		-0.07 (0.85)		-0.30 (0.66)		-0.04 (0.61)			
CONSTANT	-0.63 (0.31)	**	48.07 (41.40)		-7.92 (45.06)		6.67 (25.79)		10.32 (25.11)		-10.90 (3.49)	
Random Effects												
INTERCEPT	0.49 (0.06)	***	0.00 (0.75)		0.44 (1.42)		0.33 (0.32)		0.00 (0.48)		0.42 (0.13)	***
AGE			0.13 (0.18)		0.00 (0.18)							
AGESQ			0.05 (0.01)	***	0.06 (0.01)	***						
EDUC			0.43 (0.08)	***	0.41 (0.18)	**						
POSTDEGREE			0.19 (0.10)		0.36 (0.06)	***						
EXPORG			0.36 (0.08)	***	0.38 (0.08)	***						
FEMALE			0.80 (0.15)	***								
RESEARCH			0.04 (0.01)	***	0.04 (0.01)	***						
TEACH			0.04 (0.01)	***	0.05 (0.01)	***						
Log likelihood	**-1538.42**		**-1178.65**		**-1190.51**		**-184.1078**		**-170.89**		**-1282.41**	

*Note: [/a] Reported values are the coefficients and not the marginal effects. [/b] Figures are the coefficients and the ones in parentheses are the standard errors. *Significant at 0.10 level; **Significant at 0.05 level; ***Significant at 0.01 level.*

Table 6. Results of different models explaining the number, presence of external collaborators, and perceived adoption level of technologies produced, Nigeria, 2010.

	Model 1				Model 2				Model 3		Model 4	
Dependent variable	**Number of technologies (count data)**								**Presence of external collaborator (dummy)**		**Adoption level of technologies produced (ordered response)**	
	Multilevel ZIP				**ZIP**				**Multilevel Logit [/a]**		**Multilevel Ordered Logit**	
	Logit [/a]		**Poisson**		**Logit[/a]**		**Poisson**					
Individual characteristics (fixed effects)												
AGE	1.36 (1.06)	[/b]	0.59 (0.53)		-1.86 (1.34)		0.84 (0.60)		-0.13 (2.33)		1.13 (1.65)	
AGESQ	-0.17 (0.15)		-0.07 (0.07)		0.19 (0.16)		-0.10 (0.09)		-0.01 (0.31)		-0.5 (0.22)	
EDUC	0.28 (0.17)	*	0.20 (0.09)	**	-0.21 (0.28)		0.27 (0.11)	**	-0.17 (0.38)		-0.71 (0.33)	**
POSTDEGREE	0.07 (0.11)		0.04 (0.05)		-0.06 (0.15)		-0.02 (0.05)		-0.78 (0.85)		0.67 (0.79)	
POSTSQ									0.07 (0.09)		-0.06 (0.09)	
EXPORG	0.17 (0.18)		-0.31 (0.10)	***	-0.55 (0.27)	**	-0.34 (0.12)	***	0.53 (0.43)		0.42 (0.37)	
FEMALE	0.25 (0.34)		0.11 (0.19)		0.24 (0.52)		0.38 (0.21)	*	0.21 (0.67)		-1.08 (0.52)	**
RESEARCH	0.01 (0.01)		0.00 (0.01)		-0.05 (0.02)	**	-0.00 (0.01)		-0.01 (0.02)		0.03 (0.02)	
TEACH	-0.02 (0.01)		-0.00 (0.01)									
Organizational characteristics (fixed effects)												
FTETOTAL									0.01 (0.01)		0.00 (0.01)	
FTEPHD	0.03 (0.03)		-0.01 (0.02)		-0.08 (0.04)	**	-0.00 (0.02)					
FTEMS	-0.03 (0.02)	*	0.02 (0.01)	**	0.17 (0.03)	***	0.03 (0.01)	***				
WEB	1.04 (0.41)	**	0.78 (0.23)	***	0.78 (0.52)		1.22 (0.21)	***				
LAB	0.16 (0.16)		0.22 (0.09)	**	0.14 (0.52)	***	0.29 (0.08)	***	0.27 (0.28)			
LIBRARY	0.01 (0.26)		0.16 (0.14)		1.54 (0.52)	***	0.43 (0.14)	***				
MEPLAN	-0.79 (0.34)	**	0.42 (0.17)	**	2.77 (0.54)	***	0.54 (0.19)	***	0.62 (0.59)		0.58 (0.54)	
LINTL	-0.25 (0.58)		-0.01 (0.25)		-0.28 (1.20)		0.27 (0.25)		0.36 (0.73)		0.38 (0.65)	
LFEMALE	0.27 (0.58)		-0.50 (0.38)		-2.78 (1.20)	**	-0.71 (0.33)	**	-2.46 (1.34)	*	-2.60 (1.00)	***
YEAREST	0.00 (0.01)		-0.02 (0.01)	***	-0.04 (0.02)	*	-0.02 (0.01)	***	-0.02 (0.02)			
IMR1	-13.54 (17.14)		-14.97 (7.00)	***	59.32 (40.14)		-14.51 (8.88)	*	254.97 (266.55)		65.57 (35.33)	*
IMR2	-13.71 (15.60)		-11.91 (6.15)	*	45.52 (34.06)		-11.44 (8.38)		251.90 (266.11)		52.0.4 (32.83)	
IMR3	-15.49 (16.75)		-14.22 (6.68)	**	51.63 (36.26)		-13.99 (8.89)		253.04 (266.80)		57.74 (34.55)	*
RI	1.61 (0.72)		0.02 (0.46)		-6.64 (1.72)		-0.21 (0.41)		-0.47 (1.17)		1.62 (0.98)	*
FCA	1.80 (0.74)		0.51 (0.42)		-0.07 (1.02)		1.07 (0.63)	*	0.30 (1.17)		1.49 (1.08)	
CONSTANT	*2.05 (27.61)*		*45.65 (13.62)*		*43.39 (50.33)*		*56.72 (13.94)*	***	*-203.37 (257.88)*			
CUT1											*60.05 (33.63)*	*
CUT2											*62.08 (33.67)*	*
CUT3											*63.39 (33.68)*	*
CUT4											*64.70 (33.71)*	*
Random effect												
INTERCEPT	0.00 (0.00)		0.00 (0.00)						0.00 (0.00)		0.00 (0.00)	
Log Likelihood	**-153.41**				**-276.43**				**-47.60**		**-97.37**	

Note: [/a] Reported values are the coefficients and not the marginal effects. [/b] Figures are the coefficients and the ones in parentheses are the standard errors.
**Significant at 0.10 level; **Significant at 0.05 level; ***Significant at 0.01 level.*