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Socio-Economic Assessment of Groundwater Use for Agriculture in Ebonyi State, Nigeria

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Abstract
With rising temperature and associated adverse climate effects experienced globally, rainfed agriculture is increasingly insufficient to meet the growing demand for food. In Nigeria, climate change effects result to greater droughts periods due to delay in onset of rainfall, thus necessitating the use of irrigation to augment rainwater. Increasingly the use of groundwater for irrigation water has been observed, but few studies have focused on socio-economic dimension of groundwater use in agriculture. This paper assessed ground water use among crop farmers in Ebonyi state. The objectives of the study were to describe the socio-economic characteristics of the farmers, estimate the cost of groundwater technology used by crop farmers in the study area, examine socio-economic determinants of groundwater use by farmers and identify constraints militating crop farmers use of ground water in the study area. A multi-stage random sampling technique was used to select 80 crop farmers for interview using well-structured questionnaire. Data collected were analysed using descriptive statistics and probit regression. The results showed that the mean age was 43years, 85% were male, while mean years of schooling was nine. The major determinants of use of groundwater were farm size, type of crop grown, and farmers revenue. Major constraints to use of ground water were techno-financial factors, macro-environmental factors, and Institutional factors. It was recommended that policies removing bottlenecks to loan services for farmers be pursued, and that more awareness and training for farmers on the sustainable use of ground water should be conducted by agriculture extension service providers.

Key Words: Agriculture, irrigation, groundwater,

Introduction
Agriculture is a key sector in much of sub-Saharan Africa and in the Nigerian economy (FAO, 2018). Across sub-Saharan Africa, many households depend on agriculture for their livelihoods (Azadi, *et al*, 2021; FAO, 2018). Agriculture plays a strategic role in economic development, employment creation, poverty reduction and food security (Wembua *et al*, 2021; Ndekwa, *et al*., 2023; Endalew, 2024). For instance, in Nigeria, between January and March 2021, agriculture accounted for about 22.35% of the GDP (FAO, 2025). Yet agricultural development in sub-Saharan Africa is ridden with challenges from natural resource degradation, climate change, and intensification pressures (Mungai, *et al*, 2016)

Globally the world population is predicted to grow to 10.9 billion by 2100, and most of this growth will occur in low income countries like Nigeria (Maja and Ayano, 2021) In Nigeria, the population growth rate is higher than the food production rate , with wide demand-supply gap (FMARD, 2022; Obayelu *et al*,2021). In Nigeria, agriculture is dominated by the crop sector, with the sector contributing about 85% to agriculture (FMARD, 2016). About 88% of the production in the crop sector is by small-holders (FAO, 2018). The crop sector is characterized by low productivity and low income. Climate change as well as low level of irrigation farming are amongst the challenges facing the crop sector in Nigeria (FAO, 2025).

Climate change is adding to shocks experienced in agriculture, with a large impact on agricultural productivity (Pawlak & Kolodziejczak, 2020). As agriculture is a natural resource based activity, it is most affected due to over exposure to the vagaries of weather (Ajetomobi & Abiodun, 2010). Irregular rainfall, rising temperature, and other extremes like droughts and floods are increasingly experienced, with adverse impacts on agricultural production and livelihoods (Xie, *et al*, 2023)

According to FAO (2018), small holder agriculture relies mainly on rainfall, as only about 2% of small-holder farmland is irrigated. With the declining onset of rain due to climate change being experienced, the implication is reduction in crop growing season, and insufficient water for crop growth. Irrigation, which can be defined as the supplemental provision of water to the soil by transportation and or storage of water to promote crop growth (Fadipe *et al.,* 2022; Jayant *et al,* 2022; Imburgia, 2019; Takeshima, 2016) has increasingly been enlisted in the face of climate change. Irrigation contributes greatly in raising agricultural productivity and incomes around the world (Fadipe, 2022; Takeshima & Adesugba, 2014), yet the share of irrigated area among all cultivated area is low in Nigeria (Takeshima, 2016; FMARD, 2022). In response to this, the National Agricultural Technology and Innovation policy (NATIP) prioritizes the strengthening and coordination of water resource utilization for agriculture (FMARD, 2022). However, the thrust of the policy is for formal irrigation with little attention to farmer led irrigation.

Groundwater use, a solution to increasing water scarcity, is increasingly being explored globally. As observed by Saad (2013), the intensive use of ground water for irrigation is spreading rapidly in many countries with the adoption of tubewell and mechanical pump technologies. According to Villholth, (2013), groundwater irrigation is growing in coverage and importance in sub-Saharan Africa, with an estimated area of 1-2 million hectares. Nigeria currently has about 1 million ha of water managed area, of which about 67,000ha comprise of groundwater irrigation (Xie *et al*, 2023).

Groundwater provides a flexible and reliable source of water for farmers (Villholth, 2013). Factors that have made groundwater use amenable for agriculture is the low cost of abstracting the water to the farm, as boreholes can be sunk right in the farm, rather than transporting the water over long distances. Other factors that favour the use of ground water include cheap technology, dilapidation of public utilities, and the relatively clean state of ground water. (Shah *et al*, 2007). With a policy shift from large-scale irrigation to small-scale localized irrigation being promoted in most developing countries (Kafle *et al* 2021; Takeshima, 2016), the role of groundwater in agriculture is rising. As noted by Komakech and de Bont (2018), groundwater is more resilient towards the changing rainfall patterns due to climate change, and thus is increasingly seen as a potential source of irrigation.

Ebonyi state is one of the states of South-eastern Nigeria, where crop agriculture is practiced extensively. Known mainly for rice cultivation, the historical introduction of rice growing in the state is traced to 1942 (Okonkwo et al, 2021) by the colonial Department of Agriculture. Rice is a water loving crop that performs well in wet areas, and unlike other crops, cannot survive in low soil moisture areas (Huke, 1976, as cited in Amaechina and Eboh, 2017). Apart from rice, other high value crops grown in Ebonyi are vegetables. With erratic rainfall being experienced, there is a dire need for alternative or supplementary water source for agriculture.

Most water abstraction for irrigation is from surface water like rivers and lakes, but increasingly farmers are exploring ground water for agriculture. However the dynamics of ground water abstraction for agriculture has not been well studied. As noted by Takeshima and Adesugba (2014), private investment in small-scale irrigation has been low inspite of program targeted at stimulating private investment like FADAMA. Although demand for higher value crops grown through irrigation like rice and vegetables is growing, the use of irrigation by crop farmers is not commensurate (Takeshima & Adesugba, 2014). While some studies have been conducted in Nigeria to examine ground water use for agriculture , most focused on hydro-chemical and physico-chemical aspects (Abugu *et.al*, 2024; Fadipe *et al*, 2022; Adewumi *et al*, 2016; Asiwaju-Bello, 2013), ground water management, with few on socio-economic aspects (Xie, *et al*, 2023). Understanding farmers' perceptions and the costs of ground water irrigation equipment is important for promotion of its adoption, hence this study. The objectives of this study were to ascertain farmers' annual cost attributable to irrigation equipment; examine farmers' perception of ground water irrigation, elicit socio-economic factors that influence ground water use for irrigation; and identify constraints associated with ground water irrigation. Such information will guide program and policies on use of ground water for agriculture.

Research Methods

Study area

The study area is Ebonyi state. The State is in South Eastern part of Nigeria. The mean annual temperature is about 80°F and the mean annual rainfall varies between 1700mm to 2500mm (Eze & Idike, 1997). The state is known to have long wet season from April to October followed by a long dry season from November to March. The people in the state are predominantly crop farmers. The presence of large arable lands, rivers and streams has made farming very attractive amongst the people. The farmers are engaged in growing different types of food and cash crops such as rice, yam, cassava, sorghum, cocoyam, maize, vegetable, oil palm, groundnut

Sampling procedure, data collection and data analysis

From the three Agricultural zones (Ebonyi North, Ebonyi Central and Ebonyi South Agricultural Zones), eighty respondents were selected through a multi-stage process from local government to community level. A well-structured questionnaire was used to collect information on relevant socio-economic characteristics of the farmers, costs associated with ground water usage, farmers' perception of ground water usage as well as constraints associated with ground water usage.

The data collected were analyzed using percentages, probit regression, and exploratory factor analysis. The probit model is specified as follows:

$Pi[y = 1] = [fzi]$ …… (2.1)
Where $Zi = \beta + \beta_1 Xi$ $Y_i = \beta 1 + \beta X2i + \ldots \beta kXKi + \mu$…….…… (2.2)
Y* is observed but Yi = 0 if Yi*< 0, Yi = 1 if Yi* ≥ 0
$P(yi = 1) = p\ (y_i^* \geq 0)$
$= P(\mu_1 > -\beta_1 - \beta_2 X_{2i})$…… $- \beta K\ XK_i$……..……(2.3)
i = 1, 2……80 crop farmers.
Where Yi = use of groundwater (Dichotomous variable; use = 1, if otherwise = 0)
β = a Vector of unknown–Coefficients
X_i = C vector of characteristics of the individual and is the independent variables, which are defined as follows;
AGE = Age of crop farmers
EDU = Educational level of crop farmers
EMP = Number of employees in the farm
SEX = Sex of crop farmers
EXP = Farmers experience
TCM = Total income of crop farmers
FMS = Farm size
HHS = Household size
TOC = Type of crop (Rice= 1, otherwise =0)
DIST = Distance of groundwater site to farm
MRS = Marital Status
COOP = Cooperative society membership
ARM = Access to remittances (Access=1, otherwise = 0)
NHM = Number of Household members earning income
ε_i = Error term

Results and Discussion

Table 1: Socio-economic characteristics of the farmers

Variable	Frequency	Percentage	Mean
Age			
21-30	23	28.75	
31-40	23	28.75	
41-50	11	13.75	43
51-60	15	18.75	
>60	8	10	
Gender			
Female	12	15	
Male	68	85	
Marital status			
Married	64	80.00	
Widowed	10	12.5	
Single	6	7.5	
Years Schooled			
None	6	7.5	
1-6	20	25	
7-12	20	25	9
13 and Above	34	42.5	
Membership of Cooperatives			
Yes	53	66.25	
No	27	33.75	
Household size			
1-5	33	41.25	
6-10	26	32.50	8
11-15	21	26.25	
Farm Experience			
Below 5 years	24	30.0	
5-10	29	36.25	11
11 and Above	27	33.75	
Use of Ground water			
Yes	57	71.25	
No	23	28.75	
Farm Size(ha)			
1-2	63	78.8	
3-4	14	17.5	1.5
5-6	3	3.8	
Major Crop Grown			
Rice	37	46.25	
Maize	20	25.00	
Yam	13	16.25	
Vegetable	10	12.50	

The socio-economic characteristics of the respondents were ascertained and presented in table 1. The mean age was 43 years and most of the farmers (71.25) were within the age range of 21-50 years. This youthful age in agriculture is desirable as farming requires strength and energy. The study showed that 85% were male. Most of the respondents (80%) were married. In terms of educational attainment, 67.5% of the respondents had secondary to higher education. This level of education may influence their ability to accept good farming practices as education has been attributed to influence agricultural

productivity, income and nutritional outcomes (World Bank, 2007). The marked predominance of men in agriculture in Ebonyi state may speak to issues of gendered norms and relations that affect access to productive resources by women. The mean household size was 8, with the majority (41.25%) having 1-5 household members. The farmers have some measure of experience, having a mean year of farming of eleven years. Most of the respondents (71. 25) use ground water for agriculture. The average land holding amongst the respondents is 1.5 hectares. Rice is the major crop (46.25%) grown amongst the respondents.

Table 2: Investment cost for equipment in groundwater Use (depreciated value)

Equipment	Total value (Purchase Cost)	Life Span (years)	Depreciation	Total
Long Rubber Hose	12 000	4	3,000	
Sumo water Pump	20900	2	9,500	
Electricity Generator	61975	5	12,395	
Sub-total				24,895
Maintenance Cost				5897
Total value to depreciate				30,792

The equipment used for irrigated agriculture by the farmers are presented in table 2 as well as their purchase price and depreciated value. The farmers generated electricity to power the process using generators. They used sumo water pump for pumping the water up from the wells or borehole. For water distribution, the respondents used long hose to channel the water to their farms. The average costs are as presented in the table. The average annual depreciated value for the equipment in total was 24, 895, while the maintenance cost was 5897.

Table 3: Perception of ground water use by Farmers

Perception	Mean	S. D
Timely and suitable for crop production	4.145455*	0.543819
Not necessary to purchase ground water since rain water served the same purpose	2.509091	0.873863
Ground water poses additional cost in crop production	3.345455*	0.900036
It is not necessary to use ground water in crop production because it has true economic value and should not be wasted	2.4	0.628335
Distance of my borehole to farm poses much difficulties especially during dry season crop cultivation	2.909091	0.672029
I do not use it because I do not know how to operate the technology	2.727273	0.824936
I don't cultivate crop that need ground water	2.963636	0.933503
I do not think it is necessary using other sources of water except rain water	2.709091	0.998538
I would like to minimise cost of production	2.872727	1.01786
I like it, if the suppliers of ground water can supply to my farm	2.854545	1.257574
We should not deplete our natural resources so that future generations can use them too	2.781818	1.29133
I don't use it because of downstream effect of irrigation	2.6	1.361698
Intensive ground water withdraw for agriculture contributes to depletion of streams, rivers and lake s	2.709091	1.545416
Intensive use causes salinization of aquifers	2.581818	1.614866
Intensive pumping can cause land subsidence	2.781818	1.788854
Ground water is the best source of water in my locality	2.890909	1.869006

It is good for the crops I grow	2.654545	2.002515
Ground water site is very close to my farm, it does not cost much to purchase it	2.672727	2.186069

Note: X = Mean
SD = Standard Deviation
*Shows significance

The perception of ground water use is shown in Table 3. A five point likert scale was used to elicit the farmers' knowledge and attitude towards ground water. Only two attributes were significant. From the farmers' perspective, ground water would make water availability timely and suitable for crop production. This attribute speaks to convenience. According to Sutton and Butterworth (2021), convenience is the major reason and motive for investing in well digging. Having access to a well or borehole makes it convenient in the sense that the farmer can start farming earlier in the year, when the rains are not yet steady, and can grow higher valued crops. At the same time, the farmers felt it would entail additional costs for them to use ground water.

Table 4: Socio-economic factors Associated with Ground water Use

Variables	Coefficient	Z-statistic	Standard error
Constant	-1.545744	-0.79	1.963709
Age	-.0969049	-2.14**	0.452536
Gender	.815067	1.12	0.7272454
Marital Status	.322686	1.05	0.3061753
Household Size	-.1050019	-1.43	0.731869
Years spent in School	-.0110681	-0.16	0.690388
Type of crop grown	2.2013	2.75***	0.7993243
Crop farmers revenue	1.881121	2.31**	0.8158427
Number of Employees	.0254954	0.18	0.1405677
Dist. from Water Source	.52233	1.01	0.5164357
Farm Size	1.300478	2.66***	0.4884167
Coop. Membership	-.1454648	-0.22	0.6666935

Pseudo R^2 = 0.7207**, LR chi2(12)** = 68.68**, Prob > chi2** = 0.000
***Significant at 1%, **Significant at 5% and *Significant at 10%

As indicated in Table 4, the findings show that several socioeconomic factors were found to be significantly associated with the groundwater used by farmers. The age of the farmers, type of crops cultivated, farm revenue, and farm size notably exhibited statistically significant influence on the utilization of groundwater in the area. These findings are consistent with the previous works which highlighted the demographic influence and economic factors on adoption of groundwater use (Evans *et al.,* 2012). Bhatia and Singh (2024) emphasized that; the influence of farm size on groundwater use efficiency is evident, with larger farms consistently exhibiting higher groundwater use efficiency. Furthermore, factors such as the farmer's age, farm size, tube well type, and district-related variations played significant roles in impacting paddy efficient use of water resources. These variables have been shown to shape the capacity of farmers and decisions to invest in and access groundwater resources to enhance agricultural productivity.

Conclusion and Recommendations

Irrigation development is critical to improve food security and increase income of farmers. However ground water as source of irrigation is currently underutilized in Nigeria. Use of ground water in crop farming in Nigeria has not been well examined. This study ascertained the costs associated with ground water use, the perception of the farmers about use of ground water for irrigation as well as the factors that influence ground water usage. The socio-economic characteristics showed that majority of the farmers were youthful in age; attended at least primary school, and had average household size of 8 people.

The farmers' perception of ground water use showed they were willing to use it baring some constraints like. The socio-economic variables that determined farmers usage of groundwater were age; type of crop grown, crop farmers revenue as well as farm size. It is recommended that farmers be supported in the acquisition of groundwater equipment. Support in terms provision of pumping machine, and solar panel would make it easier for farmers to explore ground water for farming. Improving farmers' access to credit would also make it easy for them to acquire loan for investing in ground water infrastructure.

References

Abugu H.O., Egbueri J.C., Agbasi J.C., Ezugwu A.L., Omeka M.E., Ucheana I.A., and Aralu C.C. (2024) Hydrochemical Characterization of ground and surface water for irrigation Application in Nigeria: A review of progress. Chemistry Africa 7 3011-3036 (2024) https://doi.org/10.1007/s42250-024-00917-2

Adewumi A.J., Omoge O.M., and Apeabu N. (2016) Hydrochemical assessment of groundwater for domestic and irrigation usage in Uzebba Area, Edo State Southwestern Nigeria. AJors 1(2):23–36

Ajetomobi J., and A. Abiodun (2010) Climate change impacts on cowpea productivity in Nigeria. African Journal of Food, Agriculture, Nutrition and Development Vol 10 (3)

Amaechina E.C and Eboh E.C. (2017) Resource Use efficiency in rice production in the Lower Anambra Irrigation Project, Nigeria. *Journal of Development and Agricultural Economics* Vol 9 (8) 234-242. Doi: 10. 5897/JDAE2016.0764

Asiwaju-Bello Y.A., Olabode F.O., Duvbiama O.A., Iyamu J.O., Adeyemo A.A., and Onigbinde M.T. (2013) Hydrochemical evaluation of groundwater in Akure Area, South- Western Nigeria, for irrigation purpose. Eur Int J Sci Technol 2(8):235–249

Azadi H., Moghadaam S.M., Burkat S., Mahmoudi H., Van Passel S., Kurban A., and Lopez-Carr D., (2021) Rethinking resilient agriculture: from Climart -Smart Agriculture to Vulnerable-Smart Agriculture. *Journal of Cleaner Production* Vol 31 9 https://doi.org/10.1016/j.jclepro.2021.128602

Bhatia, S., and Singh, S. P. (2024). Assessing Groundwater Use Efficiency and Productivity across Punjab Agriculture: District and Farm Size Perspectives. Agriculture, 14(8), 1299. https://doi.org/10.3390/agriculture14081299

Endalew B., Elias A., and Yasunobu K. (2024) Impact of Cluster Farming on Smallholder Farmers teff commercialization in Ethiopia. Agriculture and Bioscience (2024) 5:18 https://doi.org/10.1186/s43170-024-00220-7

Enimu S.I., Onome E.G., Okuma O.L., and Achoja F.O. (2022) Choice of climate change adaptation strategies used by food crop farmers in Delta State, Nigeria: Multinomial Logistic Regression Approach. *Nigerian Agricultural Policy Research Journal* vol 10 special issue 1-290

Evans, A.E.V., Giordano, M. and Clayton, T. (2012). Investing in agricultural water management to benefit smallholder farmers in Zambia. AgWater Solutions Project country synthesis report IWMI, 2012.

Fadipe O.O. Adebanjo A.U., Thanni M. O., and Olawuyi O.A. (2022) Assessment of groundwater quality for irrigation purposes in Ilesha West Local Government, Osun State. Water Cycle 3 (2022) 160-170.

FAO (2018) Small family farms country fact sheet: Nigeria. Food and Agriculture organization

FAO(2025) Nigeria at a glance. https://www.fao.org/nigeria/fao-in-nigeria/nigeria-at-a-glance/en/

Federal Ministry of Agriculture and Rural Development (2022) National Agricultural Technology and Innovation Policy (NATIP) 2022-2027.

Imburgia L (2019). Irrigation and Equality: An integrative Gender Analytical Approach to Water Governance with Examples from Ethiopia and Argentina. *Water Alternatives* **12** (2) 571-587

Jayant B., Dahiya K., Rukhiyar A., Raj R., and Meena R.K. (2022). A review of the Drip Irrigation System. *Journal of Engineering Research and Application* **1** (2022)

Kafle K., Omotilewa O., Leh M., and Schmitter P., (2021) Who is likely to benefit from Public and Private Sector Investments in farmer-led Irrigation Development? Evidence from Ethiopia. The Journal of Environmental Studies 58:1 55-75 https://doi.org/10.1080/00220388

Komakech H.C., and de Bont C. (2018) Differentiated access: challenges of equitable and sustainable ground water exploitation in Tanzania. Water Alternatives 11(3): 623-637

Maja M.M., and Ayano S.F. The impact of Population growth on natural resources and farmers capacity to adapt to climate change in low-income countries. Earth Systems and Environment. https://doi.org/10.1007/s41748-021-00209-6

Mungai L.M., Snapp S., Messina J.P., Chikowo R., Smith A., Anders E., Richardson R.B., and Li G. (2016) Smallholder Farms and the potential for sustainable intensification. *Frontiers in Plant Science* 7: 1720 doi: 10.3389/fpls.2016.01720

Ndekwa A.G., Kalugendo E., Sood K., and Grima S. (2023) An analysis of agribusiness digitalization transformation of the sub-sahran African countries small-scale farmers' production. Research on World Agricultural Economy Vol 4 (3) 2023

Nkoka F., Veldwisch G.J., and Bolding A. (2014). Organisational modalities of farmer-led irrigation development in Tsangano District, Mozambique. Water Alternatives 7(2): 414-433

Obayelu A.E., Obayelu O.A., Bolarinwa K.K., and Oyeyinka R.A., (2021) Assessment of the Immediate and Potential Long-Term Effects of COVID-19 Outbreak on Socio-economics, agriculture,security of food and Dietary intake in Nigeria. Food Ethics (2021) 6:5 https://doi.org/10.1007/s41055-021-00085-w.

Okonkwo U.U., Ukaogo V., Kenechukwu D., Nwashindu V., Okeagu G., and Adu-Gyamfi S. (2021) The politics of rice production in Nigeria: The Abakaliki example, 1942-2020. *Cogent Arts and Humanities* 8 (1) https://doi.org/10.1080/23311983.2021.1880680

Pawlak K., and Kolodziejczak M. , (2020). The role of agriculture in ensuring food security in developing countries: considerations in the context of the problem of sustainable food production. Sustainability 12

Saad M. B. (2013) The Global Hunger Crisis: tackling food insecurity in Developing countries. Pluto Press. London pp. 183-203

Shah, T., Burke, J., and Villholth, K. (2007). Groundwater*:* a global assessment of scale and significance. In D. Molden (Eds.), *Water for Food, Water for Life, Earth scan, London,* UK and Colombo, Sri Lanka, 395–423

Sutton S. and Butterworth J. (2021) Self Supply: filling the gaps in public water supply provision. Practical Action Publishing, Rugby. Pp1-330

Takeshima H and Adesugba M. (2014) Irrigation Potential in Nigeria: some perspectives based on factor endowments, tropical nature, and patterns in favorable areas. IFPRI Discussion paper 01399

Takeshima H. (2016) Understanding Irrigation system diversity in Nigeria: a modified Cluster analysis approach. *Irrigation and Drainage* (2016) **65** (5) 601-612. DOI: 10.1002/ird.1973

Villholth K.G. (2013) Groundwater Irrigation for Smal holders in sub-Saharan Africa – a synthesis of current knowledge to guide sustainable outcomes. Water International Vol 8 (4) 369-391 https://dx.doi.org/10.1080/02508060.2013.821644

Wambua Gichimu B.M., and Ndirangu S.N. (2021) Small holder Coffee Productivity as Affected by Socio-economic Factors and technology Adoption. Hindawi International journal of Agronomy Vol 2021 https://doi.org/10.1155/2021/8852371

Xie H., Schmitter P., Obayelu A.E., Edward K., Balana B., and Ringler C. (2023) Unlocking the potential of farmer-Led Irrigation Development in Central and Northern Nigeria: what does it take? Estimates from a combined biophysical- socio-economic analysis. International food Policy Research Institute