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# Access to livelihood capitals and propensity for entrepreneurship amongst rice farmers in Ghana

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## Abstract

**Background:** This paper examines rice farmers' access to livelihood capitals (natural, financial, physical, social and human) and the relationship and propensity for entrepreneurship capacities amongst rice farmers in the northern and Ashanti regions of Ghana. A simple random and purposive sampling method was used to select a sample size of 301 rice farmers in the two regions. A structured questionnaire was used in conducting the study. The data was analysed with IBM SPSS version 21 using frequencies, percentages, means and standard deviation. Wilcoxon sign rank test, paired *t* test and Pearson correlation coefficient were also used for the analysis on the access to livelihoods, significance and relationship to entrepreneurial activities of the farmers.

**Results:** Farmers' access to natural capitals was stronger. Similarly, the Wilcoxon sign rank test and test statistics for the physical capital also revealed a significant difference in the farmers' physical capitals with all the measured variables including irrigation infrastructure ( $z = -5.581; p = 0.000$ ), processing facilities ( $z = -5.904; p = 0.000$ ), and market access ( $z = -6.171; p = 0.000$ ), after been exposed to the technology interventions. The test statistics shows significant difference in all the measured variables with the *p* value ( $p > 0.05$ ) for the human capitals of the farmers. It also showed that farmers' credit from family and friends, access to bank loans and loans from farmer groups all increased from 47 to 52 %; 26 to 37 % and 28 to 78 %, respectively. Generally farmers' access to all the five livelihood capitals was significant and higher. On the access to livelihood capitals and its entrepreneurial abilities, natural capitals before ( $t = 1.789, p = 0.074$ ), natural livelihood after ( $t = 1.664, p = 0.096$ ), social capital after ( $t = 1.838, p = 0.066$ ), and physical capital before ( $t = 2.87, p = 0.004$ ) showed a significantly positive relationship with their entrepreneurial capacities.

**Conclusions:** The study revealed that farmers' access to stronger livelihood capitals improves on their internal locus of control, improves their farming management abilities and ultimately boosts their agricultural entrepreneurial capabilities. The study recommends that farmers should leverage on their human capitals (farming skills taught them) to improving on all other livelihood capitals for better business sense and culture and entrepreneurial skills.

**Keywords:** Livelihood capitals, Farmers, Rice, Entrepreneurship, Agriculture, Ghana

## Background

Agriculture is a greater contributor to poverty through jobs creation, food security and availability to world economies [1, 2]. Approximately 1.5 billion people are engaged in smallholder agriculture across the world.

They include 75 % of the world's poorest people, whose food, income and livelihood prospects depend on agriculture [3]. It is undoubtedly seen as a bigger contributor to reducing poverty in a mass form than any other intervention according to [1]. By 2050, Africa's population will be 1.7 billion people [4] putting an overwhelming pressure on agriculture to feed the people and create jobs. These jobs will not only come from primary production of crop commodities and livestock, but through

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entrepreneurship as well. This is because of the shift in primary production to feed an agro-based processing paradigm and the wider expansion and involvement of other stakeholders in development. According to [5], the support to this shift from primary to processing, entrepreneurship and innovation stem from the support of agricultural extension support services and agricultural pro policies.

People's ability to escape poverty depends on access to assets or livelihood capitals [6]. This means that sustainable livelihoods are achieved through access to a range of livelihood resources (natural, economic, human, social and physical capital) which are combined in the pursuit of different livelihood strategies [7]. Rice is a critical, important and a major food security crop in Ghana where about 950,000–1,644,221 metric tons are consumed annually [8, 9], but can only produce 580,000–600,000 metric tons leaving a huge deficit gap. The rice farmers who produce rice as a cash crop to supplement household's income see themselves as entrepreneurs. Combining all sources of available resources to produce, process, store, transport and sell to consumers or other actors along the rice value chain are what they do as small-scale farmer entrepreneurs. The rice production process is considered a major livelihood option that depends on the available livelihood capitals. These livelihood capitals (natural, physical, human, social and financial) are a major asset for every individual wellbeing which are in different proportions of access and availability [7, 10].

Based on the sustainable livelihood framework, [11] explains livelihood as 'the activities, the assets, and the access that jointly determine the living gained by an individual or a household'. He further defined 'rural livelihood diversification' as 'the process by which households construct a diverse portfolio of activities and social support capabilities for survival and in order to improve their standard of living'. The diverse portfolio of activities requires some level of innovation and entrepreneurship to improve rural livelihoods and create enabling business opportunities and incomes. It helps to influence rural livelihoods through decisions they make about the management of their wealth or capital resources in their households.

Human capital describes the availability of farmers, rice processors, rice marketers, agro-inputs dealers, labour and agricultural technical officers who have the skills, knowledge, ability to utilise their capabilities to undertake rice production as their livelihood option. The type of knowledge and experience applied on the pre- and post-production scale of rice directly relates to the outcomes. The experience, skill and knowledge again help to minimise the adverse effects of vulnerabilities the

production processes are exposed to. Farmers' ability to select good seeds, prepare and keep good records of their incomes and expenditures incurred, appropriate agronomic practices on the life cycle of the rice plant and the right technique to reduce post-harvest losses will inure to a good yield and income. Family labour is an important form of human capital according to [12]. The quality of the rice produced will also be good, making rice millers and marketers get return on their investment because customers will have value for their money. This process will result in a sustainable livelihood process for all the actors in the chain including labour that drives the activities of the production process with guaranteed wage.

The social capitals of farmers include family, friends, trust, norms, communality, gatherings, and networks of farmer associations and other actors like agro-inputs dealers, land owners and agricultural extension officers. All the networking within these knowledge communities does that with a common purpose and interest. Availability and accessibility to the rice production technologies, and rate of adoption by the farmers have stronger links to their social capital. Social networks may indirectly affect agricultural productivity by influencing farming practices and the household's propensity to adopt newer technologies via the supply of information through these networks [13, 14]. The networking and membership allow them to learn from each other and depend on specific individual capabilities for their own benefits. Farmers' adoption levels also increase if they are influenced by their colleague's farmer other than outsiders. Memberships in more formalised groups (farmer-based organisations) often adhere to mutually agreed or commonly accepted rules, norms and sanctions. This improves their yields and livelihood outcomes with good strategies to manage the rice farming variabilities. More so, labour which is a bigger agricultural capital is largely from family and hired source for rice production activities [15]. Therefore, family plays an important role in the labour sources for rice production which helps them to reduce cost and cope with the intensification process and the vulnerabilities involved, but can have an adverse impact if the bond and belongings are not there. The solidarity component with trust helps them in times of disasters like droughts, poor yields, pest and disease outbreaks and flooding by supporting each other with inputs and even labour in the affected member's farms.

Natural capital which includes improved access to land, land area cultivated agricultural, fertile soils, water availability and accessibility, pollution elements, livestock and crops are the main drivers of agriculture. Availability and access to these elements of natural capital depend on the capability of the farmers to accessing and utilising the resources. Rice is produced well under fertile soils

and available water relying with the farmer's best use of knowledge and agronomic practices. The knowledge to maintain and sustain the availability of the natural capitals relates to the efficiency of the human capital and the shared values of the social capital. Watershed management and maintenance, not polluting the streams and canals for irrigation, dredging of the water ways, protecting the vegetation and good soil management help the farmer's production process, improving their coping mechanisms to shocks and vulnerabilities. More so, the maintenance helps in sustaining the availability of the capitals for continues use. Livelihood diversification of the available natural resources by the rice farmers can also help them cope with the disasters and vulnerabilities. Vegetables can be grown during the off-peak season of the production to improve their household incomes and financial capitals as well.

Rice farming is one of the livelihood sources with higher return on investments in Ghana aside cocoa [9] that help farmers to acquire physical assets. This fact means that production (acreage and yield), rice milling machines, power tillers, land, tractors and many others may be accessible to these farmers who have good return on their investment or otherwise good incomes. Farmers turn to invest more in housing, health care and education of their children [16]. Access to irrigation facilities, roads, storage and markets facilitates the strength of farmer's physical capital and improves the livelihood outcomes. The incomes generated from the production process provide cash to cover the expenses for their clothing, housing, education and other social amenities of the majority of people in rural areas [17]. Whereas the non-availability of the capitals weakens the resilience and coping mechanisms of these farmers during disasters or any adverse event like bush fires and droughts. The inter-relationship with social capital to physical is the link and network to seed and other input suppliers, ice millers, etc., which tends to a good will for the farmer and the other actors' concern. The financial capital of the farmer will have to be better and strong if the physical capitals are to be sustainable [18]. The knowledge, innovation and training of the farmer, and the processors as elements of human capital greatly contribute to a better coping strategy and recovery during difficulties and challenges. Government support to them in boosting their resilience will provide good roads for easy access, access to processing and bigger ware houses for their produce and easy land acquisition for rice production.

Financial capital is seen within the sustainable livelihoods framework as the financial resources people use to achieve their livelihood objectives. This capital in agriculture is generated and converted from farmers' product into cash for household expenses and also to be

used for savings towards challenging times and bad seasons. Farmers depending on their trainings and support from extension officers can utilise formal and non-formal financial resources and institutions. This type of livelihood strategies and activities can guarantee the level of financial capital they can access or it is available to them. Ministry of Food and Agriculture (MOFA) [9] in their reports argues that farmers who are in stronger farmer-based organisations (FBOs) which are a social capital element, could access financial support easily from local banks and microfinance companies as well from their own contributions than those who are not. It is inferred that a higher level of social and financial capital occurs in FBOs with internally generated revenue sources and savings culture [19]. This particular view had been earlier upheld by the [20] declaration that most successful groups are those in which a larger proportion of lending capital is derived from group members' savings. This will automatically add up to improve their coping mechanisms during hard times and better their livelihood outcomes. Aside converting their product into cash and getting support from financial institutions, labour works by the farmer and other diverse livelihood activities within the available period can result into a strong financial capital for the farmers [21]. Whilst accessing the strategies and coping mechanisms of these rice farmers and the likely outcome from agricultural interventions and its entrepreneurial leverage, it is necessary to examine the policy and institutional context within which these capitals exist as espoused by [7, 10]. Whilst some capitals may be vulnerable to certain shocks, it may be that authorities are able to act and limit any damage which occurs or perhaps provide recompense [22]. In this sense, the response and support of the district assemblies and the government agencies to the external threats of farmer's livelihoods is critical.

In complex changing economies that are globally linked with niche developmental trends, farmers need to be more entrepreneurial with business sense and approach. There is pressure for farmers to change their production roles to all-round entrepreneurship paradigms, diversifying away from the production of crops and livestock as raw commodities to an agro-based transformation and further up on the agricultural value chain [23]. Dealing with all rice value chain actors including input dealers, suppliers, transporters, farm labour, agricultural extension officers, marketers and consumers' etcetera requires some level of skills and assets. Farmers ability to deal with challenges such as vulnerability to production and post-production shocks, access to finance and credit, access to required information, low bargaining power for their produce, unskilled or low technical knowledge etcetera relates to the strength of their livelihood capitals and how

they access it [24]. In all these interplay, the relationship and propensity for entrepreneurship depend largely on the access to livelihood capitals and its level of proportions available to the rice farmers. This paper therefore aims to examine rice farmers' access to livelihood capitals (natural, financial, physical, social and human) and the relationship and propensity for entrepreneurship build up amongst them in Ghana.

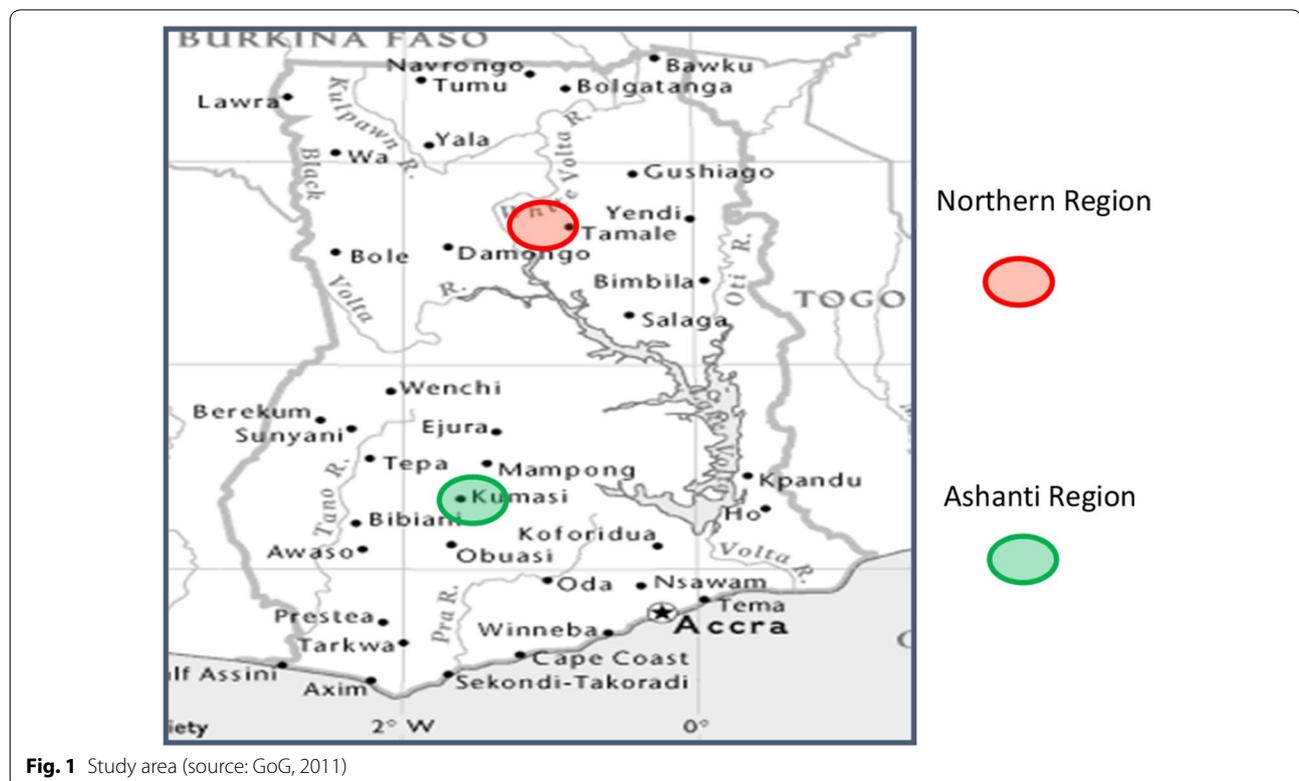
## Methodology of the study

### Study area and population of the study

The study area covers the Ashanti and the northern regions of Ghana. Ashanti falls within the semi-deciduous agro-ecological zone of Ghana and is located by latitude 6°52'N and longitude 1°51'W. The area is on an altitude of approximately 280 m above sea level. The region experiences double maximum rainfall in a year, with peaks in May/June and October. Mean annual rainfall is between 1100 and 2900 mm. The mean annual temperature ranges between 25.5 °C in the southern districts and 32 °C in the northern parts of the region. Humidity is high averaging about 85 % in the southern districts and 65 % in the northern part of the region, whilst the northern region on its part occupies an area of about 70,383 km<sup>2</sup> and represents the largest region in Ghana in terms of land area. The vegetation consists predominantly of grassland, typically Savannah with clusters of

drought-resistant trees such as baobabs or acacias, mangoes and neem. Between May and October is the wet season, with an average annual rainfall of 750–1200 mm (30–40 in.). The dry season is between about November and April. The two regions have a total of over 7000 rice farmers according to MOFA [9] (Fig. 1).

With the approval and support of the MOFA in the Ashanti and the northern regions of Ghana through their district agricultural offices, a total of 301 rice farmers were selected for the interviews. These selected farmers were beneficiaries of a rain-fed lowland rice production project where technical agricultural interventions, skills and technologies were extended to them to improve their production and incomes ultimately. The project was supported by both the Government of Ghana (GoG) through the MOFA and the Japanese Government through Japan International Cooperation Agency (JICA) from 2009 to 2014. With a total farmer population of 2221 of the project and a confidence level of 95 and 5 % precision level, a sampling formula of  $n = N/1 + N(e)^2$  was used to arrive at the sample size (301) in selecting the farmers, where  $n$  = the sample size,  $N$  = total farmer population and  $e$  = error tolerance. Sarantakos Sotirios argues that a bigger sample size gives better accuracy than smaller sample sizes and lower sampling error [25]. Simple random sampling was done to select the 301 respondents for equal chance of representation of being part of the study. This



**Fig. 1** Study area (source: GoG, 2011)

method increases the probability of every respondent to be part of the study.

Open- and close-type questionnaires were used in conducting the study. The questionnaires were grouped based on the five livelihood assets classifications of the livelihood frameworks (Bio-data, rice farming, physical capital, social capital, human capital, financial capital, natural capital and entrepreneurship). A consent approval was sort from each rice farmer before the questionnaire administration began and the entire purpose of the study explained to them before the start of the study. The data collected were subjected to descriptive analysis with the use of frequency counts, percentages, and standard deviation. IBM-SPSS version 22 and Microsoft excel sheets were used to analyse the data.

**The Wilcoxon signed-rank sum test**

Wilcoxon theory of sign test compares two related samples like (before and after) with the same sample population for scoring and ranking [26]. The test applies to two-sample designs involving repeated measures and matched pairs, in this case for beneficiaries before and after the impact or differences on their livelihoods. The Wilcoxon signed-rank sum test as used in the study does not assume that the difference between the variables is interval or normally distributed but assumes that the differences are ordinal. The test is robust and highly efficient for moderate to heavy tailed underlying distributions. In particular, it is an improvement over the sign test and very efficient when the underlying distribution is normal [27]. Hettmansperger [27] further added that Wilcoxon signed-rank statistics can be computed as sign statistic of the pair-wise averages of data.

Mathematically, the explanation for the Wilcoxon signed-rank test for the study is as follows;

$$W = \left| \sum_{i=1}^{N_r} [\text{sgn}(x_{2,i} - x_{1,i}) \cdot R_i] \right| \tag{1}$$

where  $W$  = Wilcoxon signed-rank test,  $N_r$  = sample size,  $X_{12}$  = measuring levels. For  $I = 1, 2, \dots, n$ ,  $X_1(N_1, H_1, P_1, S_1)$  before the technology intervention;  $X_2(N_2, H_2, P_2, S_2)$  after the technology intervention;  $R_i$  rank; With  $N$  natural capital,  $H$  human capital,  $P$  physical capital and  $F$  social capital. Hence

$$W = \left[ \sum_{i=1}^{N_r} \text{sign}(X_2(N_2, H_2, P_2, S_2) - X_1(N_1, H_1, P_1, S_2)) \cdot R_i \right] \tag{2}$$

As  $N_r$  increases, the sampling distribution of  $W$  converges to a normal distribution.

The remaining  $N_r$  pairs were ranked ( $R_i$ ) from the smallest absolute difference to the largest absolute difference of the capitals, thus  $[X_2(N_2, H_2, P_2, S_2) - X_1(N_1, H_1, P_1, S_2)]$ .

**The Probit model**

The Probit model is often used in situations where an individual makes choices between two alternatives. In this case, the decision is to either adopt or not adopt technologies or interventions in rice production to improve on their livelihoods and entrepreneurial activities. The Probit model was then used to determine farmer’s entrepreneurial abilities as a result of access to the key livelihood capitals. Education, age, farming experience, income, market access, gender, extension services and the livelihood capitals were the expressed attributes hypothesised to determine the entrepreneurial propensity of the farmers. Farms and farmer-associated attributes are some of the factors influencing the adoption of new agricultural technologies to improve their livelihoods according to [28]. In the Probit model, the discrete dependent variable  $Y$  is a rough categorisation of a continuous, but unobserved variable  $Y^*$ .

If  $Y^*$  could be directly observed, then standard regression methods would be used (such as assuming that  $Y^*$  is a linear function of some independent variables, for example,

$$Y^* = \beta_1 X_{1i} + \dots + \beta_j X_{ji} + \mu_i. \tag{3}$$

In this study,  $Y^*$  is entrepreneurial abilities which is used as a proxy for  $Y^*$ . A Probit model is appropriate when the dependent variable to be evaluated is dichotomous [29].

Following from [30], the binary probit for the two choice models can be written as:

$$Y_i^* = \begin{cases} 1 & \text{if } Y_i^* > Y \\ 0 & \text{if } Y_i^* \leq 0 \end{cases} \tag{4}$$

$$P\left(Y = \frac{1}{X}\right) = F(XB) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{XB} e^{-\frac{(XB)^2}{2}} dx \tag{5}$$

$$X = (1, x_{1i}, x_{2i}, \dots, x_{ki}) \tag{6}$$

$$\beta' = (\beta_0, \beta_1, \dots, \beta_k) \tag{7}$$

The actual model specification for *farmer’s entrepreneurial propensity* as a result of access to the livelihood capitals is;  $Y_i = \beta_0 + \beta_1$  Age +  $\beta_2$  Gender +  $\beta_3$  Educational level +  $\beta_4$  Age +  $\beta_5$  Years of farming experiences +  $\beta_6$  Income +  $\beta_7$  Ready market +  $\beta_8$  Extension contact +  $\beta_9$  Human capital before +  $\beta_{10}$  Human capital after +  $\beta_{11}$  Natural capital before +  $\beta_{12}$  Natural capital after +  $\beta_{13}$  Social capital before +  $\beta_{14}$  Social capital after +  $\beta_{15}$  Financial capital before +  $\beta_{16}$  Financial capital after +  $\beta_{17}$  Physical capital before +  $\beta_{18}$  Physical capital after +  $\mu_i$  where  $Y_i$  and  $\mu_i$  represent farmers entrepreneurial propensity with access to livelihood capitals.

## Results and discussion

### Demographic characteristics of respondents

Access to livelihoods and personal welfare improvement farmers depends on some qualities and characteristics. The demographic features of the respondents captured in Table 1 reveal that majority of the farmers were youthful with an average mean age of 36 years and years of farming experience averaging 11.13 years (Table 1). From Table 1, many of the youth are engaged in rice farming which is good for Ghana's present and future agriculture and also shows signs of progress which is contrary to [31] argument that majority of the youth in Africa do not have interest in agriculture.

The findings reveal that men dominates the rice production process with 86 %, and 14 % female; however, the women have designated roles and responsibilities especially on transplanting, post-harvest, processing and marketing aspect of the rice value chain. This is consistent with Ghana's [32] policy framework for rice, which argues the issues of land tenure, access and ownership that prevented a lot of Ghanaian women from engaging in agriculture and rice farming, in particular when they are proved to be more credit worthy. Majority of the farmers had basic education level qualification and had access to market and extension services for their rice

production with an average mean income of GHc 3496. The standard deviation for the livelihood capitals for before and after showed significant variance (Table 1) to the mean, an indication of improvements in their general livelihood abilities.

Non-farm income earnings for the farmers were very significant in supporting their household expenditures complimenting their agricultural incomes (Table 2). The varied sources of their incomes indicate how entrepreneurial the farmers are through generating many activities that create employment. The three sources of income-generating activities if combine for a season means that the rice farmers' financial capitals and household incomes are stronger. As farmer entrepreneurs, source of funding for their agricultural activities is critical to their farming business sustenance. Personal savings and rice buyers were their major source of funding in addition to their relative and cooperatives (Fig. 2).

### Access to livelihood capitals by respondents

About 83 percent of the farmers responded that they had good and strong access to natural capitals including agricultural land, water and the vegetation (Table 2). The access margins include usage and access of water utilisation (82 %), land access and utilisation (73 %), tenancy arrangement (70 %) and fertility management of the lands/soil (66 %). Their access margins to these resources drastically improved or increased from their early experience without the project. Similarly, all the variables showed very high levels of significance with the test statistics ( $t$  test) which include water utilisation ( $z = -15.391$ ;  $p = 0.000$ ), land access and utilisation ( $z = -10.222$ ;  $p > 0.05$ ), tenancy arrangement ( $p = 0.000$ ) and fertility management of the lands/soil ( $p > 0.05$ ). The higher response of access to natural capitals with a strong significant  $p$  value score indicates the opportunity for them to expand their farming business to take advantage of the availability and access of the common pool natural resources. Generally, agriculture thrives on the availability and access to these resources for production [33].

Farmers' access to physical capitals also reveals some remarkable changes apart from farm roads with low response of (24 %) after the project (Table 2). Market access (from 31 to 71 %), processing facilities (mills) (from 57 to 78 %), housing facilities (from 43 to 63 %), for health (from 37 to 51 %), irrigation infrastructure (from 37 to 51 %), farm sheds (from 57 to 78 %) and net scare crows (from 43 to 63 %) all show an incremental level of change from before the project to after the project. The Wilcoxon sign rank test and test statistics for the physical capital also revealed significant differences in the farmers' physical capitals with all the measured variables (Table 2) including irrigation infrastructure ( $z = -5.581$ ;

**Table 1** Demographic characteristics of respondents

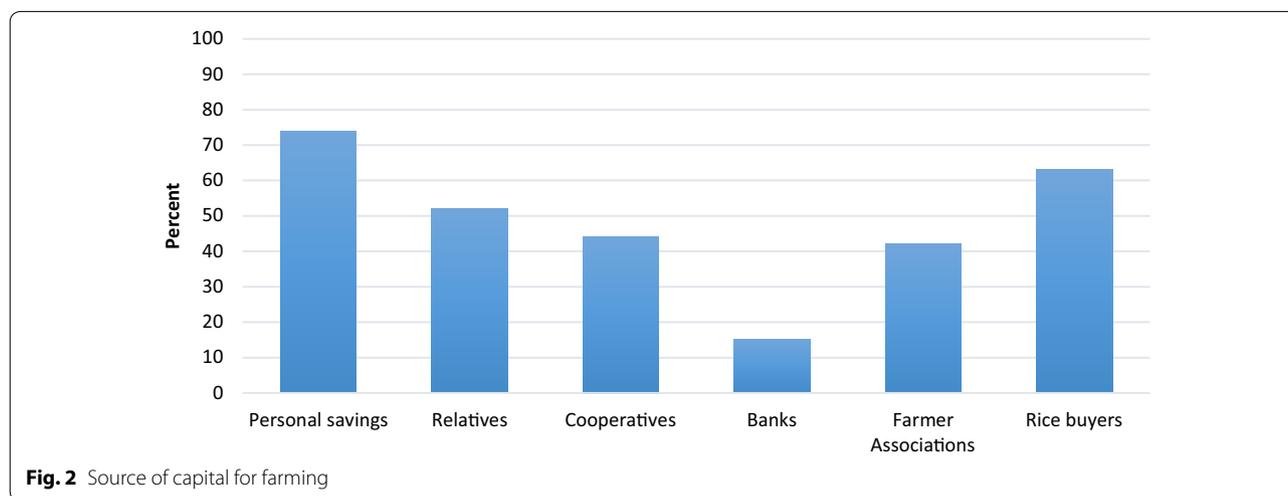
Variable	N	Mean	Std. deviation
Education	301	1.17	1.63
Age (years)	301	35.79	10.62
Farming experience (years)	301	11.13	6.98
Income (amount)	301	3496.53	3790.43
Ready market	301	1.0432	0.36714
Extension contact	301	1.8671	0.46434
Established market	301	1.8704	0.37393
Gender	301	61.6678	14.20361
Ready market	301	608.0764	57.20773
Human capital before	301	28.83	9.21
Human capital after	301	55.82	6.51
Natural capital before	301	8.59	3.48
Natural capital after	301	22.24	3.48
Social capital before	301	29.30	5.45
Social capital after	301	29.39	5.60
Financial capital before	301	11.36	1.58
Financial capital after	301	8.90	3.48
Physical capital before	301	16.79	2.94
Physical capital after	301	11.98	3.30
Positive psychological capital before	301	36.57	7.63
Positive psychological capital after	301	20.81	5.60
Entrepreneurship ability before	301	61.67	14.20
Entrepreneurship ability after	301	608.08	57.21

**Table 2 Access to livelihood capitals of respondents**

Livelihood capitals	Before the technology intervention		After the technology intervention		Wilcoxon signed ranks test			
	High	Low	High	Low	Negative ranks	Positive ranks	Z score coefficient	Asymp. sig. (2-tailed)
Natural capital								
Land access and utilisation	137 (46)	172 (57)	218 (73)	81 (27)	89	89	-10.222	0.0000
Water utilisation	98 (33)	186 (62)	245 (82)	55 (18)	246	121.5	-14.829	0.0000
Land tenure arrangement	90 (30)	208 (69)	211 (70)	87 (29)	218.73	132.5	-15.065	0.0000
Payment for land if rented	189 (63)	91 (30)	223 (74)	77 (26)	78.5	78.5	-11.609	0.0000
Land quality and fertility of soil	131 (44)	162 (54)	198 (66)	101 (34)	128.85	121.5	-9.2	0.0000
Watershed development and conservation facilities	79 (26)	162 (54)	157 (52)	142 (47)	120.91	75.8	-4.311	0.0000
Water streams	164 (55)	146 (49)	155 (52)	140 (47)	98	115.67	-10.4	0.0000
Physical capital								
Road and transport to the farms	53 (18)	247 (82)	73 (24)	227 (76)	34.85	28.5	-5.958	0.0000
Market access	92 (31)	172 (57)	212 (71)	88 (29)	29.1	28	-6.171	0.0000
Silos/storage facilities	12 (42)	162 (54)	145 (48)	155 (52)	33.17	30.5	-4.130	0.0000
Farm sheds	171 (57)	128 (43)	235 (78)	65 (22)	32.74	39.23	-4.376	0.0000
Agricultural machinery	133 (44)	176 (59)	147 (49)	152 (51)	35.68	37.73	-5.581	0.0000
Irrigation infrastructure	112 (37)	184 (63)	153 (51)	143 (47)	38.34	35.5	-6.524	0.0000
Netting scare crows	128 (43)	172 (57)	189 (63)	99 (33)	37.01	47.32	-5.328	0.0000
Processing facilities (mills)	171 (57)	128 (43)	235 (78)	65 (22)	35.87	46.19	-5.904	0.0000
Housing facilities	128 (43)	172 (57)	189 (63)	99 (33)	34.14	57.33	-5.045	0.0000
Health facilities	112 (37)	182 (61)	153 (51)	144 (48)	25.38	32.54	-3.072	0.0020
Telephone access	129 (43)	172 (57)	190 (63)	99 (33)	24.25	29.5	-2.354	0.0190
Human capital								
Extension services	137 (46)	161 (54)	198 (66)	97 (32)	118	128	-12.655	0.0000
Rice skills training	98 (33)	187 (62)	267 (89)	32 (11)	179.47	132	-14.267	0.0000
Technical training	99 (33)	189 (63)	269 (90)	33 (11)	141	141	-15.391	0.0000
Land management training	92 (31)	165 (55)	187 (62)	86 (29)	138.5	138.5	-15.229	0.0000
Disease treatment	134 (45)	162 (54)	254 (85)	46 (15)	138.5	138.5	-15.229	0.0000
Water management	121 (40)	173 (58)	215 (72)	78 (26)	141	161	-15.391	0.0000
Soil management	127 (42)	174 (58)	220 (73)	80 (27)	138	148	-14.593	0.0000
Marketing skills	93 (31)	197 (66)	187 (62)	92 (31)	138	138	-14.111	0.0000
Level of education	167 (56)	133 (44)	162 (54)	130 (43)	132	136.69	-15.098	0.0000
Innovative and creative thinking	88 (29)	181 (60)	121 (40)	173 (58)	124	125.59	-13.977	0.0000
Knowledge of farm management	87 (29)	178 (59)	137 (46)	165 (55)	114.5	116.14	-12.501	0.0000
Record keeping	96 (32)	194 (65)	262 (87)	38 (13)	154.09	192.64	-11.458	0.0000
Health status	125 (42)	175 (58)	180 (60)	120 (40)	120	121.53	-14.978	0.0000
Trainings and other services	130 (43)	162 (54)	200 (67)	96 (32)	131.5	135.72	-14.667	0.0000
Social capital								
Relationship with relatives/neighbours	230 (77)	68 (23)	231 (77)	70 (23)	122.29	89.65	-7.552	0.0000
Labour networking (for farm work)	161 (54)	134 (45)	187 (62)	119 (40)	115.37	102.65	-7.153	0.0000
Network with MOFA, AEA and assemblies	126 (42)	173 (58)	246 (82)	53 (18)	95	100.98	-11.706	0.0000
Network with financial institutions	54 (18)	165 (55)	143 (48)	160 (53)	77	83.96	-10.927	0.0000
Network with transporters	98 (33)	132 (44)	96 (32)	145 (48)	79.5	79.5	-9.388	0.0000
Network with shop owners and input dealers	97 (32)	168 (56)	154 (51)	143 (48)	106.32	98.6	-10.205	0.0000
Network with processors	125 (42)	175 (58)	197 (66)	102 (34)	96.5	98.16	-8.395	0.0000
Network with millers	134 (45)	165 (55)	243 (81)	52 (52)	88	91.46	-11.201	0.0000
Network with farmers association (FBOs)	156 (52)	140 (47)	251 (84)	49 (49)	74.5	92.71	-9.849	0.0000
Network with other production group(NGOs and civic group	118 (39)	182 (61)	132 (44)	165 (55)	69.5	74.58	-10.628	0.0000

**Table 2 continued**

Livelihood capitals	Before the technology intervention		After the technology intervention		Wilcoxon signed ranks test			
	High	Low	High	Low	Negative ranks	Positive ranks	Z score coefficient	Asymp. sig. (2-tailed)
Network with Village committee	132 (44)	165 (55)	195 (65)	106 (35)	57	71.81	-7.053	0.0000
Financial capital								
Farm incomes	178 (59)	156 (52)	213 (71)	81 (27)	82	82	-3.211	0.0010
Non-farm income/revenues	67 (22)	98 (33)	164 (55)	100 (33)	50	55.38	-3.475	0.0010
Savings	133 (44)	167 (56)	189 (63)	117 (39)	81	89.02	-5.250	0.0000
Self-help groups savings	98 (33)	192 (64)	153 (51)	144 (48)	97.26	87.38	-8.248	0.0000
Credits from relatives and friends	142 (47)	109 (36)	156 (52)	131 (44)	71	78.12	-8.493	0.0000
Access to bank credits	49 (16)	250 (83)	111 (37)	184 (61)	80.5	82.47	-6.710	0.0000
Self-help groups loan (FBOs)	83 (28)	276 (92)	234 (78)	62 (21)	75.98	72	-2.646	0.0080

**Fig. 2** Source of capital for farming

$p = 0.000$ ), processing facilities ( $z = -5.904$ ;  $p = 0.000$ ), housing facilities ( $z = -5.045$ ;  $p = 0.000$ ), market access ( $z = -6.171$ ;  $p = 0.000$ ), and telephone access ( $z = -2.354$ ;  $p = 0.019$ ), after been exposed to the technology interventions.

The level of farmers' human capital as observed from the study showed similar trend as the physical and natural capitals. Rice skill training for instance increased from 33 to 89 %, extension service from 46 to 66 %, and land management trainings of the farmers improved from 31 to 62 %. Also, the marketing skills increased from 32 to 66 % before and after the project as well as from 9 to 46 % for farmers' innovation and creativity from the study (Table 2). This affirms [34] findings that training of farmers by extension agricultural extension agents improves not only their production and skills but also their finances and household management. However, though many of the respondents experienced the change

and improvements, a few others claim they did not experience any significant change in their human capital levels. The test statistics shows significant difference in all the measured variables with a  $p$  value of  $>0.05$ .

The findings also show that farmers networking with the MOFA and the agricultural extension agents (AEAs) were very good. Their relationship with relatives and neighbours, labour networking (for farm work), network with financial institutions, network with farmers association (FBOs) as well as networking with input dealers had a strong  $p$  value ( $p > 0.05$ ) from the mean ranks which is an indication of strong access and improvements on their social capitals. Access to information and technology through networking with the relevant agencies improves farmers' performances and production abilities which lead to increase in entrepreneurial urge [35].

In addition, farmers' credit from family and friends , access to bank loans and loans from farmer groups all

**Table 3 Probit model analysis of livelihood capitals and entrepreneurial activity**

Parameters	Estimate	Std. error	Z	Sig.
Education	-0.029	0.006	-4.818	0
Age	0.003	0.001	2.83	0.005
Farming experience	0.001	0.002	0.518	0.604
Income	0	0	-27.066	0
Gender	-0.049	0.02	-2.522	0.012
Ready market	-0.065	0.03	-2.194	0.028
Extension contact	0.051	0.021	2.418	0.016
Established market	-0.143	0.028	-5.157	0
Human capital before	0.006	0.001	3.969	0
Human capital after	-0.001	0.002	-0.741	0.459
Natural capital before	0.007	0.004	1.789	0.074
Natural capital after	0.005	0.003	1.664	0.096
Social capital before	0	0.002	-0.223	0.824
Social capital after	0.005	0.003	1.838	0.066
Financial capital before	0.002	0.007	0.225	0.822
Financial capital after	0.006	0.005	1.278	0.201
Physical capital before	0.013	0.005	2.87	0.004
Physical capital after	-0.02	0.003	-6.158	0
Positive psychological capital before	0.004	0.002	1.488	0.137
Positive psychological capital after	0.002	0.003	0.533	0.594
Intercept	-1.133	0.192	-5.895	0
Chi square	13,319.44			
df	280			
p	0			

Probit model: Probit ( $p$ ) = Intercept +  $BX$

increased from 47 to 52 %; 26 to 37 % and 28 to 78 %, respectively. The  $z$  scores and the  $p$  values (Table 2) showed significant changes and relationships; thus, farm incomes ( $z = -3.211$ ;  $p = 0.001$ ), non-farm income/revenues ( $z = -3.475$ ;  $p = 0.000$ ), savings ( $z = -5.250$ ;  $p = 0.000$ ), self-help groups' savings ( $z = -8.248$ ;  $p = 0.000$ ), and self-help groups' loan (FBOs) ( $z = -2.646$ ;  $p = 0.008$ ). These results show a highly significant difference and change in their financial livelihood capitals on income, savings and credit affirming [36] position that agricultural credit and financing improve farmers' livelihoods and abilities.

#### Relationship between access to livelihood capitals and entrepreneurship

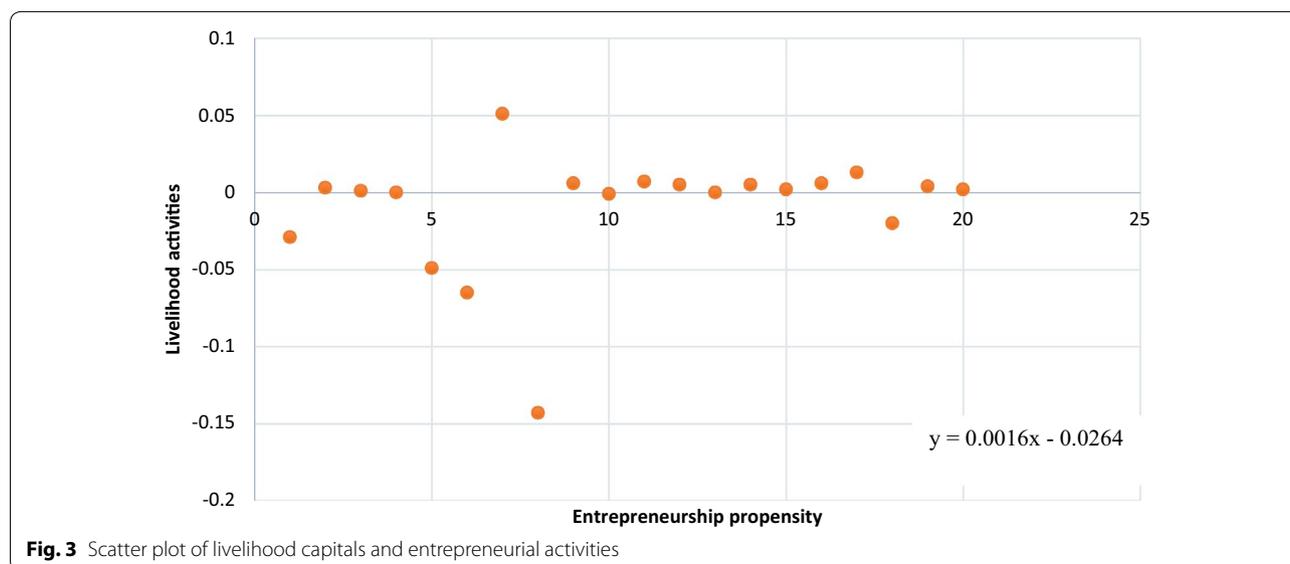
Undisputedly, farmers' main threat and challenge faced has always been strand or categorised into social barriers, economic barriers, physical barriers, regulations, access to finance and information dissemination and their managerial abilities to cope with and sustainably

be in business as well as manage risk. Hence, threading from the stronger access of these livelihood capitals of the rice farmers from the above analysis, it is expected to either translate and contribute to better and stronger entrepreneurial farmers or not have a relationship whatsoever. The coefficients in the Probit model (Table 3) reveal a statistically significant relationship that shows that access to livelihood capitals can improve the entrepreneurial abilities of the respondents (Table 3). Age is significant ( $t = 2.83$  and  $p = 0.005$ ), which means that young farmers with youthful strength are likely to develop more entrepreneurial abilities compared to the aged ones.

From Table 3, gender ( $p = 0.012$ ), ready market ( $p = 0.028$ ) for rice produce and contacts to extension officers ( $p = 0.016$ ) were all significant. These revealed how the mutual distribution of roles in the farm is based on comparative advantage, available market to sell products and other value chain products that are linked to rice. Frequent contacts to extension officers on knowledge transfer also likely could increase the business and entrepreneurial propensities of the farmers. On the livelihood capitals, natural capitals before ( $t = 1.789$ ,  $p = 0.074$ ), natural livelihood after ( $t = 1.664$ ,  $p = 0.096$ ), social capital after ( $t = 1.838$ ,  $p = 0.066$ ), and physical capital before ( $t = 2.87$ ,  $p = 0.004$ ) were all significant. Membership in multiple social networks and groups also enhances people's mental capability to perceive opportunity and additionally encourages their entrepreneurship abilities [37].

The probability of increased in entrepreneurial capacities of farmers increases with an increase in natural, social and physical capitals of farmers. The significant relationship of physical capital with entrepreneurship could be attributed to how transportation, farm machinery, market access, storage facilities and shelter can help propel entrepreneurial innovations. For social capital, the goodwill availability and the social relations and networks the farmers' access could improve their agricultural business sense and entrepreneur approach. Again, the results indicate that farmers had good access to natural capitals which is the foundation of rice farming. It could be attributed to how the access and use of land, available and access to agricultural water, however, could trigger entrepreneurial activities of farmers. These significant relationships established reveal the farmers abilities to take risk, improve on their internal locus of control and the need to achieve, and enhance their capabilities as farmers which are attributes of good entrepreneurs.

The scatter plot (Fig. 3) indicates a nonlinear relationship without layers between livelihood capitals and entrepreneurship abilities.



**Fig. 3** Scatter plot of livelihood capitals and entrepreneurial activities

## Conclusion

It can be concluded that labour is mutually shared for both males and females for the production (land preparation, weed control, fertiliser application and harvesting) and post-production (threshing, drying and cleaning) process of rice cultivation. Farmers' general access to all the key livelihood capitals strongly emerged from this research after the technology interventions. Since agriculture is the main livelihood source for the largely poor in developing and middle income countries like Ghana, a sustainable strategy of entrepreneurship propensity of farmers is the solution to many economic problems like urbanism, poverty, hunger, unemployment and economic under development. Access to stronger livelihood capitals like human skills development, knowledge of agriculture, knowledge of market, and management of the agricultural land, water resources, funding from banks and networking skills helps farmers develop strong and consolidated farming abilities. However, aside physical, natural and social livelihood capitals that showed a statistically significant relationship with entrepreneurial abilities, financial and human capitals were not significantly related though linearly correlated. The study recommends that farmers should leverage on their human capitals (farming skills taught them) to improving on all other livelihood capitals for better business sense and culture and entrepreneurial skills. Also, the business aspect of farming can be promoted by government to boost farmers' business skills and entrepreneurship capabilities too.

## Abbreviations

MOFA: Ministry of Food and Agriculture; SRID: Statistics, Research and Information Department; JICA: Japan International Cooperation Agency; FBO: farmer-based organisations; GoG: Government of Ghana.

## Authors' contributions

ME designed the data collection instruments and gathered the data, and helped in analysis and write up. OOI supervised the design, the entire data collection process and provided guide, corrections and supervision to the entire research. All authors read and approved the final manuscript.

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## Competing interests

The authors declare that they have no competing interests.

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