Farmer's Perception and Adoption of New Aquaculture Technologies in the Western Highlands of Cameroon

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Summary

Like other African countries, Cameroon is struggling to meet the food needs of its population. There are several possible solutions to this problem, such as the import of agricultural produce and increasing national production. In terms of fishery products (fish, shrimps, etc.), it would not be easy to increase national production, due to the various constraints inherent in the sector and national industry, as well as low availability of farming areas. Fish farming is one of the solutions recommended as a sustainable method of producing an adequate supply of fish (farming fish in ponds). The main objective of this study is to highlight and analyse the socio-economic obstacles that are holding back the development of fish farming in the West Cameroon. Using the univariate dichotomous LOGIT model, this study has made it possible to identify the key determinants affecting the adoption of fish farming. The results indicate that its strong commercial orientation, coupled with the positive perception of its profitability, frequent contact, extension and level of education are the main determinants for the adoption of fish farming.

Résumé

Perceptions paysannes et adoption de l'innovation piscicole dans la région montagneuse de l'Ouest Cameroun

Le Cameroun, à l'instar d'autres pays africains, connaît des difficultés pour la satisfaction des besoins alimentaires de sa population. Plusieurs solutions existent pour la résolution de ce problème. On peut citer entre autre l'importation des produits alimentaires et l'accroissement de la production nationale. Dans le cas des produits de la pêche (poissons, crevettes etc.), l'accroissement de la production nationale n'est pas toujours aisé, en raison d'une part des contraintes multiformes inhérentes au secteur et à l'industrie nationale et d'autres parts de la faible disponibilité des zones d'exploitations. L'une des solutions préconisées pour une offre durable de poissons est la pisciculture (production de poissons en étangs). C'est l'objet de ce travail qui a pour objectif principal de mettre en évidence et d'analyser les contraintes socio-économiques qui freinent le développement de la pisciculture à l'Ouest du Cameroun. En utilisant un modèle LOGIT dichotomique univarié, cette étude a permis d'identifier les principaux déterminants de l'adoption de la pisciculture. Les résultats indiquent que la forte orientation commerciale, la perception positive de la rentabilité, les contacts fréquents avec la vulgarisation, le niveau d'éducation sont les principaux déterminants de l'adoption de la pisciculture.

Introduction

In the majority of societies[a] on the African continent, fish farming represents a technological innovation, as the task involves introducing this relatively intensive practice to environments, in which only extensive farming has traditionally been practised (17). This new production technique can be seen in contexts, which are characterised by a variety of constraints - of a climatic, agronomic or socio-economic nature - and the diversity of human environments, which are not consistently receptive to technical changes.

Francis Douchamps (18) mentions that the problems affecting fish farming are very different in countries with a fish farming tradition (China, other Asian countries, Europe) from those with no established tradition. The introduction of new fish farming technologies and increased productivity therefore do not pose major problems in countries, in which fish farming goes back many generations. However, countries without a fish farming tradition face the same problem that can be observed whenever any new technology or activity is introduced. The above-mentioned authors state that the dream of improving living standards for rural

[a]With very rare exceptions, such as Benin, where traditional forms of fish farming have developed.

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households in developing countries, by increasing agricultural productivity, will remain an illusion if the rates, at which these technologies and innovations are adopted, remain low (6, 15, 22).

In terms of promoting agricultural innovations, three main paradigms are used to explain the decision to adopt these new approaches. The paradigm based on the perception of those who adopt them suggests that the perception of the attributes of the technology conditions the technology adoption behaviour of farmers. Therefore, even if they have comprehensive information on the innovation, farmers can arrive at a subjective evaluation, which give rise to different results from those obtained by scientists (9, 10, 16, 19, 24). Most studies on this topic consider the socio-economic characteristics of farmers to be key determinants affecting adoption of the new technology. Although some of these factors are important, the vast majority of these studies ignore or fail to take account of the farmers' subjective perception of the technology and its ultimate results. These studies can therefore be biased when it comes to the factors affecting farmers' decisions concerning the adoption of this technology (1).

Adesina and Zinnah (2) have shown that farmers' perception of the characteristics of agricultural technologies strongly influences their adoption behaviour, and these authors suggest that this type of factor should be included in technology adoption studies.

The objective of this study is to determine factors that may significantly influence the adoption of fish farming by farmers.

Materials and methods

Study data and region

In geographical terms, our study focused on the Cameroon's West Province. Several reasons justify selecting this region, including its relatively isolated location, in terms of fishery and hunting products, as no rivers or streams can be found there, which could be used for fish farming, except for the Mappe dam in the Noun *departement*, and the rarity of game in the savannah. In addition, the existence of a political will to promote fish farming in this area, which led to the creation of a fish farming research station, together with a breeding centre in Koupa Matapit and a centre for zootechnical and veterinary training in Foumban, which focuses on fish farming.

For the purpose of our study, the two-stage probability sampling method was used. In the end, data was collected from a sample of 120 farmers, 45 of whom were fish farmers.

Analysis model

The influence of subjective perception on the adoption behaviour for fish farming innovations and the socio-economic determinants of this adoption was analysed using the LOGIT model. The use of this type of qualitative dependent variable analysis is not a recent development (8, 9, 10). However, this was the first time it had been used for fish production in Sub-Saharan Africa. In addition, it has been shown that these models are more appropriate for the analysis of dichotomous decisions, when it is necessary to interpret a dependent variable in the form of probability (11).

Empirical model

The qualitative dependent variable (PISADOPT) assumes the value 1, if the farmer practises fish farming, and the value 0 if this is not the case.

In addition to the traditional variables, which characterise the producer and his environment, we used other variables that express the perception of fish farming, compared to food production. These variables include: perception of the complexity of fish production compared to food production, as practised by the farmer (FISHDIF), perception of the profitability of fish production compared to that of food crops (FFRENT), estimated initial cost of starting fish production (FISHCOST), perception of the income risk associated with fish production (FFRISK), the commercial or non-commercial orientation of fish production (COMMER), the existence or non-existence of marshy lowlands or a small river close to the farm (TOPO) and whether it was possible to obtain an agricultural loan (CREDIT).

Results and discussion

LOGIT model results

Like other qualitative dependent variable models, the LOGIT model enables us to predict the adoption probabilities for fish farming. However, the quality of this prediction depends on the nature and relationships between the independent variables. With this in mind, Cramer (11) states that the multicollinearity between the independent variables introduces a bias affecting the estimated coefficients.

We took this into account and therefore calculated the correlation coefficients between the explanatory variables. The results obtained by analysing Pearson-type correlations enabled us to produce three groups of explanatory variables, based on the mutual correlation coefficients. Using this procedure, all variables within the same group are those, whose mutual correlation coefficients are not significant based on thresholds of 1% and 5%.

Using the chi-square test, estimate accuracy compares the probabilities observed in the sample with those estimated by the model. Its significance rate was 0.405, 0.412 and 0.390, respectively, for explanatory variable groups 1, 2 and 3. These results indicate respective risk levels of 40.5%, 41.2% and 39% for the three estimates, if we accept the hypothesis that a difference exists between the estimated and observed

Table 1
Results from the LOGIT model - fish farming adoption estimates for the three explanatory variable groups

Group 1		Group 2		Group 3	
Variables	Estimated coefficients and probabilities ( )	Variables	Estimated coefficients and probabilities ( )	Variables	Estimated coefficients and probabilities ( )
gender (B)	1.2322 (0.080) *	commer (M)	1.592 (0.003)***		
fishcost (C)	-0.877 (0.129)	topo (N)	0.4525 (0.379)	age (D)	0.053 (0.882)
educ (E)	0.7305 (0.047) **	fsize (O)	2.06E-06 (0.851)	ffexp (Q)	0.102 (0.360)
famsiz (F)	0.029 (0.328)	credit (P)	-0.1214 (0.829)	ffrent (K)	1.505 (0.003)***
farmasso (G	-0.318 (0.588)	constant	-0.688 (0.171)	constant	-0.839 (0.326)
contact	0.574 (0.084) *				
fishdif (H)	0.407 (0.455)				
sostat (J)	-0.6081 (0.355)				
ffrrisk (L)	-1.917 (0.118)				
constante	-0.1411 (0.5933)				

Group 1: chi-square of model= 14.54 significance= 0.1041
estimate accuracy= 70.282 DL= 64 significance= 0.435***
prediction accuracy= 64.38%

Group 2: chi-square of model = 11.063 DL= 4 significance= 0.025**
estimate accuracy= 72.910 DL= 69 significance= 0.412***
prediction accuracy= 67.12%

Group 3: chi-square of model= 9.803 significance= 0.020**
estimate accuracy= 73.609 D = 70 significance= 0.390***
prediction accuracy= 67.12%

** *= significant at a threshold of 1%
**= significant at a threshold of 5%
*= significant at a threshold of 10%.

probabilities.
This prompts us to concede that there is no difference between the estimated and observed probabilities, and the three models therefore estimate probabilities accurately. The accurate prediction percentage indicates that 64.38%, 67.12% and 67% of cases (adoption and non-adoption) in the sample were correctly predicted for each of the three models.
The influence of significant variables on the probability of adoption was measured by the previously estimated LOGIT function slopes. As the LOGIT function is non-linear, its slope is therefore the product of three factors: probability of Xi, probability of the opposite event to Xi and the estimated Bi coefficient of Xi in the LOGIT function (11). The same author recommends the use of adoption percentages from the sample for the evaluation of slopes.
The slope associated with the (gender) variable reflects the fairly significant influence of gender on the adoption probability for fish farming. In fact, this result indicates that the adoption probability increases by about 28.8%, when the focus shifts from a female to a male target population.
Similarly, the transition from illiteracy to basic education increases the adoption probability by 17.1%. This result also shows that the adoption probability increases by 17% if we shift our attention from a less educated to a better educated or trained population.
The slope of the variable (contact) shows us that the adoption probability can be increased by about 13.5%, by means of a more present extension policy, in terms of the number of contacts with the target populations.
The commercial orientation or purpose of fish production increases its adoption probability to highly significant extent (37.5%).
In the same way, the idea or perception of fish farming as a more profitable activity than food crops increases its adoption probability by about 35.2%.

Discussion

It emerges from the results obtained from the three estimates that fourteen of the sixteen explanatory variables produce the expected outcomes and five of these variables have a significant influence on the adoption probability for fish farming.
The commercial orientation of fish farming (COMMER) is significant at around 1%. This result confirms those obtained by other empirical studies (11) and also reflects the fact that farmers see fish production as

Table 2
LOGIT curve slopes for the adoption of fish farming
(Quasi-elasticity of adoption probability)

Xi variables	Gender (B)	Educ (E)	Contact (I)	Commer (M)	Ffrent (K)
Coefficients	1.232	0.730	0.574	1.595	1.505
Slopes or Quasi-elasticity	0.288	0.171	0.135	0.375	0.352

an activity with high start-up costs, which cannot only be used to feed their families, and therefore assign a commercial orientation to it. Similarly, the results obtained by Ajaga (4) show that the high initial investment cost is still a factor that leads to low adoption levels for fish farming. This result is also linked to that obtained from the initial start-up cost variable (FISHCOST), which shows itself to be negatively linked to the adoption behaviour, although it is not significant, as the quality of the mountain terrain requires farmers who do not have access to lowlands or a river/stream close to their farms to undertake relatively costly landscaping work. This reflects the major financial concerns of fish farmers and may therefore explain the "commercial orientation" perception that they assign to this innovation. Even if some farmers consider that it would cost nothing to dig a pond, as most of them (fish farmers) used (paid) outside labour to create their fish ponds, by taking advantage of assistance provided by the Peace Corps Volunteers. This result is very close to those obtained by Beck (1980) and Koknik (1981)[1] who estimate the cost of setting up domestic fish farming to be 1% of what it would cost to set up fish farming for purely commercial purposes.

Frequent contact with fish farming and/or agricultural extension agents (CONTACT) positively influences adoption behaviour for fish farming. This has been observed by Koffi (20), who recorded an abandonment rate of 46% for loosely monitored fish farmers in the Ivory Coast. When it comes to fish farming in West Cameroon, the presence of extension officers, US Peace Corps volunteers and the increasing number of farmer groups, which sometimes comprise fish farmers, may represent explanatory factors.

Of the variables that characterise the perception of fish farming innovations by farmers, only the financial profitability of fish farming (FFRENT) is statistically significant at a threshold of 1%. Similarly, for Ajaga (5), economic factors that contribute to the abandonment of fish farming in *departements* of West Cameroon are the investment cost and market price of fresh fish produced in the ponds. These results are similar to those obtained by Modadugu *et al*. (21) who found that, before the introduction of the silver barb (*Puntius gonionotus*) in Bangladesh, the major constraints identified by farmers were the lack of capital (81.5%) and know-how (72.2%).

Therefore, the more farmers consider it costly to set up fish farming, the more they believe that fish farming must be more profitable than other agricultural activities. This situation is reflected in the analysis results by the high significance level (1%) of the variable (FFRENT). This conclusion is also similar to that obtained by Koffi (20), who notes that 94.6% of the new fish farmers surveyed are motivated by the need to maximise income.

[2]Quoted by Ajaga (3).

The other variables that characterise the perception of fish farming innovations by farmers are risk (FFRISK) and complexity (FISHDIF), which, although not significant, are negatively linked to the adoption probability. These results are in line with the observations, as most fish farmers, including even the most experienced and some new fish farming extension workers, are unaware of farming techniques, such as stocking and sexing methods (20).

This can be seen as a way, in which the idea of a complex and relatively high-risk activity influences the adoption behaviour.

This reality is also explained by Amy (7) and Elamin (12) who state that irreversibility and uncertainty play a very important role in the decision to adopt a new technology. In the case of fish farming, the farmers know or at least consider that it will not be possible to recover the initial investment if the technique is abandoned, or only a very small amount will be recovered, compared to a traditional agricultural activity.

The results linked to the characteristics of fish farming technology, as seen by the farmer, confirm those of previous studies that used the farmer ''perception paradigm" (1, 2). This convergence reinforces the idea that it is vital that all fish farming extension policies take account of the farmers' perception of fish farming innovations.

The other variables that characterise the farmer, such as level of education (EDUC) and gender (SEX), are significant at 5% and 10%, respectively. These results are closely linked to the farmers' idea of complexity (FISHDIF) and are reflected by the strong male domination of fish farming. This is in line with the conclusions of Koffi (20), who encountered only 2% of women in a sample of over 100 fish farmers. Koknik[2] explains this by the fact that the agricultural innovation extension services have always targeted men and ignored women and their crucial role in the economic and social life of farm households.

The topographic variable (TOPO), although not significant, is positively linked to the adoption probability for fish production. This is close to the reality, as a certain number of the farmers surveyed say that they do not practise fish farming, due to the lack of lowlands required for this activity.

In fact, lowland hydromorphic soils found (PH= 7) and neutral soils are suitable for fish farming (20, 25). The creation of a pond using pipes, in the absence of lowlands, increases the initial cost and is therefore a disincentive to fish farming.

This finding is very useful, as it encourages those responsible for promoting this innovation to promote fish farmer associations, which will enable them to make use of lowlands that are suitable but not used for fish farming, and do not exist on all farms.

[3]Cité par Ajaga (4).

Conclusion

By using a univariate dichotomous LOGIT model, this study made it possible to identify the main determinants affecting the adoption of fish farming in the temperate aquaculture zone of West Cameroon. The results obtained indicated that a strong commercial orientation, positive perception of profitability, frequent contact with extension officers, a high level of education and masculine gender are the main determinants affecting the adoption of fish farming.

In addition, increasing these variables may also increase the probability of adoption by 37.5%, 35.2%, 13.5%, 17.1% and 28.8 %, respectively.

The role of aquaculture development policy

In view of the important problem of an insufficient supply of fish in the rural regions of West Cameroon and the main conclusions of this study, we wish to make the following the recommendations.

Due to the difficulties associated with farmers' level of education, we recommend the introduction of primary education and practical training in fish farming. More precisely, this means setting up fish farms at rural schools. The existence of such *farmer field schools* may facilitate the acquisition of a farmer mentality and effective management of fish farming innovations. This procedure is very important, as the absence of a fish farming tradition is one of the main causes of failed adoption of fish farming in Africa.

Extension must place special emphasis on improving farmers' perception of the profitability of fish farming. In practice, it is necessary to show farmers that fish farming, when properly managed, is very profitable in economic terms.

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