Decision-Making and Participation in Labour Markets: The Case of Rural Households of Office du Niger area at Mali

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Abstract— *Developing countries' agriculture sectors were characterised by low productivity and low capital-intensive, dominated by smallholder agriculture exposed to imperfect markets. However, the study aims to examine rural labour market participation decisions in the Office du Niger region in the republic of Mali. This article analyses the behaviour of rural households using the agricultural household model by applying the multinomial logit model. The data used in this study were obtained through stratified random sampling. According to the sampling method, 400 rice farmers were studied, and the data was obtained through a household survey conducted from March to June 2020.*

The results showed that the household head age, livestock value, dummy savings, distance from the financial institution to the village, and distance from the farm to the town lowered the probability of participating in the supply labour regime. However, the number of active women and the off-farm income increased the likelihood of household participation in the supply regime. The results showed that credit constraints negatively influenced the probability of the farm using hired labour in household production. However, off-farm income is essential in selecting the hiring labour regime. Furthermore, the other characteristics of households and farms were a critical factor in selecting labour regime participation.

Reducing credit constraints will increase hired labour use in agricultural production and increase production levels in the study area. To reduce credit constraints, policymakers should revise cadastral laws allowing farmers to use their land as collateral when applying for loans.

Keywords— Agricultural household, Imperfect market, Labour demand, Mali, Office du Niger, Smallholder.

I. INTRODUCTION

Mali's economy is based on the agricultural sector, dominated by small-scale farms, characterised by low productivity and the persistence of low-capital-intensity agriculture, and it is subject to imperfections. Market imperfection often leads to the non-separability between production and consumption decisions. However, the rapid increase in the agricultural population, coupled with the failure of rural markets and the effects of climate change, are today the determining factors in the decline in agricultural productivity of rural households. It poses the challenge of food insecurity in most developing countries. Today more than a billion people live in food insecurity (IED, 2014).

However, the significant problems that rural households face in developing countries, which need to be solved to understand household behaviour in the labour market, remain, as do how these households make their production and consumption decisions. In the rural market of developing countries, household production and consumption decisions are non-separable (Benjamin, 1992). Otherwise, production and consumption decisions are made independently in rural markets.

Households in developing countries frequently confront imperfect or even non-existent markets. Even if the markets exist, transaction costs or quantity constraints (labour markets, credit markets, input markets) prevent them from participating in these markets. When all markets function perfectly, farms with sufficient family labour will transfer their surplus to those with insufficient family labour to maintain production levels. However, when the market does not function perfectly (the main characteristic of developing countries), the household withdraws into itself (autarky). Production and consumption decisions are made instantly. In this case, we find ourselves in subsistence farming (autarky), where the household produces for its own consumption, not for the market. Under this assumption, there will be excess labour on farms, reducing labour productivity per worker. The downward trend in agricultural production (farm profit) per active worker would, in the long term, create a situation of food insecurity and poverty within households. The surplus labour must be transferred to off the farm to compensate for the loss of farm productivity. Due to the necessity for the market to operate effectively, income derived from agriculture needs to be improved to fulfil the requirements of family members. Consequently, family labourers migrate to non-agricultural activities or to the regions where labour remuneration is better.

According to the perfect market hypothesis, households base their decisions on comparative advantage and wages rather than household endowments. Market imperfections generally affect the organisation and use of resources within small farms (Bell, 1988; Conning & Udry, 2007; Ali et al., 2014). However, market imperfections in developing countries affect small-scale farms' production levels and technical efficiency (Stiglitz et Weiss, 1981; Eswaran et Kotwal, 1986; Ma & Abdulai, 2019).

However, studies on rural households' composition give divergent results but are of great interest in agricultural policy formulations. Lopez (1984) rejects the hypothesis of separability between household production and consumption decisions in the case of Canada. Benjamin (1992), in his famous paper on household composition and labour demand in the labour market in India, accepts the separability hypothesis, while Grimard (2000) studies the rural household behaviour in Côte d'Ivoire and rejects the separability notion between production and consumption decisions. De Janvry and Sadoulet (2002) assert that the household participates in the labour market according to its endowment of working time and disposable income. However, it allocates time between leisure, family, and off-farm work. The household hires labour in his farm when it needs it or sells it at the market wage rate **w** (Benjamin, 1992; Porgo et al., 2017; Ma & Abdulai, 2019) on the labour market. Examination of household involvement in the labour market was approached from various perspectives. (Huffman, 1980; Lopez, 1984; Benjamin et al., 1993; Porgo et al., 2017). Benjamin (1993) divided them into eight different regimes and then analysed the men's and women's behaviour outside the farm. However, in the case of Burkina Faso, Porgo et al. (2017) divided the work into four work regimes and then added a credit constraint to determine the impact of this on the different work regimes.

The decision to participate in the labour market was associated with the gender of the household's head, the farm's size, and the household's size. We note that farms with too few farm workers employ more salaries labour in their farms than farmers with more workers. In general, the demand for labour depends on the type of crop cultivated by the household. The need for labour evolves according to the type of activity, the crop grown on the plot and the growing season. In Mali and the Office du Niger area, for example, activities such as ploughing, sowing, fertiliser spreading, herbicide use, and plant protection products are generally carried out by family labour. However, transplanting, weeding, and harvesting activities often require external support, as they depend on experience and technical expertise. We also note that the demand for labour is higher during the rainy season than during the low-water period when water levels in the dams are lower. It raises the issue of using family and hired labour in farm activities.

II. MATERIALS AND METHODS

2.1 Material:

Empirical research on the analysis of rural households' behaviour uses either aggregated or primary data. The research relied on primary data gathered from households within the Office du Niger region. Using primary data in research studies improves

the accuracy of information and makes better recommendations for agricultural development policies. A well-structured questionnaire was developed and administered to selected households to obtain information on socio-economic and demographic factors. However, all the rice producers' households in the Office du Niger area constitute the primary basis of this study. To carry out the study list of all households engaged in rice production was acquired from the statistics department of the Office du Niger. Subsequently, this list was utilised for sampling.

2.2 Sampling technique:

Rice-producing households operating in the Office du Niger area constitute the base population of this study. The Office du Niger is subdivided into seven agricultural zones, including, among others, Niono, Macina, M'Bèwani, N'Débougou, Kouroumani, Molodo, and Kolongo. The Niono zone comprises four irrigated areas and 45 villages, the Maciana zone 3 irrigated areas and 46 villages, the Kolongo zone 4 irrigated areas and 60 villages, the Kouroumani zone 5 irrigated areas with 39 villages, the M'bewani zone 5 irrigated area with 62 villages, the Molodo zone 4 irrigated areas and 33 villages and the N'Debougou zone 4 irrigated areas and 49 villages. To undertake this study, two agricultural areas were selected, and within each agricultural area, three irrigated areas were chosen. The primary data collected through this method constitutes the main material of the study. This framework determined the sample volume using the stratified random sampling method. The results thus obtained through this method have made it possible to increase the precision and quality of the data and adequately represent the different sections of the population studied. Thus, the sample volume was determined using the stratified random sampling method (Yamane, 1967).

$$n = \frac{N\sum(N_h S_h)^2}{N^2 D^2 + \sum N_h S_h^2} \quad (1)$$

$D = d^2/Z^2$

n= number of samples

N= number of farmers in the population

N_h = number of farmers in stratum h

S_h^2= the variance of stratum h

Z= the value of Z in the standard normal distribution table as a function of the error term.

After briefly describing the survey methodology, the sample size was established at 400 households with a 95% confidence interval and a 5% margin of error.

2.3 Analytical model:

The household maximises its utility, a function of its consumption, the endowment of its total available time and characteristics. The household program is formalised as follows:

Max U_h (C, l, θ) c, l, L^o, L^h, L^f ⟶ *household utility function* (2)

s/c

q= f(L ; Q ;G ; A) ⟶ *production function* (3)

$c = F(L;\ A) - wL^h + wL^o + y$ ⟶ *budget constraint* (4)

$l + L^f + L^o - L^h = T(\theta)$ ⟶ *Time constraint* (5)

$L^o \leq H$ ⟶ (6)

The household utility U_h=u(C, l, θ) is defined twice as derivable and quasi-concave on consumption (c) and leisure (l). θ is a vector containing the demographic characteristics of the household (size and sex of the household members). c, designates the household's total consumption, which includes goods produced by the household and goods purchased on the goods and services market. The household produces with the technology represented by the convex and twice differentiable production function such that Q=f (L, A), where L is the sum of family labour and hired labour (L^f, L^h), A designates the land, which is an exogenous and fixed variable. De Janvry et al. (2002) assert that the household participates in the labour market according to its available resources (working time endowment and disposable income). He allocates his total time between leisure, family work and off-farm work. He can also hire labour when needed or sell his labour force at the market wage rate w (Benjamin, 1992; Abdulai, 2000; Porgo et al., 2017).

U(.) is the household utility function, which is quasi-concave and strictly increasing. θ is the vector of the demographic characteristics of the household, such as the number of people in the household and the level of education of the head of the household. The variable c designates the total consumption of the household. L^f and L^h denote family and hired labour in the household; L^o denotes the family labour supply by household; ***l*** leisure time; ***w*** the market wage rate; A is a fixed variable. Constraint (6) above means that the market allows a maximum of H hours of labour to be sold. If the family labour supply is less than the labour market need (L^o<H), the household could sell all its surplus labour at the market wage rate. In such a condition, we will say that the market is functioning perfectly. However, if the constraint is saturated, i.e., L^o=H, the household would like to offer more labour, but the market can only offer H work hours. Under these conditions, we find ourselves in a surplus of labour within the family, which cannot be transferred to the market because of the constraints linked to the imperfect. There would be disguised unemployment in the labour market (Sen, 1966), a direct consequence market of market imperfection.

2.4 Empirical model:

Empirically, several studies have focused on analysing the behaviour of agricultural households worldwide. Some studies have analysed rural households' labour market participation decisions (Lass & Gempesaw, 1992; Gunter, 1992; Lovo, 2012; Bedemo et al., 2013; Porgo et al., 2017). Other studies have focused on the participation decisions of men and women on and off the farm (Huffman & Lange, 1989; Lass & Gempesaw, 1992; Benjamin et al., 1993). The decision to allocate total household time between family work, off-farm work and the demand for hired labour depends on the marginal productivity of labour (shadow price) and the market wage rate.

However, as specified in the literature, the household faces four types of regimes: (1) a regime in which it offers only its family labour off-farm, (2) a regime which its only hired on-farm labour, (3) a regime which simultaneously offers and hired labour, and (4) a regime which neither supply nor hired labour (Porgo et al., 2017). However, his participation depends on the market wage rate. As a result, he chooses the regime with the highest internal wage rate. Let r_j (j with j=1.2.3.4) be the wage rate of the regime. The household will choose the regime with the highest wage rate among the four alternatives described as preconditions for participating in the labour market.

Generally, the rural markets of developing countries are incomplete or imperfect. The decisions taken by the household in such a scenario are taken simultaneously (hypothesis of non-separation). The internal wage rate in such a situation is endogenous and depends on the characteristics of the household. The characteristics of the household being heterogeneous, we can then write the utility function of the household as follows:

$$r_{kj} = \beta_j{}' X_k + \varepsilon_{kj} \;\; avec\; k = 1 \ldots . n \; et \; j = 1 \ldots .4 \tag{7}$$

Thus r_{kj} denotes the indirect utility function of household k in regime j and $\beta_j{}'$ is the vector of parameters to be estimated. X_k, the vector containing the explanatory variables of the model for each household, ε_{kj}, the error term of the indirect utility

function of household k in regime j. Let us introduce a binary variable to consider the internal wage rate relative to each regime, which is not observable. Let us call this variable μ_{kj} and define it as follows:

$$\mu_{kj} = \begin{cases} 1 \; if \; r_k \max(r_1, r_2, r_3, r_4) \\ 0 \; otherwise \end{cases} \quad (8)$$

The probability that household *k* is found in the j[th] alternative is given by the following formula:

$$Pr_{kj} = \Pr(\mu_{kj} = 1) = \Pr(r_{kj} > r_{ki}) \, \forall j \neq i \quad (9)$$

$$= \Pr(\beta_j{}' X_k + \varepsilon_{kj} > \beta_i{}' X_k + \varepsilon_{ki}) \, \forall j \neq i$$

$$= \Pr\{(\beta_j{}' X_k - \beta_i{}' X_k > \varepsilon_{ki} - \varepsilon_{kj})\} = \Pr\{(\beta_j{}' - \beta_i{}') X_k > \varepsilon_{ki} - \varepsilon_{kj})\} \forall j \neq i$$

In such a situation, the residuals are assumed to be independent and identically distributed according to Weibull law (McFadden, 1974; Porgo et al., 2017). Thus, (Maddala, 1983) suggests defining a multinomial model with definite probability as follows:

$$\Pr(\mu_{kj} = 1) = e^{(\beta'_j X_k)/\sum_{j=1}^{4} \beta'_j X_k)} \quad (10)$$

For simplification, one regime is chosen as the reference regime to standardise the system. Here, regime (4) was chosen as the reference regime by constraining its coefficient to zero. The reduced model is then written as follows:

$$log \frac{Pr_{kj}}{Pr_{k4}} = \beta_j{}' X_k, \; j = 1,2,3 \quad (11)$$

III. RESULTS AND DISCUSSION

Before proceeding with multinomial logit model estimation, it is recommended to consider whether it is appropriate to perform multinomial logit model analysis. First, the test for Independence of Irrelevant Alternative (IIA) is performed. A significant value of Chi² would indicate a violation of the IIA hypothesis. In this study, the Chi² values obtained are all insignificant at the 10% level. This shows that the independence assumption of irrelevant alternative cannot be rejected (Hausman & McFadden, 1984; Long & Freese, 2006). This allows us to conclude that the multinomial logit model analysis should be continue. Hausman's hypothesis test is given in Table 1.

TABLE 1
HAUSMAN TESTS OF THE IIA HYPOTHESIS

Omitted	Chi²	P>Chi²	Evidence
Autarky	15,83	0,15	For Ho
Hire labour	0,00	10,000	For Ho
Supply labour	2,31	0,9995	For Ho
Supply and Hire Labour	4,37	10,000	For Ho

The estimation results of the multinomial logit model are presented in Table 2 below. However, it is not easy to interpret the coefficients of the multinomial logit model directly because the sign of the estimated coefficient associated with a variable does not indicate in which direction the probability of the j[th] regime varies with a variation of this variable. Therefore, it is recommended to calculate the marginal effects first. The results of the marginal effects are calculated and given in Table 2.

TABLE 2
REGRESSION COEFFICIENT OF MULTINOMIAL LOGIT MODEL

Variables	Supply labour			Hire labour			Supply and hire labour		
	Regime 1			Regime 2			Regime 3		
	Coefficients	Z	Marginal effects	Coefficients	Z	Marginal effects	Coefficients	Z	Marginal effects
Household characteristics									
Farm size	-0,20	-0,59	-0,002	-0,15	-0,78	-0,03	0,63	-1,04	-0,00002
	(0,34)			(0,19)			(0,60)		
Gender of household head	-0,80	-1,23	-0,14	-0,88	-0,53	-0,003	4,66	0,01	0,00004
	(2,28)			(1,64)			(699,18)		
The age of the head of household	-0,55***	-2,53	-0,008	-0,24	-1,59	-0,04	0,36	0,84	0,00002
	(0,22)			(0,148)			(0,43)		
Squared age of head of household	0,004**	2,17	0,00006	0,0022	1,51	0,0003	-0,0030	-0,76	-0,001
	(0,0020)			(0,0014)			(0,0039)		
Household head's level of education	-0,53	-0,74	-0,004	-0,47	-0,96	-0,08	-0,086	-0,12	-0,02
	(0,72)			(0,48)			(0,74)		
% primary education labour	-2,47	-1,04	-0,07	0,54	0,32	0,14	-1,91	-0,55	-0,00007
	(2,37)			(1,66)			(3,50)		
Active men	0,001	0,00	0,0014	-0,08	-0,19	-0,01	1,43	1,25	0,00005
	(0,67)			(0,42)			(1,14)		
Active women	2,60***	3,22	0,05	0,12	0,29	-0,02	2,38**	2,08	0,00007
	(0,81)			(0,42)			(1,14)		
Dependency ratio (%)	1,18	1,06	0,011	0,90	1,47	0,15	0,28	1,06	0,00002
	(1,12)			(0,61)			(1,21)		
Credit constraint	170	1,49	0,10	-2,50***	-3,73	-0,48	-2,66*	-1,80	-0,00003
	(1,14)			(0,66)			(1,47)		
Farm characteristics									
Farm size (da)	-0,43	-1,15	-0,009	-0,04	-0,21	-0,0008	-5,73**	-1,98	-0,0002
	(0,76)			(0,22)			(2,90)		
Log input (FCFA)	0,85	1,23	0,05	0,82*	1,76	0,14	0,64	0,64	0,0046
	(0,38)			(0,46)			-1,003		
Log Farm Income (FCFA)	-0,09	-0,12	-0,004	-0,39	-0,89	-0,07	0,21	0,19	0,00002
	(0,70)			(0,44)			(1,07)		
Off-farm income (FCFA)	**0,004****	4,01	0,00004	0,0028***	3,06	0,0005	0,0046***	3,77	0,003
	(0,0009)			(0,0009)			(0,0012)		
Livestock value	-0,00008***	-2,35	-0,04	-0,000016	-2,75	-0,004	-0,00010**	1,93	-0,0004
	(0,25)			(0,16)			(0,00006)		
Village characteristics									
Dummy savings	-1,18	-0,87	-0,02	-0,27	-0,28	-0,04	0,71	0,39	0,0002
	(1,36)			(0,96)			(1,83)		
Distance from the financial institution to the village	**-0,60*****	-3,05	-0,006	-0,44***	-4,84	-0,07	**1,72****	0,95	0,00007
	(0,25)			(0,16)			**(0,89)**		
Distance from farm to village	**-0,16*****	-2,73	-0,001	-0,16***	-1,07	-0,03	0,12	-1,82	0,020
	(0,05)			(0,032)			(0,13)		
Constant	**15,45***	1,68	-	12,04***	2,10	-	37,96	-0,05	-
	(9,17)			(5,74)			(699,44)		

Note: Pseudo R^2 =0,5888; Log likelihood=--94,88 Restricted Likelihood=-230,75. *** Significant at 1%, ** at 5%, * at 10%.

Table 2 shows that the age of the household head has a non-linear and significant effect on the decision to participate to the labour market. However, the coefficient associated with the variable age of the head of household is statistically significant and negative in the labour supply regime. Indeed, the effect of the age of the household head on the supply of household labour outside the farm decreases until the age of 47 and then increases. In other words, compared to the reference regime (autarky regime), the probability that household headed by young household heads supply their labour outside the farm decreases by 0.80%. In contrast, the supply of labour employment of elderly households' heads increases significantly. According to this result, it is concluded that households headed by the young are less endowed with family labour and are less able to supply family labour outside the farm than households headed by the old ($p<0.01$). Household headed by older are more likely to supply their labour outside their farm than younger ones.

The coefficient associated with the active women on the farm is positive and significant in regimes 1 and 3. This coefficient means that the increase in the active women in each of these regimes increases the probability of labour by 5% and 0.007% respectively compared to the reference regime (autarky). This result is consistent with empirical results found in previous studies, which state that as the number of active women in a household increases family labour use also increases (Porgo et al., 2017). It would be due to the possibility of substituting family labour on the farm.

The results confirm that credit constraints strongly influence the hiring regime for hiring labour. The credit constraint also impacts the regime in which the household is simultaneously a supplier and hiring labour. The results show that the credit constraint reduces the probability that the household participates in the hire labour regime by 48% compared to autarky households ($p<0.01$). However, the credit constraint variable was negative and significant in regime-3. This variable means that credit constraint reduces the probability of the household being into the regime in which the household is simultaneously hiring and supplying labour at 0.003% ($p<0.01$). In the presence of capital-intensive agriculture, access to agricultural credit remains one of the alternatives for coping with the cost of hiring labour and the short-term consumption needs of poor households.

Regarding the characteristics of the farm, we find that the area variable is negative and significant in regime-3. That means that the increase in the agricultural area reduces by 0.20% the probability that the household will be in the regime where the household is simultaneously hiring and supplying labour ($p<0.05$). However, the variable represented the input expenditure is positive and significant at 10%. That means that the increase in input expenditure increases by 14% the probability that the household being into hiring labour regime compared to the autarky regime ($p<0.10$).

The variable represented the non-agricultural income was statistically significant and positive at the 1% threshold. However, any increase in non-agricultural income leads to an increase of 0.004% and 0.05% in the probability of the household being in the supplying and hiring labour regime, respectively ($p<0.01$). This result could be explained by households using only hired labour generally working in non-agricultural sectors. That means an increase in off-farm income will increase the demand for hiring labour on the farm. The increase in non-agricultural income increases by 0.3% the probability of the household being in the regime where the household is a hiring and supplying labour compared to the autarky situation ($p<0.01$). The agricultural income variable positively affects rural households' decision to participate in the market. Under credit constraints, the local labour market is a natural alternative to generating non-agricultural income, making it possible to meet short-term liquidity needs. However, this strategy remains optimal if labour productivity on the farm is at least equal to the market wage. When the market wage is lower than the productivity of farm labour, the decision to participate in off-farm labour becomes a consumption-slowing strategy rather than an income-maximizing strategy. It can lead to loss of welfare for the household.

Village characteristics showed that the distance from the village to the microfinance institution has a negative effect on the probability of supplying family labour outside the farm and the likelihood of using hired labour on the farm. However, we also find that the distance variable from the village to the microfinance institution positively affects the probability of the household being in the regime where the household is simultaneously hiring and supplying labour. On the other hand, the distance between village to the microfinance institution reduces the probability of employing family labour outside the farm by 0.6% and the probability of using hiring labour in the farm by 0.007% compared to the reference situation ($p<0.01$ and $p<0.05$).

The variable represented village-to-farm variable also affects the household's decision to participate in the labour market. The distance from the village to the farm is negative in regimes 1 and 2. It also negatively affects the household's decision to participate in the labour market. The further the farm is from the village; the more labour costs increase. The further the farm is from the village, the more the probability that the household being in the supply labour and hiring labour regime decreases by 0.1% and 3% compared to the reference situation ($p<0.01$ and $p<0.01$).

IV. CONCLUSION

The agricultural sector in developing countries is characterised by low productivity and low capital-intensity agriculture and is dominated by small farms exposed to incomplete markets. Based on this, this study examines the rural labour market participation decisions in the Office du Niger zone in Mali. The data used in this study were obtained through stratified random sampling. According to the sampling method, 400 rice farmers were studied, and the data was obtained through a household survey conducted from March to June 2020.

This article analyses the behaviour of rural households using the agricultural household model. However, the multinomial logit model examined rural labour market participation decisions. To carry out this study, the households were classified into four work regimes, namely: the regime in which the household is only a supplier of labour, a regime in which the household is only a labour demander, the regime in which the household is simultaneously a supplier and a demander of labour and the regime where the household is neither a supplier nor a demander of labour.

The results show that young heads of households are less endowed with family labour and are less likely to offer their labour off the farm, while the labour supply off-farm by elderly household heads is increasing significantly. In other words, younger household heads are less likely to participate in the labour market as labour supplier than older household heads. However, households headed by women participate more in the labour market as labour supplier than households headed by men.

The results shows that the credit constraint strongly influences the household's decision to hire labour on the farm. Indeed, the increase in input expenditure encourages households to employ only hire labour on their farm. In contrast, increased off-farm income encourages households to participate in all three labour regimes. The presence of livestock, the household's proximity to a microfinance institution and the distance from the village to the farm reduce the household's participation in the labour supply market. However, the household's proximity to a microfinance institution and the distance from the village to the farm have been determined as factors to discourage the household's participation in the wage labour market.

According to the results obtained, improving human capital level within a household would give agricultural households more flexibility in their decision to participate in the labour market. In addition, measures taken to improve the human capital of a farm will promote the use of hired labour and allow households to work off the farm at the same time.

Furthermore, it is essential to promote subsidy policies for phytosanitary products to reduce family labour supply outside the farm. Policies to increase fertiliser use on farms would allow households to use wage labour on the farm and work off their farm simultaneously. In addition, to improve the labour market in the Office du Niger zone, the government must promote access to the credit market, likely to promote the use of hired labour on farms.

The farmers in the area are small-scale farms and need to be equipped with agricultural machinery and equipment to ensure the farm's activities. However, promoting agricultural machinery and equipment would be an excellent way to improve the use of agricultural machinery and equipment, promoting household participation in the labour market and increasing agricultural production.

Farms distant from villages are less likely to hire labour on their farms due to high transaction costs. Therefore, interventions to improve feeder roads would likely increase household participation in labour markets

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