



ADRRJ JOURNALS (www.adrri.org)

E-ISSN: 2026-5204 VOL. 4, No.1 (3), September, 2018

Drivers of Participation in Artisanal Gold Mining and its Effect on Agriculture in Mali

Mahamadou Moussa Keita^{1,2}, George Owuor³ and George Morara Ogendi^{1,4}

¹ Department of Environmental Science, Egerton University, Njoro Campus, Nakuru, Kenya

²Rural Polytechnic Institute of Katibougou, Koulikoro, Mali.

³Department of Agricultural Economics and Business Management, Egerton University, Njoro Campus, Nakuru, Kenya

⁴ Dryland Research Training and Ecotourism Centre, Chemeron, Baringo, Kenya

¹**Correspondence:** mahamadou77@yahoo.fr

Available Online: 30th September, 2018

URL: <https://www.journals.adrri.org/>

[**Cite Article as:** Keita, M. M., Owuor, G. and Ogendi, G. M. (2018). **Drivers of Participation in Artisanal Gold Mining and its Effect on Agriculture in Mali.** ADRRI Journal of Agriculture and Food Sciences, Ghana: Vol.4, No. 1 (3), Pp. 1-16, E-ISSN: 2026-5204, 30 September, 2018.]

Abstract

A large part of the population of Mali is facing food insecurity. Some farmers see a way out of this situation through their involvement in artisanal gold-mining as for instance in the Sikasso region of Mali. Many migrate from agricultural production to off-farm activities such as artisanal gold mining. The objective of this study was to determine the socio-economic factors that influence households to get engaged in artisanal gold mining in Sikasso region. The study site was located in Farabacoura artisanal gold-mining area, some 170 km from the capital Bamako. The study used an exploratory and descriptive research design with a random sample of 200 households. Research tools used included questionnaires, focus group discussion, key informant interviews. Data was analysed using descriptive and inferential statistics. The factors that had significant influence on households to decide to get engaged in gold mining included profession ($\chi^2 = 96.8$; $p < 0.001$), origin ($\chi^2 = 78.1$; $p < 0.001$) and education level ($\chi^2 = 22.9$; $p < 0.001$) thus driving some members of households out of agriculture. The study therefore concluded that in order to keep the households engaged in agriculture, more emphasis on male sensitization for food security is necessary. There are also needs to promote cash crops and credit access of farmers. In order to keep the population willing to invest in agriculture, they have to be convinced that the revenues are comparable with those they can obtain through gold mining.

Keywords: agriculture; food security; gold mining; Mali community; socio-economics.

INTRODUCTION

A large part of the population of Mali is facing food insecurity. Some farmers see a way out of this situation through their involvement in artisanal gold mining as for instance in the Sikasso region of Mali. The government initiated special programmes to reduce food insecurity through agricultural subventions in the form of credit, cotton seeds and fertiliser focused especially on youth and women. Despite these intervention many persons, especially young farmers and women are still changing from agricultural production activities to artisanal gold-mining (MA, 2006). This change in engagement has impacted agricultural productivity by making rural population vulnerable in mining area (Danquah, 2017) through the absence of work force especially in the regions where gold mining is practised. In addition, artisanal gold-mining is one of the anthropogenic activities that destroy cultivable land, forests, water quality and livestock pasture when open pits collapses, erosion and the use of chemical products (Funoh, 2014; Kitula, 2005; Zhou et al., 2017). Gold mining is compromising sustainable agricultural process to be realized in the area. Gold mining contributes to social implication such as labour displacement, community conflicts, alcoholism, drugs and cultivable land degradation (Cartier & Bürge, 2011). Wilson et al. (2015) documented the complexities that involve multiple drivers and diverse disciplines influencing AGM in Ghana. Moreover, mining affects agriculture productivity through crops health deterioration by leaf tissue injury or plant growth (Aragon & Rud, 2013; Papworth et al., 2017; Amune, 2012; Hilson, 2016). The artisanal gold-mining is an attractive business to many people in rural areas, since it has low barriers of entrance and impacts are various according to community perceptions (Ince, 2018). By doing so, it drives thousands of people from farm activities who expect easy money from mining. However, mining creates a local market opportunities for small traders in these areas (Funoh, 2014; Kitula, 2005; O'Driscoll, 2017; Danquah et al., 2016).

The objective of this study was to determine socio-economic factors that influence households to get engaged in artisanal gold mining in Sikasso region. The finding of this research show how did socio-economic factors influence households engaged in artisanal gold mining in Sikasso region. This research assumed that socio-economic factors were influenced households engagement in artisanal gold mining and that may driving them out of agriculture. This study has been carried out in Tangadougou Commune, Mali in 2016.

METHODOLOGY

Study area

Sikasso region is located in the southern part of Mali and is the third administrative region of the country. Its neighbours are Segou region to the northern side, Republic of Cote d'Ivoire to the South, Republic of Guinea to the West, Burkina Faso to the East and the region of Koulikoro to the North-West. The region covers 71,790 Km² which represents 3.8% of national territory of Mali. It has 7 districts that include Sikasso, Bougouni, Kadiolo, Kolondièba, Koutiala, Yanfolila and Yorosso. In Sikasso region, there are 3 urban commune, 144 rural commune and 1,831 villages. Farabacoura and Tiégucourouni are villages in Tangandougou commune, district of Yanfolila in Sikasso region. Tangandougou commun is some 170 km from the capital Bamako. The study sites, Farabacoura is about 10 Km from Selingué Dam which is on Sankarani river while Tiégucourouni is 75 km away from Selingué. The population of Tangandougou commune is about 5,775 inhabitants and belong to the ethnic groups Bambara, Senufo, Manliké, Bozo and Peulh.

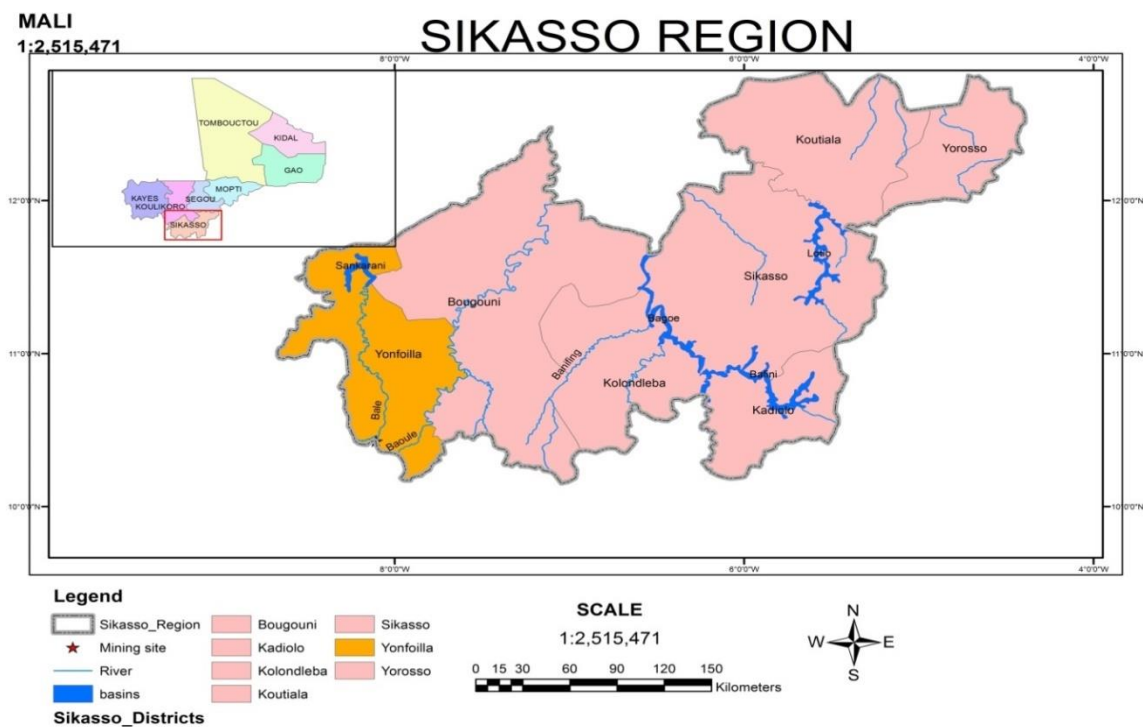


Figure 1 Geographic location of the Study area in Sikasso region

The economic activities of the commune include crop-livestock production, fisheries, agroforestry, commerce and gold mining. These production systems are characterized by small-scale farming with low yields. In term of cereal production,

these small-scale farmers deal with maize, sorghum and millet to cover their subsistence. The commercial crops include rice, cotton, groundnut, onions, and sweet-potatoes among others. The animal husbandry systems include extensive system which requires transhumance during the dry season and some of the households keep animal at home so as to supply crop production with compost and other activities in farm. The main livestock reared includes cattle, goats, sheep, donkeys and chickens. They are only used for domestic use and expenditures to cover health care, marriage, burial, school fee etc. Agroforestry activities are focused on both indigenous and exotic plants. They exploit indigenous plants such as *Vitellaria paradoxa*, *Parkia biglobosa*, *Adansonia digitata*, *Azizelia africana*, *Khaya senegalensis* and *Prosopis africana* for food production, precious wood and medicinal needs. In addition, they also grow *Citrus sinensis*, *Citrus aurantium*, *Mangifera indica*, *Carica papaya* and *Tereticornis globulus* fruits and wood production.

Data collection tools and methods

Structured questionnaires were used to gather information from the household head or his/her representative. The questionnaires were structured on professions (gold mining, crop, livestock, agroforestry, fisheries, age, gender, origin, marital status, education level, etc.). In addition, three focus group discussions were held with local government, miners and non-miners in Tangandougou Commune plus key informant interviews and observation check-list. The collected data was analysed using the Statistic Package for Social Sciences (SPSS) while ArcGIS was used for geographical information to come up with study area Map. The sampling technique that was employed in this study considered artisanal gold mining as a factor that caused impacts on social economic functions of the natives of Sikasso region. Data was collected by the use of structured questionnaire which were administered through interviewing the households' heads. In each case one representative of the household who was 18 years old was interviewed. The sample size was 200 households consisting of respondents drawn from the study area and had some information about artisanal gold mining and impacts on the social economic systems. The questionnaires were administered in Farabacoura and Tieguecourouni villages both in Tangandougou Commune, of Yanfolila district. The respondents were drawn from the two villages equally as follows:

The mining site: Farabacoura village respondents represented the mining site. These respondents were involved in either mining and/or agricultural activities. The information on these activities was collected from an area of approximately 20 km².

The non-mining site: as a nearby site of Tieguecourouni village, the study interviewed 100 households by soliciting information about mining and agricultural activities

based on study objectives. The distance between the two study villages was approximately 45 km but within the same commune.

The sample for this study was calculated using the Nassiuma (2000) equation indicated as Equation 1. The study was used this formula, because the population of Tangandougou commune is ready known.

$$n = \frac{NC^2}{[C^2 + (N-1)e^2]} \quad (1)$$

Where,

n = is the sample size

N = is the known population of Tangandougou commune

e = is the error margin of (3%)

C = is the coefficient of variation (30%)

The sample size based on Eq. 2 was:

$$n = \frac{5775 \cdot 0.3^2}{[0.3^2 + (5775-1) \cdot 0.03^2]} = 100 \quad (2)$$

The result was multiplied by two giving a total of 200 households distributed as 50% between the two villages for data collection in Tangandougou commune. The study used exploratory and descriptive research designs with cross sectional random sampling of 200 households. Data collection was done using household survey in Farabacoura and Tiéguécourouni. The questionnaires were administered on mining site of Farabacoura and non-mining site of Tiéguécourouni. This study sites were approximately 50 Km apart. The proportionality of 100 samples was used for household survey as sample size on each site. Data was analysed using descriptive and inferential statistics such as Chi-square, correlation and logit model computed with location as dependent variable.

According to Kleinbaum and Klein (2010), "the model is defined as logistic if the expression for the probability factors given the Y , is 1 over 1 plus e to minus the quantity α plus the sum from I equals 1 to K of β_i times X_i " the Eq. 3 is defined mathematically Logistic Regression model.

$$P(X) = \frac{1}{1 + e^{-(\alpha + \sum \beta_i X_i)}} \quad (3)$$

Where $P(X)$ stands for location, α and β_i represented in the model formula are unknown parameters which have to be estimated from data collected on X and D for a group of study subjects (Kleinbaum & Klein, 2010). In this case study, the binary variables were used and codified as no or yes which are equal to (0, 1).

RESULTS AND DISCUSSIONS

The drivers of participation were ranging from profession (gold mining, crop, livestock, agroforestry and fisheries), origin, gender, age, education level, marital status, presence of children on site and family size. These parameters were analysed on both mining and non-mining sites.

Observed profession in study areas

The professions within the study area were categorized into four types based on the activities engaged in during household survey on both sites. Of these categories, 55% of them were farmers who practiced crop farming. This comprised 88 farmers from the non-mining site and 22 from the mining site (Table 1). Livestock farmers constituted only 4% of the respondents and all of them were from the mining site. Twenty-five percent of the respondents were artisanal gold-miners whereas 16% were involved in other small scale business or activities connected to gold mining. Our findings indicate that there was a significant association between gold-mining and respondents' professions ($\chi^2 = 96.80$; $p = 0.000$).

Origin of observed population

Of the 200 respondents in this study, a total of 67 individuals were considered non-native and they represented 33.5% of the entire population of Farabacoura mining area (Table 1). Approximately 67% of the respondents were natives of the study area. The study findings indicated that there was a significant association between nativity and gold-mining ($\chi^2 = 78.12$; $p = 0.000$).

Gender representation of population

Approximately 23% of the respondents were female (Table 1). The distribution was 16 females from the non-mining site and 29 from the mining site whereas 84 males were drawn from the non-mining site and 71 from the mining site. Our study findings demonstrated that there was a significant association between gender and gold-mining in the study area ($\chi^2 = 4.84$; $p = 0.041$).

Distribution of ages in study areas

The ages of the individuals who formed the study population was arranged into five categories for households interviewed. The results showed that 26% of the respondents were between 15 and 25 years old (Table 1). Within this age bracket, there were 20 respondents from the non-mining site and 32 from the mining site. Those who were between 26 and 35 years old constituted 36% of the respondents. This comprised of 31 people from non-mining site and 41 from the mining site. The last age bracket of 55 years old and above constituted only 7.5% of all the individuals

interviewed. Again, there was a significant association between age of the respondent and gold mining ($\chi^2 = 11.61$; $p = 0.020$).

Marital status

Out of the 200 respondents that were interviewed, 15.5% of them were not married whereas 84.5% of them were married. Again our Chi-Square indicated that there was a strong and significant association between marital status and their involvement in gold mining or agriculture ($\chi^2 = 8.58$; $p = 0.006$) (Table 1).

Table 1 Different factors observed on sites by frequency, percentage on sites

Variables	Freq.	%	N = 200		χ^2	p
			Non-mining	Mining		
Professions						
Crops	110	55	88	22	96.805	0.000
Livestock	8	4	0	8		
Mining	50	25	1	49		
Others	32	16	11	21		
Origin						
No	67	33.5	4	63	78.128	0.000
Yes	133	66.5	96	37		
Gender						
Female	45	22.5	16	29	4.846	0.041
Male	155	77.5	84	71		
Ages						
15-25	52	26	20	32	11.612	0.020
25-35	72	36	31	41		
35-45	42	21	25	17		
45-55	19	9.5	14	5		
55+	15	7.5	10	5		
Education level						
None	141	70.5	83	58	22.943	0.000
Primary	44	22	8	36		
Secondary	13	6.5	8	5		
University	2	1	1	1		
Marital status						
No	31	15.5	8	23	8.589	0.006
Yes	169	84.5	92	77		
Children presence						

No	174	87	95	79	11.317	0.001
Yes	26	13	5	21		
Family size						
1-5	111	55.5	44	67	10.789	0.005
6-10	53	26.5	34	19		
10+	36	18	22	14		

Source: Authors

Education level of observed population

The levels of education ranged from illiterate (no formal education) through the primary, secondary and college or university. There were more none educated individuals than other levels as shown in the results. Out of the 200 respondents, those without formal education constituted 70.5% (Table 1). The distribution was 83 from the non-mining site and 58 from the mining site. Those with college and university level education were only 2 representing 1% of the total sample. A significant relationship was observed between level of education and gold mining and other activities including agriculture at the study area ($\chi^2 = 22.94$; $p = 0.000$).

Presence/ absence of children in households

Eighty-seven percent of those interviewed had no children. This comprised of 95 respondents from the non-mining site and 79 from the mining site. The respondents whose children were involved in different economic activities within the study population constituted 13% of the entire study population. The distribution was 5 respondents from the non-mining site and 21 from the mining site. There was a significant association between presence/absence of children in the households and in the existing economic activities ($\chi^2 = 11.31$; $p = 0.001$).

Family size

Household size was categorized into three groups ranging from 1 to 5 people, 6 to 10 and those have more than 10 family members. Results showed that 111 households had a family of between 1 to 5 members representing 55.5% of the interviewed households (Table 1). They comprised 44 households from the non-mining site and 67 from the mining site. Those households who had between 6 to 10 family members were 53 which was represented 26.5% of the respondents. It was 34 households from the non-mining site 19 from the mining site. Those that had more than 10 family members were 36 households representing 18% of the interviewed households. The distribution was 22 on non-mining site and 14 on mining site. Our Chi-Square calculation indicated a significant association between household size and gold mining/agriculture in the study area ($\chi^2 = 10.78$; $p = 0.005$).

Pearson's correlation of socio-economic factors

The correlation of socio-economic factors was applied on different factors including profession, originality of the respondents, gender, age, education level, marital status, children presence on mining site and family size. Results showed that they were significant negative relationships (Table 2). Our results showed that there were significant positive relationships between profession and education level ($r = 0.28$; $p > 0.01$), children presence on mining site ($r = 0.35$; $p > 0.01$). There were significant positive relationships between age and marital status ($r = 0.43$; $p > 0.01$), family size ($r = 0.71$; $p > 0.01$), education level versus children presence on mining site ($r = 0.32$; $p > 0.01$), between marital status and family size ($r = 0.34$; $p > 0.01$) (Table 2).

Table 2: Pearson's correlations of socio-economic factors

	Location	Profession	Nativity	Gender	Age	Education level	Marital status	Children presence	Number people (Family size)
Location	1								
Profession	0.485**	1							
Nativity (origin)	-0.625**	-0.299**	1						
Gender	-0.156*	-0.072	-0.002	1					
Age	-0.225**	-0.328**	0.300**	0.146*	1				
Education Level	0.169*	0.280**	-0.220**	0.167*	0.213**	1			
Marital Status	-0.207**	-0.329**	0.252**	-0.065	0.437**	-0.238**	1		
Children Presence	0.238**	0.353**	-0.198**	0.101	0.397**	0.322**	-0.861**	1	
Number people (Family size)	-0.201**	-0.295**	0.328**	-0.029	0.711**	-0.184**	0.347**	-0.313**	1

Source: Authors

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Logistic regression of socio-economic factors

The results showed that primary profession had a significant influence on agricultural production ($p > 0.001$), nativity ($p > 0.001$), gender ($p > 0.003$), marital status ($p > 0.019$) and children' presence on gold-mining site ($p > 0.003$) is significant and positively influenced participation in artisanal gold-mining in Tangandougou (Table 3).

Table 3: Logit regression results of socio-economic parameters

Explanatory variables	Coefficient	S.E.	Wald	Sig.
Profession	0.839	0.170	24.358	0.000***
Nativity (origin)	-4.826	0.786	37.685	0.000***
Gender	-1.659	0.553	8.986	0.003**
Age	0.292	0.268	1.184	0.277
Education level	-0.441	0.387	1.297	0.255
Marital Status	2.947	1.257	5.494	0.019**
Presence of children	4.172	1.417	8.674	0.003**
Number people/ family size	0.281	0.423	0.442	0.506
Constant	-0.472	1.351	0.122	0.726

Source: Authors

***, ** significant at 1% and 5% levels of respectively.

The negative relationship between gender and location (-1.659) indicate lack of gender balance in agriculture activities as more males are engaged in gold-mining than women. In addition, the strong relationship between location and nativity given by a negative coefficient of (-4.826) indicates that the presence of more non-natives undertaking artisanal gold-mining activities. The derived multiple linear regression equation was as provided as Equations. 4 and 5.

$$Y = \beta_0 + \beta X_1 + \beta X_2 + \beta X_3 + \beta X_4 + \beta X_5 + \beta X_6 + \beta X_7 + \beta X_8 \quad (4)$$

Then,

$$Y = 0.839X_1 - 4.826X_2 - 1.659X_3 + 0.292X_4 - 0.441X_5 + 2.947X_6 + 4.172X_7 + 0.281X_8 - 0.472\beta_0 \quad (5)$$

This study of socio-economic parameters showed that agriculture was negatively affected by artisanal gold-mining in Tangadougou commune in Sikasso region. For instance, the finding of this study revealed that 88 famers were abandoned crops production for mining activities only on artisanal gold mining site. Thus contributing to increased food insecurity of native communities involved in artisanal gold mining areas (Nabaasa, 2016).The social problem drivers are many in artisanal gold mining areas. The local population who are living with low economic status become oppressed and marginalized by miners' community.

The low economic status observed is not within the results reported by Bryceson and Geenen (2016) on the transformative nature of artisanal frontier mining in view of

sub-Saharan Africa's mining history. As a result, artisanal gold mining has generated livelihood earnings for millions of people in sub-Saharan Africa (Bryceson & Geenen 2016; Arthur et al., 2016). The socio-economic challenges and benefits are mostly related or similar among miners community, because of externalities issues in artisanal gold mining areas (Gumede, 2018). Owing to the deplorable conditions within the mining sites women and children become the most affected by such social ills as prostitution, drugs and unsanitary environment (Huesca, 2013). Furthermore, mining site and nearby are exposing to multinational problems because of the nature of free entrance of artisanal mining (Kitula, 2005).

Couch (2002) reported the case of environmental and socio-economic impacts on Aborigines in Canada, which was strongly highlighted by policies than the ongoing on artisanal gold mining sites, generally in Africa and especially in Mali. This process was out of the problems of intercultural communications between a multinational corporation, four small Aboriginal groups and officials working in a period of transition within government (Couch, 2002). Gender was referred to socially constructed relationships between men and women. Gender differences were evident in Tangandougou Commune not only for biological sex of individuals, but also through the roles they play and the expected responsibility on them in the society. These roles of gender are very dynamic and related to the time lines of changes in many environmental and socio-economic factors (Großmann, 2017). The founding is within the results reported by Mwakumanya et al. (2016) on socio-economic and environmental impact of mining on women in Kenya, especially women working in Kasigau mining zone in Taita Taveta County. The integrations of these considerations into the different projects of artisanal gold mining and agricultural production is very helpful for local and national governments, and populations.

These workforces in terms of age express the rude activity of artisanal gold mining and that impacts agricultural production which is also related to the same bracket of age. Funoh (2014) has reported the above problems of workforce's availability for agricultural production in Cameroon, especially during the period of production. The ages were ranked categorically so as to find out different age brackets of workforces on both sites of study. The expected output of age limits was the involvement of youth in gold mining and also agriculture production in Tangandougou commune. For instance, the age bracket of 15 to 45 years old constituted the majority of those working at the mining sites. The research was expected that education level of population was one of the best explanatory variables which influenced them to be engaged in artisanal gold mining Tangandougou Commune. The results of this study were confirmed that more people are educated

the more they are out of artisanal gold mining activity (Coulibaly, 2017). Our findings are within the results reported by Adu et al. (2016) that household size, Age, sex, Educational attainment, perceived risk and peer influence are key predictors of one's decision to participate in illegal mining in Denkyira corridor in Ghana.

Marital status is one of the significant considerations in society, especially in Malian society. That marital status consideration is due to the socio-culture and religions impacts on populations. Coulibaly (2017) was within that logic of marital status which is one of the socio-cultural parameters to involve married people in artisanal gold mining in Mali. That involvement is motivated by weak likelihood of household, so they have to move to supplement activities so as to supplement expenditures as a head of family. This parameter was paramount to determine whether the interviewed households allowed their children to be involved in artisanal gold mining and other forms of production activities on both mining and non-mining sites of Tangandougou commune. The assumption was that the involvement of children in different activities could affect their progression at school and also the future development of the commune. Human Rights Watch (2011) documented the presence of children on mining sites and whereby site in Mali is estimated to be between 20,000 and 40,000 those working in Mali's artisanal gold mining sector. These children are subjected to the worst forms of child labor, leading to injury, exposure to toxic chemicals, and even death. Furthermore, these children suffer serious pain in their heads, necks, arms, or backs, and risk long-term spinal injury from carrying heavy weights and from enduring repetitive motion. In addition, the same similarity of the presence of children and their exposure to different negative factors through child labor was reported from Philippines (Caymo II, 2016; Human Rights Watch, 2015). These children risk grave injury when working in unstable shafts, which sometimes collapse, especially during the rainfall season.

Family size is not directly linked to marital status, but results shown that most of the interviewees were justified their involvement in mining by the largest of household and its expenditures. Coulibaly (2017) reported that households were impacted from climate change that why they were run for other alternatives to sort the poorest likelihood, especially those with a large family. The driving forces in artisanal gold mining are many and various. The local population who are living with low economic standards become oppressed and marginalized by miners' community. As a result, the living conditions will be increased and following up by insanitation, malaria, prostitution, alcoholism and drug-taking. These factors drive women and children to be the most affected in such societies (Kitula, 2005). Land use-related and environmental impacts affecting agricultural production, human health and human

rights appear to be the most concerning social aspects in most the artisanal gold mining areas (Mancinia & Sala, 2018).

CONCLUSIONS AND RECOMMENDATIONS

The study concludes that agriculture has been negatively impacted by artisanal gold mining and connected activities in Tangandougou commune, Sikasso region. The study therefore concluded that in order to keep the households engaged in agriculture, more emphasis on male sensitization and promoting agriculture as a main activity for food security is necessary. There are also needs to promote cash crops and credit access of farmers. In order to keep the population willing to invest in agriculture, they have to be convinced that the revenues are comparable with those they can obtain through gold mining.

Acknowledgements

This material is based upon work supported by the United States Agency for International Development, as part of the Feed the Future initiative, under the CGIAR Fund, award number BFS-G-11-00002, and the predecessor fund the Fond Security and Crisis Mitigation II grant, award number EEM-G-00-04-00013.

Conflict of Interest

The author declares that there is no conflict of interests regarding the publication of this manuscript.

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