Effects of Artisanal Small Scale Mining on Household Food Availability and Access in the Amansie West District of Ghana

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Abstract
Artisanal Small Scale Mining has become an important livelihood activity for most rural households in Ghana. In this study, we examined the impacts of artisanal small scale mining otherwise known as "galamsey" on household food access and availability in the Amansie West District of Ghana. A multistage sampling technique was employed to select respondents from four communities in the district. Two hundred and forty five (245) household heads were interviewed. A probit estimation model was employed to determine the effects of households' involvement in galamsey on food access and availability. The results revealed positive and negative impacts of galamsey on household food access and availability respectively. Households engaged in galamsey activities are likely to have access to food throughout the year. However, the results indicate a decrease in availability of food to those household. We conclude that, galamsey activities in the Amansie West district impacts positively on food access which contribute to food security and negatively on food availability i.e. reduced local environmental capacity to support adequate food production. The study recommends mainstreaming galamsey livelihoods through the introduction of a regulated regime, afforestation of degraded lands and compulsory reclamation, and capacity building of artisanal miners on safe environmental practices.

Keywords — *Food security, artisanal mining, galamsey, probit model*

I. INTRODUCTION

It is anticipated that the world population would double between 2010 and 2050. This means significant effort is required to push the frontiers of food production to enhance food availability and access to households [1]. This anticipated development in the face of global food security challenges makes it imperative to take cognizance of the efforts taken by global organizations and countries aimed at achieving agenda 2030 of the sustainable development goals. In Ghana, food access and availability has become an important issue because of the prevalence and gravity of poverty in the country [2]. Food access and availability are affected by seasonal and unstable domestic production of staple food, high prices of food and unstable inflation, low incomes, persistent high level of unemployment and environmental degradation [1]. Laborde et al., (2016) identifies the determinants of food security to include income changes, distribution of income, education, and waste in the food system and food prices. From the foregoing it is clear that food access and availability are influenced by purchasing power and domestic production levels which are directly influenced to a large extent by income levels of individuals and households.

Mineral resource extraction particularly, artisanal gold mining plays a key role in the livelihood conditions of the people hence, providing a means of living. According to [4], Artisanal Small Scale Mining (ASM) otherwise known as "*galams*ey" has become a major livelihood activity for many households over the last decade in Ghana. The artisanal and small-scale mining sector in Ghana is estimated to directly employ about one million people and supports approximately 4.5 million others indirectly [4]. In spite of the widely acclaimed employment and income earning opportunities offered by *galams*ey, research findings by scores of authorities reveal that *galams*ey activities are environmentally unsustainable and negatively affects food production ([2], [5], [6]). According to [2] *galams*ey has been the main cause of water pollution, biodiversity loss and air pollution, destruction of forest ecosystems and agricultural lands in Ghana. The negative impacts of *galams*ey have become a challenge to achieving the Sustainable development goals two (2) and four (4) aimed at ensuring zero hunger and good health and wellbeing by 2030.

Despite the overwhelming evidence of the socio-economic and the environmental impacts of *galams*ey in Ghana, there is limited information with regards to its impact on food access and availability. Evidence gathered by [7] and [8] shows negative

impacts of *galams*ey on the environment and livelihoods in Ghana. However, little has been done in terms of evidence gathering in the Amansie West District of Ghana to assess the impacts of Artisanal Small Scale Mining (*galams*ey) activities on household food access and availability. Therefore, this study was set out to understand the impacts of *galams*ey on household food access and availability in the Amansie West District of Ghana using the probit estimation model.

II. LITERATURE REVIEW

Overview of Artisanal Small Scale Mining in Ghana

Gold is the most predominantly mined mineral in Ghana and has been produced in the country since the 15th century. The Portuguese traded gold to Europe by 1460, and subsequently, the English and Dutch became an integral part of gold trade in the then Gold [9]. The main methods employed for mining has been small scattered/open cast (pits) by the local people and underground mining [10]. The mining industry in Ghana has gone through a series of policy and institutional shifts. According to [11], about 60 Mining Acts, ordinances and regulations have been enacted to regulate mining activities in the country since 1990. The most significant initiative undertaken in the mining sector was the implementation of the Minerals and Mining Law (PNDC L 153). This law liberalized and made large scale mining attractive to private investors with introduction of investment allowances, reduction in Government entitlements; elimination of import duty on capital equipment etc. [12]. Again the passing of the Mercury law (PNDC 217), Small-Scale Gold Mining Law (PNDCL 218) in 1989 and the Precious Minerals and Marketing law (PNDCL 219) in 1989 further boosted local people's participation in the sector in the form of Artisanal Small Scale Mining [12].

In Ghana, small-scale (gold) mining is defined as "mining (gold) by any method not involving substantial expenditure by an individual or group of persons not exceeding nine in number or by a co-operative society made up of ten or more persons" [13] This definition reflects the United Nations definition of small-scale mining [14]. According to the World Bank, "Small-scale mining is widely regarded as a poverty-driven activity, usually undertaken in the poorest and most remote rural areas of a country by a largely itinerant, poorly educated populace with limited employment opportunities". The artisanal and small-scale mining (ASM) sector continues to grow in size and significance. It is an important livelihood activity for many households, contributing to wealth creation and employment. As indicated earlier, it is estimated that artisanal and small-scale mining (ASM) in Ghana directly employs about one million and supports approximately 4.5 million others indirectly [4].

Determinants of Household Food Accessibility and Availability

The Food and Agriculture Organization of the United Nations defines Food security as a "situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" [15]. This definition espouses four (4) key measurements of food security: Access, Availability, Utilization and Stability. Food availability denotes stable physical presence of food available for use by households, and it is determined by all forms of domestic production, imports, reserves and food aid ([16], [17]). Food Accessibility refers to a household's capability to acquire food regularly with one or a blend of domestic production, purchases, gifts, borrowing and social support such as food aid [16].

Some earlier studies have reported several socio-economic, biotic, and demographic factors as the possible determinants of household food access and availability. For instance, Ahmed (2015), suggests that food access and availability is influenced by climate change and unpredictability of the weather such as drought and extreme weather events, pest infestations, livestock diseases and military conflicts, lack of emergency plans, human diseases and rapid population growth [18]. Other studies (such as [3], [19]) have reported income changes, distribution of income, education, waste in the food system and food prices as the essential factors that influence household's food availability and access. In addition to these factors, other researchers have established an array of factors that determine household food access and availability including; household's socio-economic and demographic characteristics, purchasing power (ability to buy food at prevailing prices), food price volatility, access to agricultural credit, total income per adult equivalent, asset possession, ownership of home garden, access to subsidized food, source of food, availability of food commodities, inadequate labor and land ([16], [20], [21]).

Artisanal Small Scale Mining is a livelihood activity that most rural households depend on for income [22]. Frankenberger (1992) asserts that income and sociocultural characteristics influence household food accessibility. Engagement in ASM impacts income level and the ability of households to procure food. Also, ASM drives the livelihood of service providers (often women) who move to the mining sites to be engaged in minerals transporting, washing, sorting, grading or treatment. These additional activities in the value chain add to employment opportunities and income generation for households [24]. However, communities with *galams*ey activities are faced with food shortage and high cost, which affects the household's ability to

procure food [22]. Even though the factors that determine household food access and availability are usually generalized, household food availability typically determined by land access and quality, availability of infrastructure and household head characteristics such as age, sex, household size, education level which influence the level of food production and availability to the household ([9], [22], [23]), ASM, as a livelihood activity could impact positively or negatively on household food accessibility and availability in the study area. In addition to the above, [25] notes that households' food sources are interrupted by environmental degradation resulting from activities such as *galams*ey which directly affects food production.

The effect of these factors discussed above as possible determinants of household food access and availability in relation to households' involvement in *galams*ey as a livelihood activity is tested in this current study.

III. MATERIALS AND METHODS

The Study Area

The study was conducted in the Amansie West District (AWD) in the Ashanti region of Ghana. The District lies within latitude 6.05^o West: 6.35^o North: 1.40^o South and 2.05^o East. The rainfall pattern in the district permits inhabitants to practice both farming as well as use of water resources for "washing" gold. The geological formation of the district's soils is developed over granite rocks which comprise the Nyanako-Tinkong Association, Birimian rocks, Bekwai-Oda Compound Association, Mim-Oda Compound Association, Kobeda-Esciem-Sobenso-Oda Complex and Awaham, Kakum, Chichiwere Association [26]. This geological composition supports both mining and agriculture production. For instance, the Bekwai- Oda Compound Association has been noted as having relatively good agricultural value for the production of crops such as plantain, cocoyam, cassava, maize, legumes and vegetables. According to the 2010 Population and Housing Census, the population of the district is estimated at 134,331 with 67,485 males and 69,790 females [27]. Among the resources identified in the district are potentially rich mineral (gold) deposits. In the Jeni Bonte River for instance, it is estimated that there are about 21,361,400 cubic meters of soil containing 5,209,866 grams of gold. The activities of artisanal and small scale miners is notable in the district.

Sampling Technique, Size and Data Collection

A cross-sectional survey was used to collect primary data from 245 households at Asuadie, Abodom, Essienkyiem and Watreso communities in the Amansie West District. The communites were selected using purposive sampling procedure due to the predominance of *galamsey* practice within the district. Afterwards, Yamane's (1967) formula for sample size determination as given below was employed to determine the sample size for the survey [28].

$$n = \frac{N}{1 + N(\alpha^2)}$$

Where:
N= Proportionate sample frame
n= Sample size
α = confidence interval
α =0.05= Confidence level 95%

From a sample frame of 722 households and operating at 95% confidence level, the formula produced 257 households for data collection. The sample size of 257 was proportionally determined for the four (4) study communities as shown in Table 1. In each community a focus group discussion was held with representatives of the communities, and 4 key informant interviews were conducted with representatives of major stakeholders such as the Millennium Villages Project, Department of Agriculture, Manso Nkwanta Traditional Authority, and the District Assembly.

Table 1: Summary of Proportional Distribution of Sample Sizes of Selected Communities

Communities	Number of households	Proportion (%) of sampled households	Community sample size
Abodom	109	15.0	39
Watreso	339	46.9	121
Esienkyem	100	13.8	36
Asuadie	175	24.2	62
Total	722	100	257

Source: Amansie West District, 2015

Analytical Method

Both descriptive and inferential analytical tools were used to analyse the data. Descriptive techniques such as measures of central tendencies (means, media and mode) and dispersions (standard deviation and variance), frequencies and cross-tabulations were used to describe the data. A probit model was employed in this study to examine the household engagement in *galamsey* and its effects on household food access and availability. Table 2 presents a summary of the variables used in the probit model. Empirically, the empirical model is specified as:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{13} + \beta_{13} X_{13} + \varepsilon_i$$

Where:
Y_i = Access to food and availability of food (1 if yes and 0 otherwise)
X_1 = Sex of Household head (1 if household head is a male and 0 otherwise)
X_2 = Age of household head in years

X_3 = No years for formal education of household heads

X_4 = Number of persons in the household

X_5 = Employment status of respondent (1 if household head is employed and 0 otherwise)

X_6 = Main Income source from Farming (1 if households main income is from farming and 0 otherwise)

X_7 = Main Income source from *Galamsey* (1 if households main income is from *galamsey* and 0 otherwise)

X_8 = Monthly income of household in Ghana cedis

X_9 = Engagement in *Galamsey* (1 if any household member is engaged in *Galamsey* and 0 otherwise)

X_{10} = Number of household members engaged in *Galamsey*

X_{11} = Main food source from Farm (1 if households main food is from the farm and 0 otherwise)

X_{12} = Main food source from market (1 if households main food is from the local market and 0 otherwise)

X_{13} = Access to arable land (1 if household has access to arable land and 0 otherwise)

IV. RESULTS AND DISCUSSION

Demographic Characteristics

The results in Table 2 outline household demographic characteristics. These characteristics are important factors that influence household's food access and availability [29]. The results show that majority of households were headed by males (59.6%) while 40.4% of the households were headed by females. About one-third of the respondents were in the 20-30 years category while 23% were in the 51-60 years category. The average age of the respondents was about 39 years. The age distribution of household heads shows that, about 77% of household heads were within the active labour force indicating the presence of endowed man power in the study area.

Just a small proportion of the respondents (6.5%) had attained a tertiary education while 33.1% had obtained some formal education up to the middle school level. Also, 27.3% had no formal education. It became evident from the study that majority of the households (63.7%) were unemployed whereas the remaining 36.3% were employed. The employment status of households influences income levels and purchasing power which influences economic access to food [30]. Also, [29] asserts that the size of the household influence the quantity of food required for a household. The average household size is about 4 persons per household. Also, about 42% of households comprise between 3 and 4 members. This indicates that households may require more resources to meet their household food needs. This is supported by the fact that there are extremely large households in the communities with sizes ranging from 5 to 8.

Table 2: Households distribution by socio-economic characteristics

Household characteristic	Frequency	Percentage
Age		
20-30	82	33.5
31-40	41	16.7
41-50	65	26.5
51-60	57	23.3
Sex of household head		
Male	146	59.6
Female	99	40.4
Employment status		
Employed	89	36.3
Unemployed	156	63.7
Household size		
1-2	70	28.6
3-4	102	41.6
5-6	49	20.0
7- 8	24	9.8
Level of education		
Primary	16	6.5
Middle school	81	33.1
Junior high school	41	16.7
Senior high school	24	9.8
Tertiary	16	6.5
No formal Education	67	27.3

Determinants of Households' Food Access

Table 3 presents the parameter estimates for the probit model of the determinants of household's access to food. Results of the probit model show that the likelihood ratio chi-square is 66.53 and is significant at 1% level. This indicates that the variables jointly influence household's access to food throughout the year. Among the variables considered in the model, seven were found to have a significant relationship with household food access. They included sex of household head, age of household head, years of formal education, employment status, main income from farming, engagement in *galams*ey activities, and main food source from market.

Table 3: Probit estimates of determinants of household's food access

Variable	Coefficient (Std. Err)	Marginal Effect	z-value
Sex of Household head	1.0540 (0.2993)	0.3201	3.52***
Age of Household head	0.0188 (0.0110)	0.0054	1.71*
Years of formal Education	-0.1633 (0.0460)	-0.0493	-3.55***
Household size	-0.1035 (0.7288)	-0.03124	-1.42

Employment status of respondent	0.8450 (0.3107)	0.2378	2.72***
Main Income source farming	-0.5563 (0.3144)	-0.1665	-1.77*
Monthly Income	0.0532 (0.0276)	0.0212	1.93*
Engagement in *Galamsey*	0.2126 (0.0344)	0.0674	6.18***
No. of household members engaged in *Galamsey*	-0.0654 (0.1288)	-0.01974	-0.51
Main food source from market	-0.5572 (0.3285)	-0.1848	-1.70*
Constant	0.1840 (0.9023)		0.20
LR Chi2 (11) = 66.53***			
Log likelihood = -77.5821			
Pseudo R2=0.5130			

Note: *, ** and * denote significance at 10%, 5% and 1% respectively.**

Sex of household head was significant at 1% and the coefficient from the probit estimates indicated that households headed by males are more likely to have access to food throughout the year than those headed by females. In terms of the marginal effects, having a male headed household increases the probability of having access to food throughout the year by about 32%. This could be explained by the fact that male-headed households are in a better position to have better access to productive resources such as fertile land and labor while female-headed households are constrained by cultural and social factors that limit their access to such resources. Especially in a rural setting like the study area, male-headed households will therefore be in an advantageous position regarding crop production and are more likely to have access food through own food production and purchasing from the market. This result is consistent with the findings of [31] and [32]. Also, there is a positive relationship between household's age and food access and this is significant at 10%. A unit increase in household head's age increases the household's food access by about 0.54%. A plausible explanation to this finding may be the fact that older household heads are more likely to be more economically stable and have better access to production resources such as land than younger household heads. Similar to this finding, [33] reported that over the course of their lives, people acquire adequate knowledge and build social networks that enable them to engage in more successful agricultural production strategies that increase their access to food. Also, younger

household heads are most likely to have more dependents than older household heads. This finding is however at variance with that of [34], who in their assessment of food security conditions of rural households in Pakistan found an inverse relationship between household head's age and food access. On the other hand, there is a negative impact of number of years of formal education on household food access. The results show that a unit increase in the household head's years of formal education decreases the household's food access by about 4.9%. Thus, households headed by more educated people are unlikely to have access to food throughout the year. This finding is contrary to that of [34] and [35]. But in local settings studied, the possible explanation might be that the more educated a household head the less likely they are inclined to take to agriculture which is mainly traditional and laborious, but provide ready access to food and minimizes food insecurity. Most of the educated respondents were very much interested in formal jobs, which were very limited and poorly paid.

The results further show that employment status of the household head and household engagement in *galams*ey activities positively influence households likelihood to have access to food throughout the year. In terms of the marginal effects, having an economically active (employed) household head increases the household's food access by about 24% and this is significant at 1% level. Similarly, a household member's engagement in *galams*ey activities increases the likelihood of having access to food throughout the year by about 7%. The implication is that households with a member engaged in *galams*ey activities are more likely to have access to food throughout the year than households with no involvement in *galams*ey activities. This is due to the fact that much more money is derived from these activities which increase the household's income and subsequently enabling the household to acquire food from various sources. This finding is comparable to that of [20] and [21] who reported the household's purchasing power to procure food at the prevailing prices as a major determinant of food security. Bashir et al. (2012) confirms that income appears to be the most important determinant of food accessibility since food security relies mainly on having more access to food and having access to food depends on whether an individual has enough income to purchase the quantity of food that is required. This is further confirmed by the results of estimates that household whose main source of income is from farming activities are about 17% less likely to have access to food throughout the year compared to household whose main income source is from *galams*ey activities. Similarly, obtaining majority of the household's food supply from the market has a negative relationship with household's food access

throughout the year. In terms of the marginal effects, having the local market as the household's main food source decreases the household's food access by about 18% and this is significant at 10% level.

Determinants of Household's Food Availability

Table 4 presents the probit estimates of determinants of household food availability. The likelihood ratio with a Chi-square value of 102.13 which is significant at 1% indicates that the variables jointly influence household's food availability throughout the year.

Table 4: Probit Estimates of Determinants of Households Food Availability

Variable	Coefficient (Std. Err)	Marginal Effect	z-value
Sex of Household head	1.0869 (0.3429)	0.3166	3.17***
Age of Household head	-0.0114 (0.0123)	-0.0033	-0.93
Years of formal Education	-0.2025 (0.0613)	-0.0582	-3.30***
Household size	-0.1957 (0.0822)	-0.0563	-2.38**
Main Income source Farming	-1.6456 (0.4612)	-0.4513	-3.57***
Monthly Income	0.0162 (0.0036)	0.0465	4.54***
Engagement in *Galamsey*	-0.9144 (0.5133)	-0.1968	-1.78*
Number of household members engaged in *Galamsey*	0.2790 (0.1517)	0.0802	1.87*
Main food source from market	-1.5023 (0.4226)	-0.5131	-3.56***
Access to arable land	1.0225 (0.2799)	0.2820	3.65***
Constant	1.9375 (1.1658)		1.66*
LR Chi2 (10) = 102.13***			
Log likelihood = -63.9921			
Pseudo R2=0.6438			

Note: Values in parentheses are standard errors.
*, **, *** indicates significance at 10%, 5% and 1% respectively.

Sex of the household head, monthly income of the household, number of households members involved in *galamsey* activities and access to arable land significantly and positively influence household's food availability throughout the year. On the other hand, household head years of formal education, household size, farming as household main income source, household engagement in *galams*ey, household's main food supply from the market significantly and negatively influence household's food availability throughout the year. More specifically, the results show that having a male headed household increases the household's probability of having food available throughout the year by about 32% compared to female headed households. Also, household head's number of years of formal education has a negative relationship with access to food throughout the year as found by [9] and [22]. An additional year of formal education attained by a household head is likely to decrease the probability of the household's food availability by about 5.8% and this is significant at 1% level. This finding is in agreement with earlier studies such as [22] and [9] but however at variance with [23]. Again, this is particularly true as individuals with higher levels of educational attainment normally seeks formal jobs which may not be readily available compared to jobs for those with less formal educational achievement in Ghana. Most of the respondents of this study are engaged in *galamsey* activities which mostly are undertaken by people with lower formal educational achievement.

Also, an additional household member is decreases the household's likelihood of having food available throughout the year by about 5.6%. Banchirigah & Hilson (2010) and Bashir et al. (2012) found household size as major determinant of household food availability. In their study, [9] reported that households with large size do not have food available throughout the year principally because they will consume large quantities of their food stock. Similarly, [36] found that an additional household member results in increasing household food insecurity by 0.8% among rural households in Rwanda. The results also show that households that have farming activities as their main income source are less likely to have food available throughout the year compared to households that have *galamsey* activities as their main income source. This may be due to the fact that quite a substantial income could be realized from the *galamsey* activities compared to farming as confirmed by [30]. Specifically, Households with farming as their main income source are is likely to decrease the household's food availability by about 45%, significant at 1%.

Furthermore, households with high monthly income are more likely to have food available throughout the year compared to households with less

monthly income. Specifically, a Ghana Cedi increase in the monthly income of the household will increase the probability that the household will have food available throughout the year by about 4.7%, principally due to the fact that they can have a substantial income to acquire their food stock. This finding is comparable to that of [21] and [37]. Similarly, [38] found that low-income rural households are disadvantaged in terms of food availability throughout the year.

The results also show that a household with a member engaged in *galams*ey is less likely to have food available throughout the year compared to households with no involvement in *galams*ey activities. The marginal effects of the probit estimates show that having a household member engaged in *galams*ey decreases the household's probability of having food available throughout the year by about 19.7% and this is significant at 10%. Consistent with this finding, [17] and [35] observed that although much more money could be derived from *galams*ey activities which increase the household's income, and subsequently enabling the household to acquire food from various local markets, there could be unavailability of food stuffs in the local market. If the income generated from *galams*ey activities is not enough to source food from external markets, the households may run into problems of food availability throughout the year due to alteration of local economy. However, the results indicate that households with more of its members involved in *galams*ey activities are more likely to have food available throughout the year. This is so as an additional household member engaging in the activity will increase the income generated from *galams*ey activity enabling the household to source food from other external markets even if it is not available in the local market. An officer at the district department of agriculture confirmed in an interview that:

"*Households depend on food from neighboring markets such as Kumasi because most of the wet lands in the communities have been used to mine gold*" – Key Informant, Department of Agriculture, Amansie West District 2015. Indeed, this confirms the results on increased food access in the short term by household depending on external markets.

Results of the probit model show that an additional household member in *galams*ey activities increase the probability that the household will have food available throughout the year by about 8%. Furthermore, households who obtain the majority of their food supply from the market are less likely to have food available throughout the year than households that obtain the majority of their food supply from their own farm. This is particularly true as food from own farm may be more secure in terms of sustainability than those that are obtained from other markets. In terms of marginal effects, households whose major food supply is from the market are about 51% less likely to have food available throughout the year. Although the household could obtain its food from other markets if the household has adequate purchasing power, the vagaries in food supply and its subsequent prices may cause variability in food availability. Lastly, the results indicate that households that have access to arable land are more likely to have food available throughout the year compared to households that have no access to arable land. This is also particularly true as they could engage in farming to secure their food source. Statistically, having access to arable land increases the household's likelihood to have food available throughout the year by about 28%. This finding is comparable to that of [36] who reported that having access to suitable land decreases household's probability to become food insecure.

V. CONCLUSIONS

This study was set out to examine the impacts of artisanal small scale mining otherwise known as "*galams*ey" on household food access and availability in the Amansie West District of Ghana. Empirical results of the study showed that households engaged in *galams*ey activities are likely to have access to food throughout the year. However, the results indicate a decrease in household food availability throughout the year for households engaged in *galams*ey activities. The study conclude that, currently *galams*ey impacts positively on food access which contribute to food security and negatively on food availability. The study recommends mainstreaming of *galams*ey livelihoods through the introduction of a regulated regime, afforestation of degraded lands and compulsory reclamation and capacity building of artisanal miners on safe environmental practices. Crop intensification through the introduction of high yielding varieties in the most affected *galams*ey areas should be considered by the government and other development agencies to increase food production to enhance availability of food to households. This process, should be based on forming strong farmer based organizations where smallholder farmers can be trained and assigned to extension officers to facilitate application of good agronomic practices.

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