Adoption of new Technologies of Traditional Transformation of Products Made from Cocoa (*Theobroma cacao L.*) in Cameroon

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Abstract
The project "Training and monitoring of women's groups on the manufacture of cocoa products" of World Cocoa Foundation (WCF) with the Institute of Agricultural Research for Development (IRAD) and NGO's CONAFAC, have permitted to diffuse some new technologies of cocoa processing into derived products among farmers in order to reduce poverty, malnutrition and food insecurity in rural areas. The objective of this study is to measure the level of utilization of new technologies and to determine factors that can affect the adoption of these new technologies by farmers. The methodology used in data collection was the direct survey. The levels of adoption were confirmed by a descriptive analyses method, probate and generalized linear model. A case study was done in Mbalmayo and Mbangassina. The results showed that, generally, cocoa butter was the most adopted innovative product, followed by cocoa power and soy-chocolate drink. The adoption rate may differ with studied areas. The major difficulties encountered during the technological adoption were as follows; crushing cocoa bean (30%), lack of cocoa bean (21%), lack of adequate sunshine (12%), lack of electricity (11%). The econometric Logit Model showed that two variables; occupation and level of education influenced the adoption model positively and significantly (coefficient of regression are 0.54806 and 0.16477 respectively). Age group (-0.04778), Marital status (-0.00094) and sex (-0.14214) were negative with no significant coefficient of regression. Our results indicate that cocoa bean transformation into its varied derivatives, offer opportunities to farmers to generate more income. But most female cocoa farmers do not own personal cocoa farm land, and do not have adequate processing materials. Both factors have negative effect on the adoption of new technologies.

Key words: adoption, new technologies, traditional transformation, cocoa beans, cocoa derived products, Cameroon

1- Introduction

In 2005, the population of Cameroon was estimated at 17,463,836 inhabitants with an average growth rate of 2.8% / year. According to the Central Bureau of Census and Population Studies [1], the population is expected to reach 26.5 million in 2020, with an estimated average density of 37.5 habt / km ². This density changes geographically: there are regions with low average and those with high population density. Women constitute about 50.5 % of the population [2]. Over the years, Cameroonian agriculture faced the challenges of feeding a rapidly growing population. She will have to sufficiently increase food production and income to ensure food security in Cameroon and Africa. Researches in agriculture sector are quite challenging and enormous: it entails to favor an increase in crop yields, define, improve and transfer new technologies to stakeholders. The challenge is also to improve food quality for better marketing and competitiveness. All of these changes must be environmentally friendly.

World cocoa production goes from 18 000 tons in 1850 to 155,000 tons in 1900 and reached 672 000 tons in 1940 [3, 4]. In 1997, cocoa production was close to 207 million tons. Today it is 3.5 billion tons and Africa alone provides 72 % of the production. Cameroon cocoa production is estimated at 220 000 tons in recent years [4] and ranks 4th in Africa. Fermented and dried cocoa beans, is the raw material used for the grinding industry. After roasting and removing the shell, it is used to manufacture semi-finished products (cocoa paste and its direct derivatives: cocoa powder and cocoa butter), or finished products intended for direct consumption (chocolate powder, tablets or chocolate confectionery).

Thus women found in these two regions of cocoa production (Mbalmayo and Mbangassina) in the Central region were trained on the traditional transformation of cocoa beans into its derivatives: cocoa butter, cocoa powder and soy chocolate drink, with the aim of enable them practice theses technologies.

Objective

The objective of this study is to analyze the perception of women cocoa farmers' as concerns the processing of cocoa into its derivatives as well the difficulties encountered during the adoption technology.

Most specifically, this work would aim at;

- Estimating the level of adoption and diffusion of technologies;
- Determining the socio-economical and institutional factors influencing technological adoption.

2- Methodology

2.1 - Study areas

Two important pools of Cameroonian cocoa production have been selected for this study: Mbangassina and Mbalmayo. Mbangassina is a highly agricultural and far off division, whereas Mbalmayo is a more developed sub division along the main road between Yaoundé and Kye-ossi (border between Cameroon, Gabon and Central Africa).

Surveys were conducted in 6 villages of Mbangassina and 5 villages of Mbalmayo. These two areas belong to two different agro-ecological zones: forest zone (Mbalmayo) and transition zone (Mbangassina) (Figure 1).

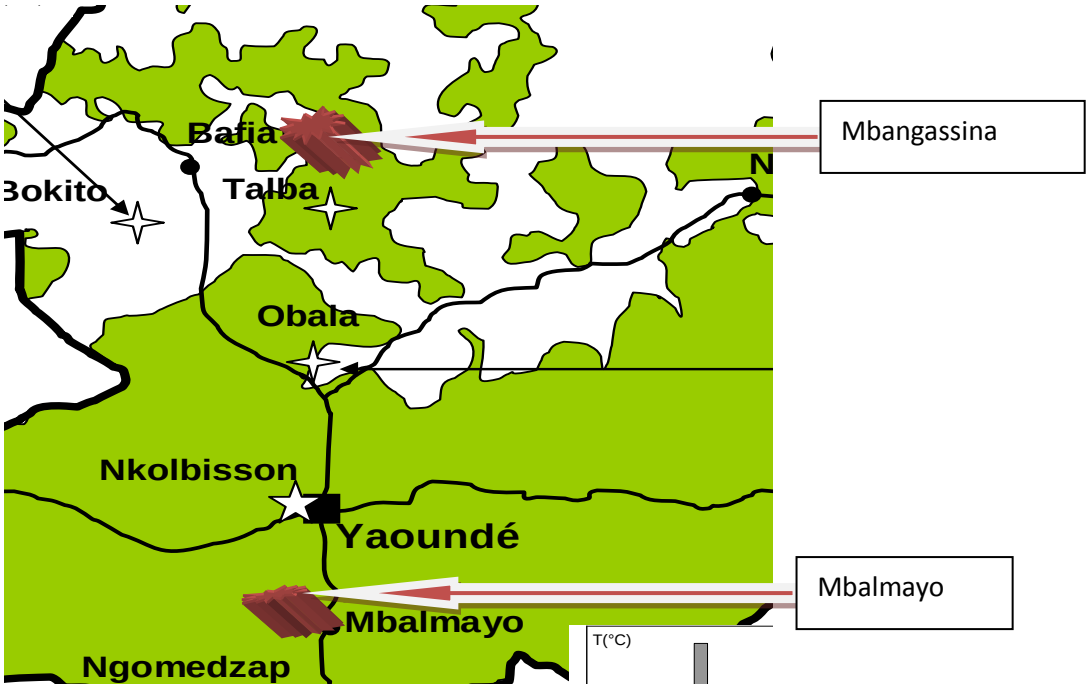


Figure 1: Localization of studied zones

2.2- Technology of cocoa processing

Women cocoa farmers of Mbangassina and Mbalmayo regions were trained on the manufacture of cocoa butter, cocoa powder and soy chocolate drink (figure 2). This training took place at a selected study zones. The technologies to be transfer were simple and practicable, using local materials that were available in rural areas (pot, tissue, spoon, fire

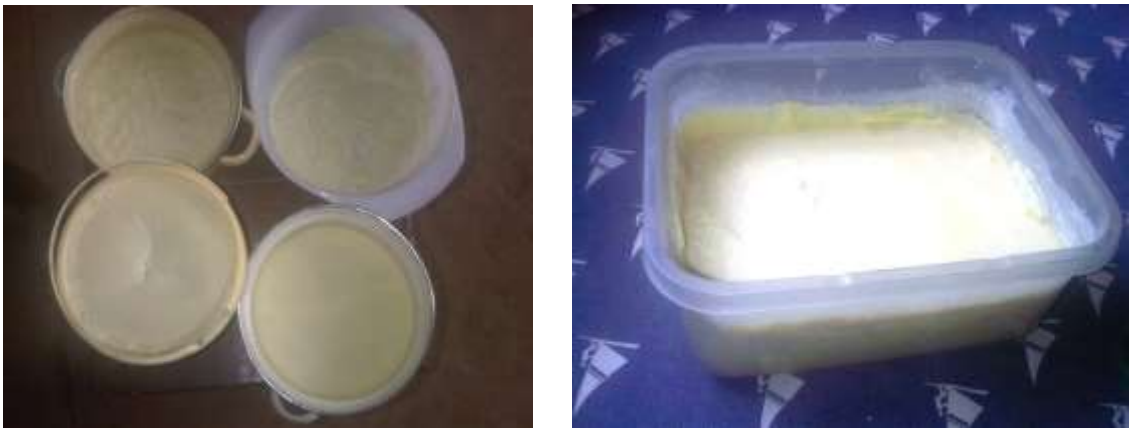
wood, fire side, clean water, mortar and pistil). These technologies were defined by Mounjouenpou and al [5].

- **Cocoa Butter:** Cocoa beans were placed in a locally made aluminum heating pot for roasting and were regularly being stirred for about 60 minutes under the temperature of about 50°C. Next, the roasted cocoa beans was introduced into a mortar and lightly pounded in order to facilitate removal of the husk by winnowing. Thereafter, the beans were finely ground into paste with the aid of a mill. Water was added to the paste and then cooked for several hours. During boiling, cocoa butter emerged to the surface of the mixture, and was collected with the help of a spoon. This liquid cocoa butter was washed using clean water and filtered using a clean tissue.

- **Cocoa powder:** After extracting the cocoa butter, cocoa paste was obtained by evaporating the water. Cocoa paste was dried to obtain cocoa cake. The dried cake was finely ground unto the desired consistency. Cocoa powder obtained can be consumed as a hot drink with sugar or honey during breakfast or as cold chocolate drink.

- **Soy-chocolate drink:** To prepare 3 liters of this drink, soak 500 g of soya-beans in a saline solution for 24hrs. Whiten the soaked grains. In order to eliminate the smell of the beans, boil for 10 to 15 minutes at 80°C. Grind the soy-beans with little water. Measure 300g of soy-beans paste that will be poured into a large saucepan. Add 3 liters of water and 30% of cocoa paste (approximately 100g). Filter well with a very fine mesh sieve. After grinding, the collected paste is boiled for 10 to 15 minutes. The drink is flavored by adding lemongrass and later sweetens to give the desired taste.

Two years after the transfer of technologies to stakeholders, researchers organized and supervised adoption surveys in different areas where women were being trained. Techniques and adoption tools for survey were being defined according to the village, area and the condition of lifestyle of households. Generic questionnaires were being made to collect data. Enquiries focused on women who were trained by researchers and those who were trained by "trainer of trainers". The adoption survey concern 127 women of two selected regions:



Cocoa butter

cocoa powder

soy-chocolate drink

Figure 2: Cocoa butter, cocoa powder and soy chocolate drink.

2.3- Data collection and analysis

Primary data was collected through an area of study by a survey to obtain the characteristics of the farmers and the level of their adopting the new technology. The structured survey served as a control for checking or comparing information obtained through participatory methods. Information was gathered through a questionnaire administered to the farmers by the facilitators.

Statistical analysis were performed on an SPSS (release 16.0)[6] computer package, Logistic Model to explain the ad optional factors, with coefficients of regression and procedure in SAS 9.2 (SAS Institute, 2002)[7] with the DUNCAN test to separate the mean.

Analytical Model

The decision to adopt a technology is dichotomous; a woman can decide whether to use the technology or not. The adopter was defined as a woman who uses one of these technologies regardless of the frequency. The decision to adopt is considered as a dependent qualitative variable with a regression value of 0 or 1. This value depends on the characteristics of the adopter. The approach used in analyzing the factors determining the adoption can be estimated using a model which can predict the decision of farmers in the adoption of the technology proposed or not. The decision will also depend on the socio-economic characteristics of the decision maker. In other words, this model aims, at a given economic agent, to determine the probability to adopt or not to adopt a given technology. The literature on adoption studies allows for the distinguishing of at least three types of commonly used models to analyze the decision to adopt an agricultural technology: Linear Probability Models are Logit and Probit but the most commonly used model that best explains the diffusion process is the Logistic Function [8](Rogers, 1983). The Probit model has drawbacks because the probability can often exceed 1 but does not hold same for the other two, who through any transformation maintains the estimated probability between 0 and 1. We used the Logit Model, often used in case studies of technology adoption for reasons of convenience [9].

The model can be presented by the following equation:

$$E(Y_i) = P(Y_i) = \frac{e^{\alpha+\beta X_i}}{1+e^{\alpha+\beta X_i}}$$

Therefore, the probability of non - adoption of technologies becomes

$$\text{P (not-adoption)} = 1 - \text{P } \mathbf{(Yi)} = \frac{1}{1+e^{\alpha+\beta X_i}}$$

Where:

P (**Y** i) = probability of an individual i to adopt the technology; P (Yi) = 1 if the technology is adopted and 0 if the technology is not adopted.
e = the exponential function
Yi = the dependent variable; adoption technology
Xi = characteristic of individual i; represents the vector of explanatory variables (age, village, etc.).

β = parametric vectors to estimate where the sign permits the interpretation of results
α = constant

Model Specification

Based on the results of studies on the adoption of technologies, some socio-economic factors are considered instrumental in the adoption of technologies. This includes age, gender, education, occupation and marital status. These variables that characterize the socio-economic status of women can be instrumental in the adoption of technological innovations. In fact, women are considered adopting a technology when making use of this technology at whatever intensity. This adoption is influenced positively or negatively by socio - economic and technical factors like explain Kebede and al [9], Ibro and Bokar [10]. These hypotheses are greatly influenced by the following variables:

Age: the adoption of technology can be highly influenced by the age of the women. The adoption of new technologies requires a certain level of risk associated with the decision to apply technology. Young producers are willing to take more risk compared to older producers.

Education: this variable can be of great importance in the adoption of new technologies. Those with a higher level of education will easily embrace new skill, innovations and assess new technologies compared to those at a lower level. This variable could positively or negatively influence the adoption of technologies.

Gender: women from time immemorial have been proven to easily access information on processing compared to men. Because of these factors alone they stand a better chance of facilitating the adoption of new technology compared to men. The gender variable negatively affects the probability of adopting a new processing technology.

Occupation: occupation may influence adoption. Women who are involved in agriculture and who own cocoa farms have a higher probability of adopting a new technology in the processing of cocoa into its derivatives. The Adoption rate is the proportion of peasants that make use of this technology. Descriptive statistics (Average, Frequency, and Histogram) were used for data processing.

3- RESULTS AND DISCUSSIONS

Results are a summary of the investigations undertaken in the study sites. Analysis identifies variables that can affect the adoption of technologies of processing cocoa beans into cocoa butter, cocoa powder and soy-chocolate drink.

Analysis of socio-economic profile

This study analyzes the socio-economic characteristics of respondents under the following: age, occupation, education and marital status. The data is represented on table 1. Table 1 indicates that the occupation of farmers occupied a dominant proportion (71%). those with a primary and secondary school levels of education, occupied at least 98% of the attendants, the level of education are at least in secondary and primary school (98%), the most dominant age group were greater than 40 years of age with most of them being married (as the dominant marital status). These data are in accordance with those published in several scientific reports [11, 12, 13, 14].

Table 1: Household Socio-demographic characteristic of respondent's involved in the survey on transformation technologies of adoption on cocoa beans.

Characteristic	Sub-division		Overall mean
	Mbalmayo	Mbangassina	
Household size			
females	83	41	62
male	3	0	1,5
Categories of occupation in %			
Agriculture	77	33	
merchant	43	57	
Education level frequency			
non formal education	1	0	0,5
Primary school	35	14	24,5
secondary school	46	27	36,5
university	1	0	0,5
Age category frequency responding			
18-21 years	8	1	4,5
21-25 years	2	2	2
25-28 years	4	0	2
28- 32 years	2	1	1,5
32-40 years	16	6	11
< 40 years	52	29	35,5

Adoption of Technologies

Surveys have permitted the determination of the level of adoption of new technologies. The highest adoption rate of technologies was recorded in Mbalmayo where the women have tried to apply these three processing technologies at least once. In Mbalmayo, Approximately 78% of women who have been trained adopted: 71% of cocoa butter, 81% of cocoa powder and 95% of soy- chocolate drink. The lowest rates were recorded in Mbangassina, with rates of 29%, 19% and 5% respectively for cocoa butter, cocoa powder and soy-chocolate drink (Figure 3). Where ever the region this study was being carried, farmers did express some difficulties in applying the technologies due to the lack of adequate processing equipment and difficulties in crushing beans.

Table 2: awareness of new methodologies of transformation of cocoa bean

Variables	Category	percent
Acceptante of new technologies		100
Level of practice	No	6
	Yes	94
How to crush cocoa bean	On hand machines	81
	In electrical machines	18
	On hand stones	1
Level of used new methods	cocoa butter	54
	cocoa powder	34
	soy - chocolate drink	1
Level of selling new products	cocoa butter	58
	cocoa powder	30
	soy - chocolate drink	12

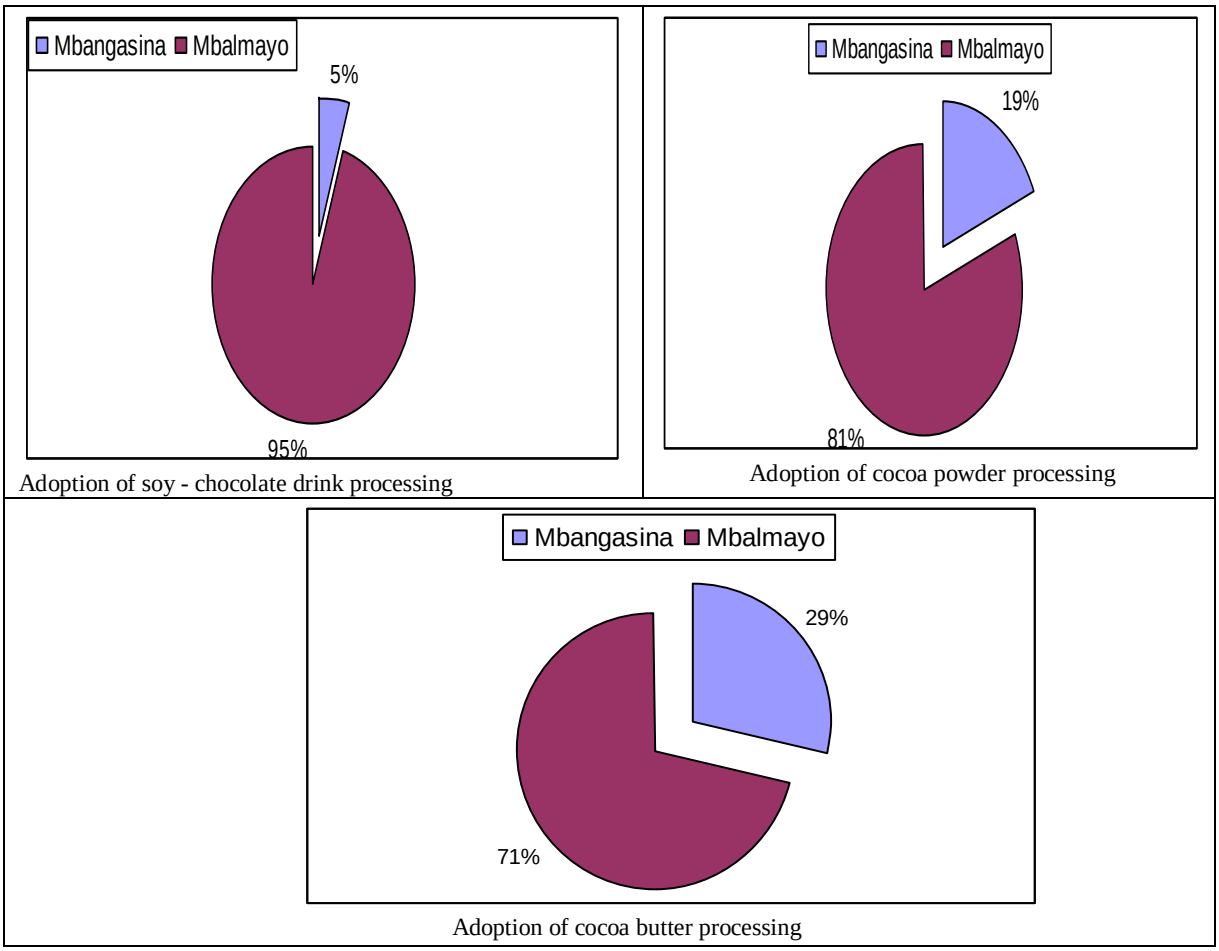


Figure 3: Level of adoption

Factors affecting technologies adoption

Table 3 provides econometric analysis of the adoption of technologies. Two variables namely socio-professional characteristics and the level of general education have a significantly positive influence on the adoption of processing technologies. The improvement in the adoption rate of new technologies therefore requires efficiency of the farming profession and an average level of education. Producers who went to school are aware of the importance of cocoa processing. On the contrary, variables based on: age, marital status and sex have negative regression coefficient and appears not to be significant on the use and adoption of cocoa processing technologies.

Table3. Results of the econometric analysis of the adoption of cocoa derived product technologies (regression coefficients)

Variables	**P- Value**
Occupation	0.54806 ***
Level of education	0.16477**
Age group (years)	-0.04778
Marital status	-0.00094
sex	-0.14214

, * : signifiant at 5%

Difficulties faced by farmers during the adoption of new technologies (table 4). The majors difficulties were: at the level of crushing cocoa bean (30%), lack of cocoa bean (21%), lack of electricity (11%) and lack of sunshine (12%).

Table 4: Farmers difficulties faced by farmers during the adoption of new ;

Constraints	**Frequency**	**Percent**
no water	1	2
Crushing cocoa bean	14	30
far of farm	1	2
remove skin of beans	1	2
roasting beans	2	4
lack of electricity	5	11
lack of cocoa bean	10	21
smoked	1	2
lack of drying room	3	6
lack of sunshine	6	12
expensive of machine	1	2
presence of mousse	1	2
problem of conservation	1	2
problem of transport	1	2

In the two district (Mbalmayo and Mbangasina) the socio-characteristics and the adoption factors are not significant at α=5% level when we used the test of the comparison of DUNCAN in the procedure of GLM (Table 5). These confirm that the conditions of adoption of new technologies are the same in the entire study zone.

Table 5: Comparison of variables of two districts based on the generalize linear model

Variables	**Districts**		**Over all means**	**P-value**
	Mbalmayo	**Mbangassina**		
Sex	1.96512	2.00000	1.976378	0.2344
occupational category	1.2683	1.0513	1.198347	0.0754
Education level	1.4940	1.3415	1.443548	0.1873
Marital status	1.7647	1.7436	1.758065	0.8345
Age	5.0476	5.4615	5.178862	0.1479
Overall Innovative products	1.08235	1.05128	1.072581	0.5041
Cocoa butter	69.620*	60.811*	66.81034	0.0499
Cocoa powder	41.667	45.536	43.15068	0.1324
Soy-chocolate drink	30.048	29.167	29.85185	0.9204
Farmers difficulties when practicing the technology	3.7273	3.1250	3.609756	0.2878
Quantity of transformed cocoa butter per week	1.6042	1.7672	1.657303	0.7386
Quantity of transformed cocoa powder per week	3.60*	64.06*	21.15000	0.0197

* : significatif à 5%

Many scientists investigated on factors that could influence the acceptance of new technologies by households. The critical review of articles related to adoption of technologies has been done by Peek and al [15]. The majority of data available are based on qualitative data relative to adoption level. They have demonstrated that acceptance of new technology are influenced by 27 factors, divided into six themes: Concerns regarding technology (e.g., high cost, privacy implications and usability factors) [16, 17, 18];

- Expected benefits of technology (e.g., increased safety and perceived usefulness) [19, 20, 21];
- Need for technology (e.g., perceived need and subjective health status) [19, 21];
- Alternatives to technology (e.g., help by family or spouse) [20, 22, 23];
- Social influence (e.g., influence of family, friends and professional caregivers) [19, 23];
- And characteristics of older adults (e.g., desire to age in place) [24, 22].

4- Conclusion and recommendations

This study aimed at studying levels and constraints of adoption of new technologies of traditional transforming cocoa beans traditionally into its derivatives. A targeted population of 127 women cocoa farmers underwent training and monitoring on the manufacture of cocoa products: soy-chocolate drink, cocoa butter and cocoa powder. After field trip and inquiry, the adoption of transferred technologies was measured. The result portrayed that new technologies were mostly used by women of Mbalmayo than those of Mbangassina

subdivision. Cocoa butter was the most adopted product, followed by cocoa powder. The major adoption constraints in the two areas are the lack of cocoa bean and some useful material. The lower percentage of adoption was recorded with soy-chocolate drink. The problem of conserving the drink due to the lack of electricity in the villages can also explain the low adoption rate of soy chocolate drink. To improve the adoption rate of these technologies by farmers, some constraints have to be solved; availability of cocoa, availability of the adequate material of transformation, reinforcement of local systems of communication.

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