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## THE COVID-19 PANDEMIC EFFECT TO LIVELIHOOD STRATEGY ADAPTATION OF RUBBER SMALLHOLDING HOUSEHOLD: A CASE STUDY IN SONGKHLA PROVINCE, THE SOUTHERN THAILAND

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### ABSTRACT

The objective of this study was to study how COVID-19 affected the livelihood of rubber smallholding households in Songkhla Province. Total 280 households were randomly selected and interviewed using questionnaire. The results revealed that, finding both positive and negative impact of economy, 74.3% of respondents showed that farmers had adequacy of financial assets, fewer consuming products purchased from the community market and switched to buying more products from supermarkets at 69.7%, decreasing incomes at 93.6%, more saving with considering home expenditure at 92.7%, and 74.3% of farmers had more plantation management. 95.4% of farmers reported changes in social capital as a result of the impact on their livelihood, and 56.0% of farmers were required to take part in the government's initiative to enhance their standard of living. The effects of livelihood adaptation strategies on rubber-producing techniques include an improvement in production efficiency, a decrease in production costs, an expansion of production, an increase in the diversify of production systems, the use of hired labor, employment outside the farm sector, and household financial management. When examining the contributing factors, the livelihood adaption strategies of rubber smallholding households can be explained at 63.7% ( $R^2$  adjust=0.637) by social effect, economic effect, production technology, and environment effect. It was discovered that social effect was best explained (0.490Zx1). The study recommended farm adaptation strategies, including increasing the use of household labor rather than hired labor, using online market channels with different media, increasing farmers' digital markets to adapt agricultural products and livelihoods, and providing a financial plan, diversifying the production system, and increasing sources of income.

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### INTRODUCTION

The rapid emergence of the COVID-19 pandemic had a global effect, affecting more than 4.9 million people with more than 0.32 million deaths recorded in 215

countries. As at 21 May 2020, there had been 4,904,413 confirmed cases of COVID-19, including 323,412 deaths globally (WHO, 2020; RAOT, 2020). In Thailand, from Jan 13 to 21 May 2020, there had been 3,037 confirmed

cases of COVID-19 with 56 deaths (Department of Disease Control, 2020; Tantrakarnapa and Bhopdhornangkul, 2020). In a speech made by the Prime Minister, upon the approval of the Council of Ministers in a meeting held on 24 March 2020 in accordance with recommendations of the medical and public health administrators and technical personnel, under Section 5 of the Emergency Decree on Public Administration in Emergency Situations 2005 (Committee on Agriculture and cooperative, 2020.), regarding an emergency in all areas of the Kingdom of Thailand, from 26 March 2020 to 30 April 2020; The declaration of an emergency situation follows the existing law in force since B.E. 2005 due to the present situation of the coronavirus outbreak; a recent pandemic that is rapidly spreading all over the world, and is also affecting Thailand (EOC, 2020). At that time, there is yet no known vaccine or effective medication. The government has correspondingly applied measures to prevent, suppress, and delay the outbreak, as well as create public awareness and understanding (Public Relation Department, 2020). It has made daily assessments of the situation in response to new developments, information, and medical recommendations of various experts, taking into account the impacts on the public in terms of societal well-being, the standard of living, and public healthcare resources of the government, in order to prevent unnecessary panic (United Nations Thailand, 2020; Worldometer, 2020). The government has been allocating resources and putting several measures in place to curtail the pandemic as soon as possible. It is a humanitarian crisis that is difficult to envision the future of its impact. This crisis can qualify as a contingent point that will create waves of changes to the economic, social, environmental, and global context in all sectors (FAO, 2020). According to the pandemic situations and the Declaration of an Emergency Situation in all areas of the Kingdom of Thailand, the Thai economy is being semi-halted. The measures, including the travel restrictions, are likely to have a substantial impact on the rubber industry and the supply chain (Charnvirakul, 2020), which will affect farmers' and farm workers' livelihoods. Easing up of physical distancing is likely to be staggered and vary from location to location (Donghyun and Pilipinas, 2020). Analysis on the current impact of the pandemic under rubber sectors is not yet identified. The statistical generalizations of the findings; which can provide insight into the issue are needed to be assessed.

Consequently, the current priority aims at assessing the impact of COVID-19 on the rubber business and supply chain in order to answer how Sustainable Natural Rubber (SNR) Practices can meet the challenges of the new normal of rubber business, rubber supply chain, and smallholders' livelihoods under pre and post COVID-19. This includes how the business can go forward sustainably, with resilience, and prompt recovery. Regarding COVID-19, the risk mitigations and responsive measures are needed to be considered, either short-medium-long term crisis or low-medium-high impact scenario and how it might impact the project activities/implementation. The objectives are to study the effect of COVID-19 on the economy, society, technology, and livelihood of Rubber smallholding households in Songkhla province, to examine the factors influencing the livelihood strategies adaptation of rubber smallholding households and suggestions on how Rubber Smallholding Household can adapt to the COVID-19 Pandemic in the future from

## **MATERIALS AND METHODS**

Study area of this study was Songkhla province (Figure 1). Study population is rubber smallholding households in Songkhla province. According on Covide-19 measurements, 280 rubber smallholding households were chosen using a purposive sampling method. Personal interviews using structured questionnaires were used to obtain the data. For data analysis, descriptive statistics, multiple linear regression analysis, and Pearson Correlation were used. To evaluate the COVID-19's effects as determined by being impacted or not. The Likert scale was used in this study to assess the impact level, with 1 having the least impact and 5 having the greatest impact. The findings were then interpreted using midpoint values.

Also, parameters considered in using reference Statistics such as Pearson Product Moment Correlation and multiple Linear Regression analysis for hypothesis analysis are as follow; Independent variables: (1) Social effect (X1); Educational level, Happiness at work, Decreased social activity, Anxiety and living, Receive welfare benefit, Trajectory and interaction in community, Agricultural transport limitation, Household living problems, Modify consumption behavior, Learning and self-defense, Psychological Well-being, (2) Economic effect (X2); Net household income Level, Present household debt level, Present household savings level,

Present household expenses level, Ability to debt settlement of households level, Household owned area, Household production expenditure level, Community Employment level, and (3) Production Technology and Environment effect (X3): Rubber technology management such as fertilizer, weed control, plant disease and pest protection e.g. of households, Labor in rubber management and rubber harvesting of household, Labor in preparing rubber product and sale of household, Level of all chemical Fertilizers utilizations in rubber management, Level of biodiversity for rubber management sustainability of household, Level of household rubber product sale, The source of purchase of rubber produce by households, Sufficiency of rubber production resource level. Dependent variable: The Livelihood adaptation strategies of Rubber

smallholding households (Y) comprised of the quantitative change in rubber-producing technique, increase in production efficiency, reduction the production cost, production expansion, increase in diversify of the production system, use of hired labor in the agricultural sector, non-farm employment, and household financial management

For formulae of Multiple linear regression as;

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \dots + \beta_p x_{ip} + \epsilon$$

where, for  $i$  = no. observations:

$y_i$  = dependent variable

$x_i$  = independent or explanatory variables (socio-economic factors)

$0$  = y-intercept (constant term)

$\beta_p$  = Slope coefficients for explanatory variable

$\epsilon$  = the model's error term (also known as the residuals)



Figure 1. The Study research area; Thailand Map(1) and Songkhla Province Map(2.)  
Source: <https://www.mapsofworld.com/thailand/provinces/songkhla-map.html> (ແກ້ງປ)

**RESULTS**

**Characteristics of rubber household**

Table 1 summaries the characteristics of respondents. All of the farmers who participated in the survey are on average 52.8 years old. 63.3 percent of the farmers were men. The primary occupation of every respondent is a

rubber farm. The average annual household income was 273,665.94 baht, but the average annual household expense was 233,398.53. A typical farmer debts 564,054 baht. Land size by farmers totals 27.67 rai, of which 25.21 rai are used for rubber plantations. The majority of them join 2.8 farm groups.

Table 1. characteristics of rubber household.

Variables	Value
Age (years)	52.8 years
Gender	Male 63.3%, Female 36.7%
Main Occupation	Rubber farm 100%
Household Income	273,665.94 baht/yr.
Household Expense	233,398.53 baht/yr.
Debt	564,054.05 baht

Landholding size	27.67 rais
Rubber Areas	25.21 rais
Group participant	2.8 groups

**Effects of COVID-19 to Negative and Positive impact of Society of Rubber Smallholding Households**

For the effects of COVID-19 (Negative and Positive impact to the society of rubber smallholding households), the following were considered:

Receiving Welfare/Social Policy from the Government: For negative effects to society, receiving welfare/social policy from government (Figure 2(1)), the study found that receiving supports for the cost of utility bill gave the most effect at 67%, 5,000 baht-relief measure at 58.7%, 3-month free internet and extend tax payment had the same effect proportions at 35.8%, and lower water bill measure had the least effect at 30.3%.

Interaction in the Community During COVID-19: For the negative effects to society, in considering interaction within the community during COVID-19 (Figure 2(2)), the study found that practicing social distancing had the most effect at 89%, having more meetings online at 72.5%, less interaction within people in the community at 71.6%, and having community closed as a means of preventing the COVID-19 at 50.5%.

Wellness of Rubber Farmers: For negative effects to society regarding the wellness of rubber farmers (Figure 2(3)), the study found that farmers experienced a decreased physical and mental wellness at 73.4% mind anxiety at 71.6%, and the least of the stress of just staying home at 58.7%.

Learning and Adaptation: For the positive effects to learning society and adaptation (Figure 2(4)), the study found that farmers showed learning and adaptation for livelihoods at 80.7%, more labor has a chance of

returning to the homeland at 78.9%, the chance that lets all people help each other and attempt to build the local economic system, strongly at 78%, group/institute performs more roles to help members at 73.4%, farmers used digital technology for increasing production, creating more values, and approaching the market for agricultural products at 64.2%, and household has more labor which can reduce labor shortage problem at some level for at least 59.6%.

Supporting Careers for More Incomes: For positive effects to society of supporting careers for more incomes (Figure 2(5)), the study found that farmers had more incomes using the principle of the Philosophy of Sufficiency Economy at the most for 60.6%, those who had supporting careers by getting involved in other agricultural activities along with rubber plantation at 56.9%, and having a chance of hiring outside the community at the least for 18.3%.

Getting Together for Cultural Activities in the Community: For effects to society of getting together for cultural activities in the community (Figure 2(6)), the study found that farmers involved in the religious activities such as going to the temple for merit was at the most for 63.3%, prepared aid packages for poor people in the community at 41.3%, and did the activity of community little free pantry at the least for 30.3%. The result shows that rubber smallholding households were socially impacted by the Covid-19 pandemic, in accordance with research conducted by Poovorawan (2021) and Wonsawassana (2021).

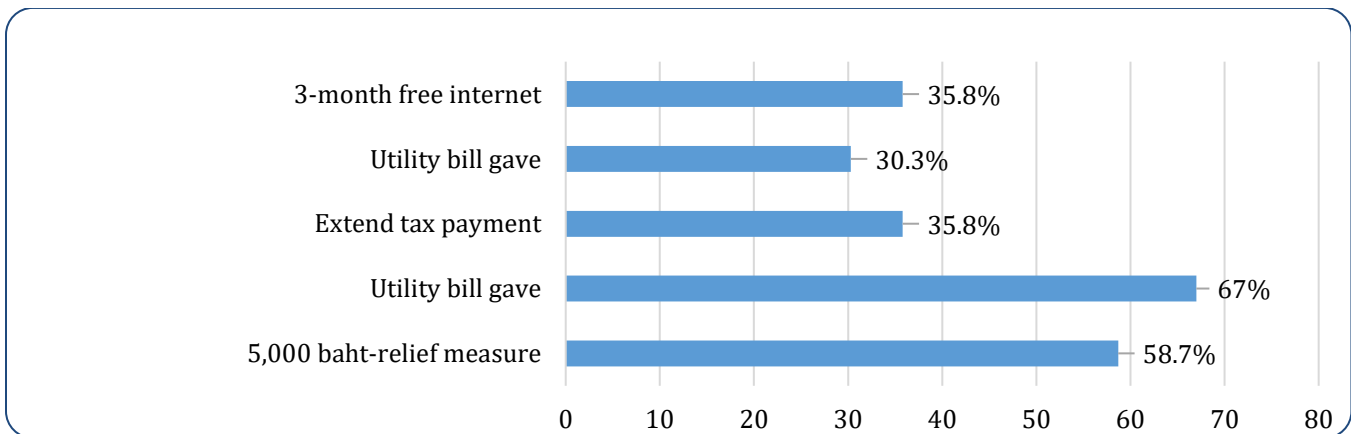


Fig (1).

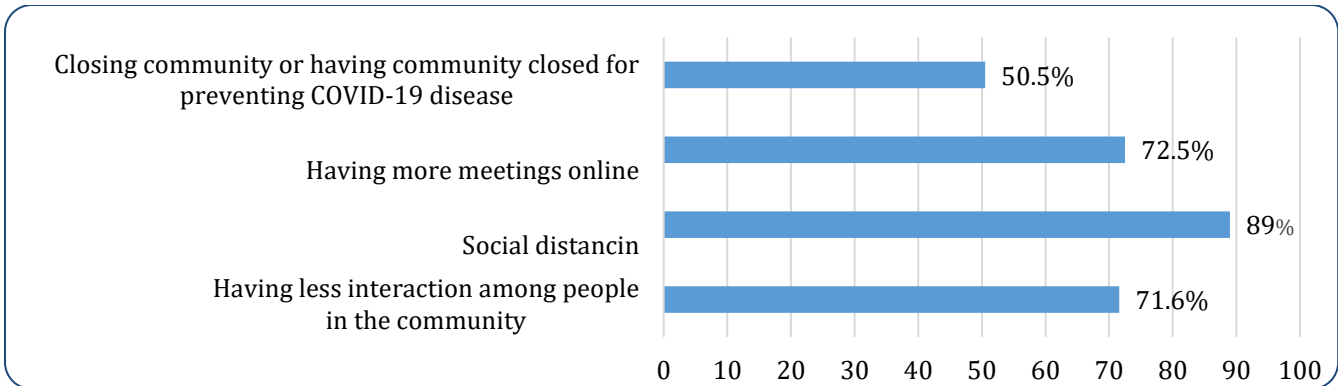


Fig (2).

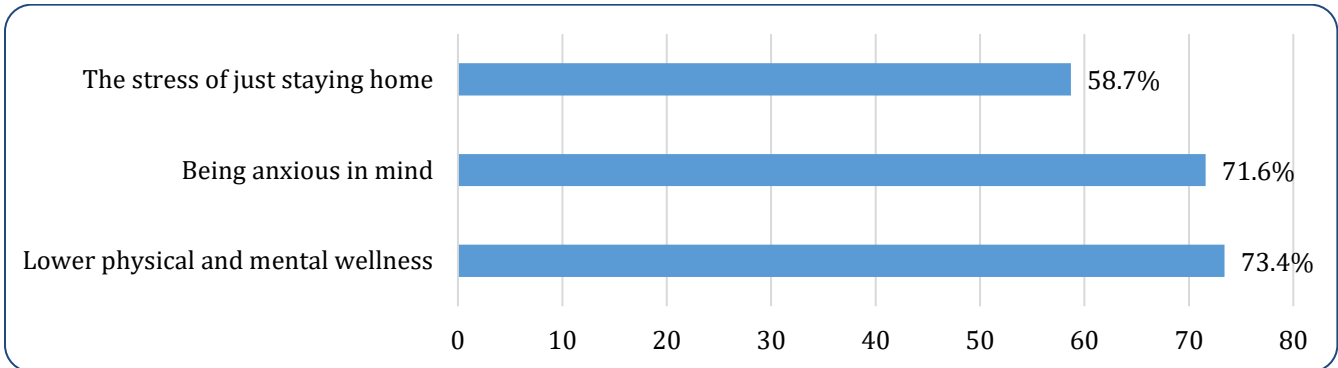


Fig (3).

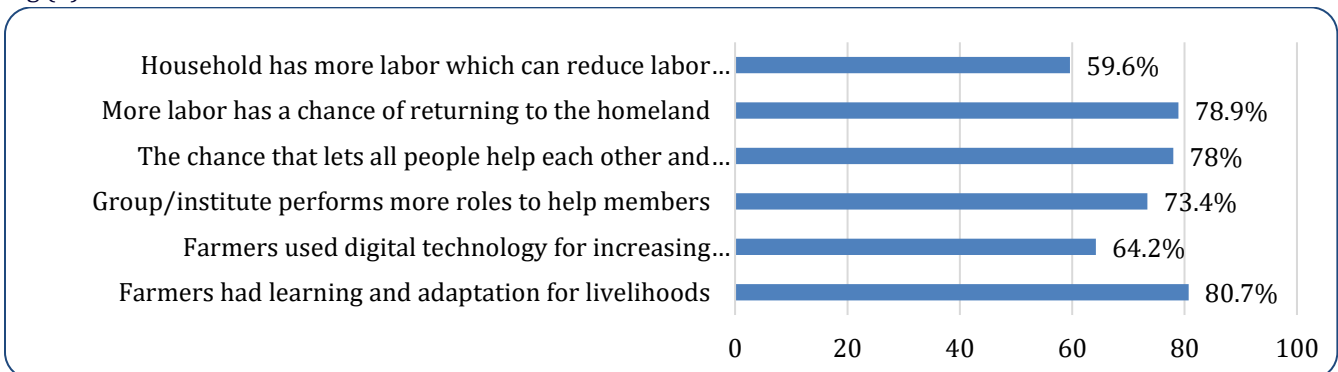


Fig (4).

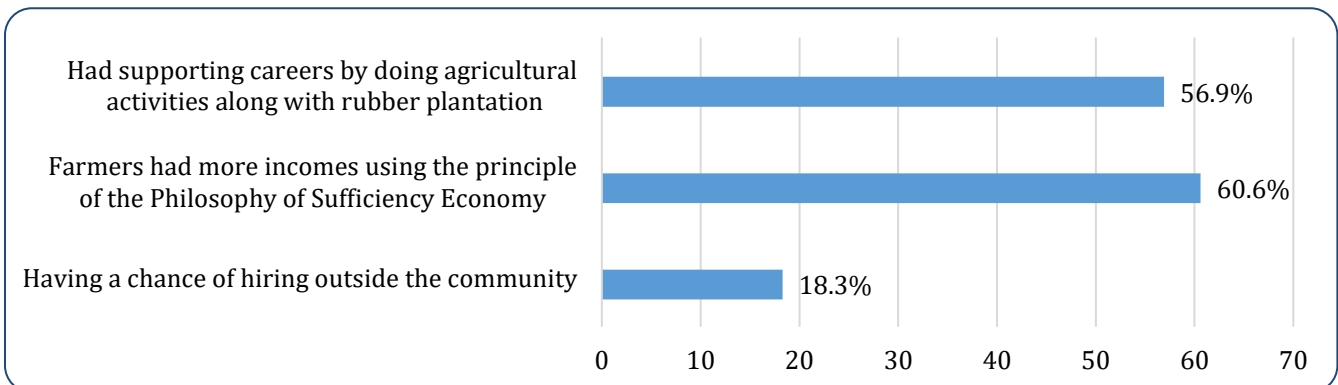


Fig (5).

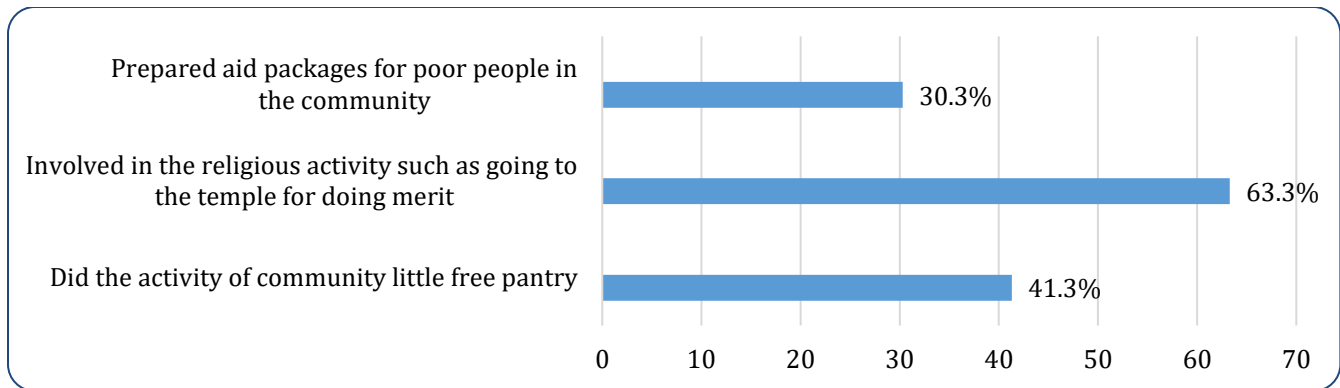


Fig (6).

Figure 2 (1)-(6). The Negative and Positive Impact of COVID-19 to society of rubber smallholding households.

Remark; figure 2(1): Negative Impact: Receiving Welfare/Social Policy from the Government, Figure2 (2: Negative Impact: Interaction in the Community During COVID-19 Figure2(3); Negative impact: Wellness of Rubber Farmers Figure2(4); Positive Impact: Learning and Adaptation Figure2(5); Positive Impact: Supporting Careers for More Incomes Figure2(6); Positive Impact: Getting Together for Cultural Activities in the Community and survey from 280 Rubber smallholding households.

### Effects of COVID-19 to Economy of Rubber Smallholding Households

The effects of COVID-19 on the economy of rubber smallholding households are as follows;

Problems of Household Economic Status: For Negative Effects to Economy regarding Problems of Household Economic Status (Figure 3(1)), the study found that farmers had adequacy of financial assets at 74.3%. Transportation systems and logistic limitation were disrupted due to measures put in place to restrain the pandemic with the creation of debts for more expenses at 59.6%, had more unemployment in households and community at 58.3%, had more crimes in area/community, and had sold of mortgaging assets at the least effect for 45.9%.

Behavioral Change of Rubber Farmer Households (lower income from the outside agricultural sector): For negative effects on the economy regarding consuming behavior of rubber farmer households (Figure 3(2)), the study found that farmers had less consuming products bought from the community market and switched to buying more products from supermarkets at 69.7% and online products at 55%.

Household Income and Expense: For negative effects of rubber farmer household income and expense (Figure 3(3)), the study found that 93.6% of farmers had decreasing incomes (not many buyers and dropping

rubber price), followed by 79.8% of farmers with more expenses of consumption goods (higher prices of goods and more charges of electricity and water bills), 73.4% had household debts, 72.5% had high costs of production & livelihood, 62.4% had received help and relief of livelihoods, 54.1% encountered buying sources stopped buying fresh latex/dealer lowered the price of rubber and households had saved at the same proportions, 50.5% had received help from the financial institution, 49.5% had adequacy of household expenses, much labor in the household, the capability of paying debts/solving debt problems at the same proportions. 47.7% had adequacy of household incomes and the capability of future investment at the same proportion, 38.5% had to create jobs in the local area for the community and economic dependency e.g. borrowing funds from the system outside, loan at the same proportion, and 26.6% sold household assets for livelihoods.

Saving and Sufficiency Economy: For positive effects to the economy (Figure 3(4)), the study found that 92.7% of farmers saved and considered more before spending, 86.2% used Philosophy of Sufficiency Economy for livelihoods, 74.3% had building institution and culture of saving for households, 73.4% attempted to seek more incomes by supporting, 70.6% had to build strong local economic system from the inside, and 5% had.

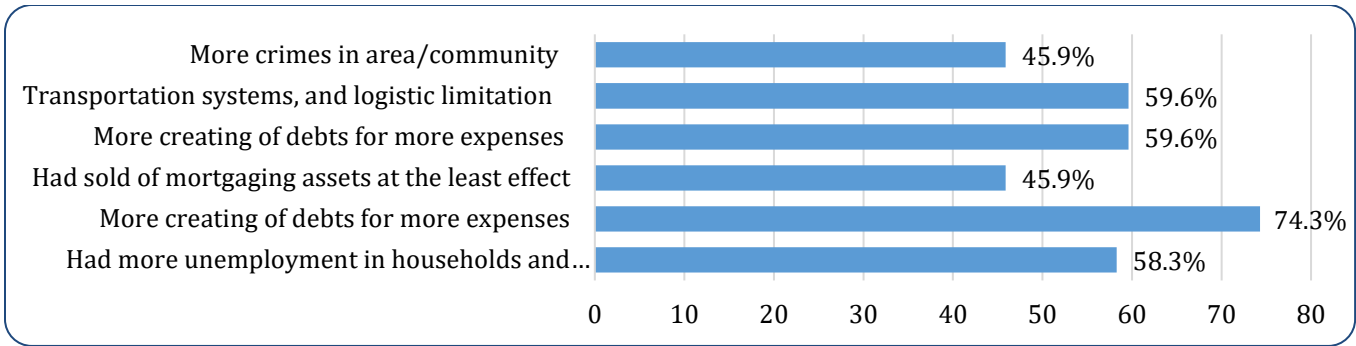


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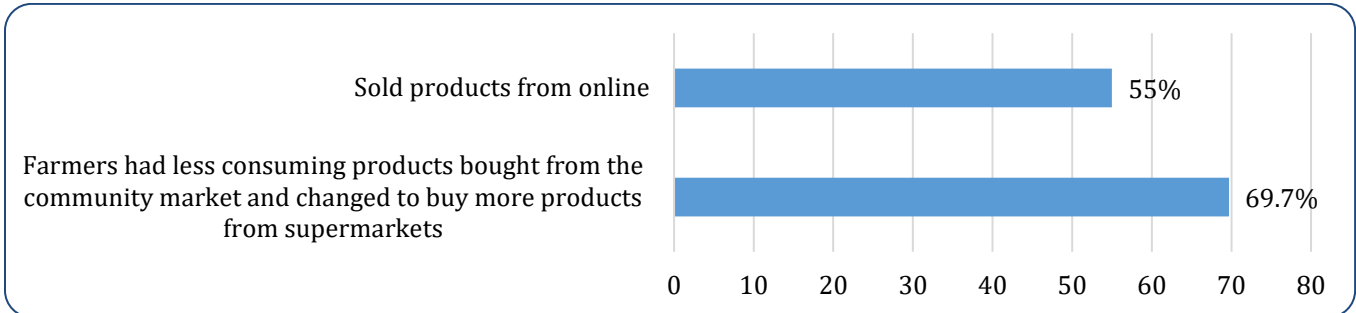


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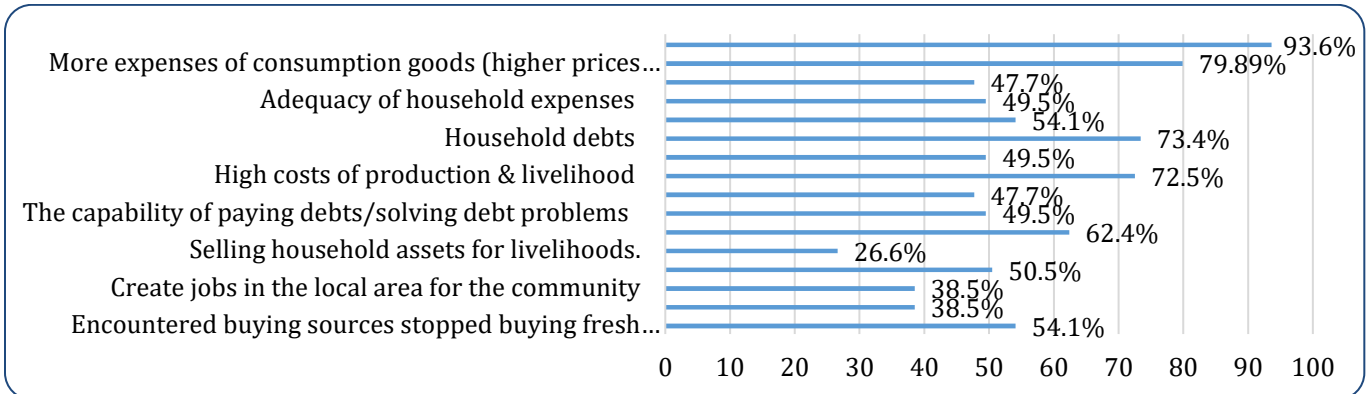


Fig (3)

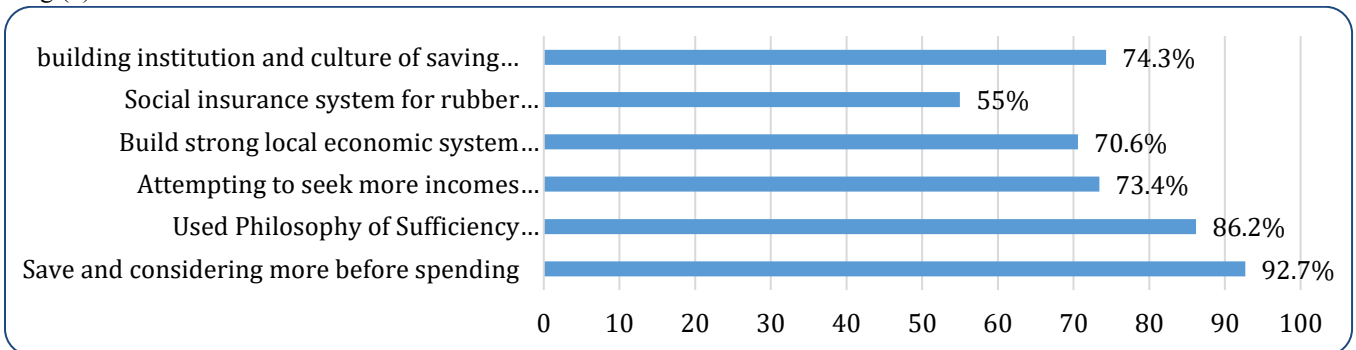


Fig (4).

Figure 3 (1)-(4). The Negative and Positive Impact of COVID-19 to Economy of Rubber smallholder Households. Remark; figure 3(1): Negative Impact; Problems of Household Economic Status figure 3(2): Negative Impact; Behavioral Change of Rubber Farmer Households (lower income from the outside agricultural sector) figure 3(3): Negative Impact; Household Income and Expense figure 3(4): Positive Impact; Saving and sufficiency economy and survey from 280 Rubber smallholding households.



**Effects of COVID-19 to Production Technology and Environment of Rubber Smallholding Households**

Figure 4 shows that 74.3% farmers had more plantation management e.g. fertilizer application, pest control, disease elimination, followed by 70.6% who had higher capital, production factors (factor resources, price), 66.1% had transporting household products, 65.1% had to sell more productions at local markets, 62.4% had more buying sources, goods, and enough production resources e.g. water, soil, technology, and information, 61.5% had more labor for production and plantation management (managing and harvesting), 60.6% had higher production quantity, 57.8% managed to prepare for the production, 54.1% had a higher increase of biodiversity in a rubber plantation, and 36.7% used more chemicals.

**Effects of COVID-19 to Livelihoods Change of Rubber Smallholder Households**

Considering the effects on livelihoods of rubber farmer households in terms of issues related to capital change for livelihoods of rubber farmer households based on

sustainable livelihoods approach by DIFD (Sheets, 2001). Figure shows that 89.9% of farmers human capital was affected and 10.1% faced no effect. Similarly, 83.5% of farmers had effect on natural capital and 16.5% had no effect followed by 92.7% of farmers facing affect on financial capital and 7.3% were not affected. In addition, 89.0% farmers physical capital was affected and 11.0% were not affected followed by 95.4% farmers who face change in their social capital and 4.6% were not affected.

**Structure and Policy Changes**

Figure 6 shows that 56.0% farmers for had to participate in activities/projects and/or received bits of help from working units/government sectors and 44.0% did not participate. Having help from working units, 54.1% farmers got involved in the project of no one was left behind, 0.9% were involved in the project of farmers remedy, and 0.9% involved union cooperative limited. Receiving help for livelihoods, 82.0% farmers had better live, 8.2% had worse living, and the living condition of 9.8% was not affected.

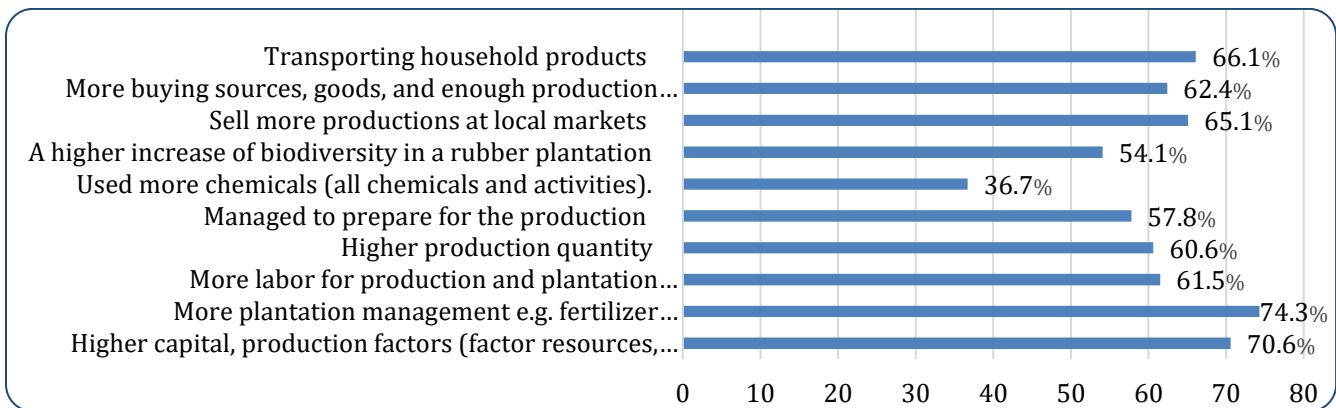


Figure 4. The effects to production technology and environment of Rubber Households.

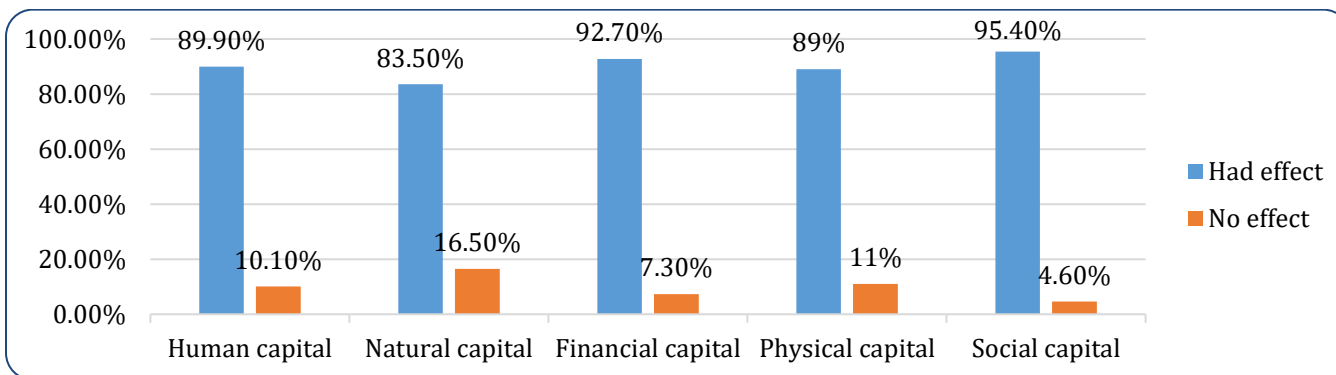


Figure 5. Changes in Livelihood Capital of rubber smallholder household.



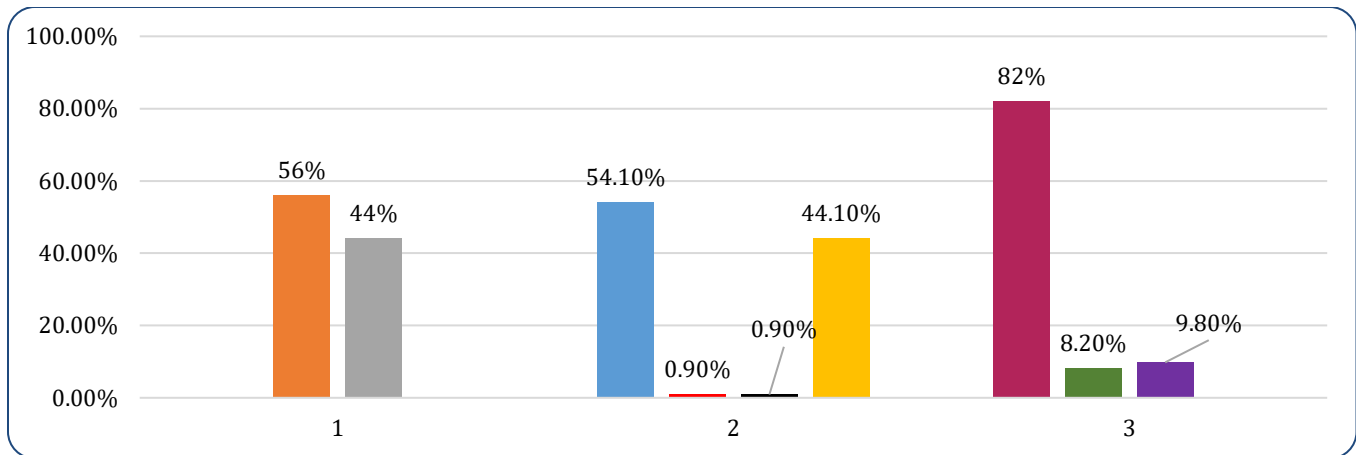


Figure 6. Structure and Policy Changes of rubber smallholding household.

### Livelihood Strategy Adaptation of Rubber Smallholder Households

Effects on livelihoods of rubber farmer households in terms of Livelihood Strategy Adaptation of Rubber Farmer Households are as following;

**Change Rubber-Producing Technique:** From Figure 7(1), the study showed that most farmers for 45.9% stopped tapping for some periods, followed by 25.7% decreasing days of tapping, 24.8% changed producing raw rubber sheet to fresh latex, 22.9% increased days of tapping, 20.2% cut down rubber trees, using the land for other purposes, 19.3% switched from hired labor to family labor, 17.4% changed tapping contract (hired tapping) and cut down rubber trees to sell rubber woods at the same proportions, 15.6% changed producing raw rubber sheet to cup lump, and the least 11.1% changed from producing fresh latex to cup lump.

**Increase in Production Efficiency:** From Figure 7(2), the study showed that most farmers for 29.4% switched to growing plants (perennial plants/vegetables) that gave high yields instead of growing rubber trees, followed by 26.6% who changed to growing higher-yield rubber breed 251 (replanting), 24.8% used skilled tapping labor along with low tapping frequency (every other day), 22.9% increased frequency of weed control in a rubber plantation, and 16.5% the least. 16.5% increased more chemical fertilizer applications.

**Reducing the Production Cost:** From Figure 7(3)), the study found that most farmers for 45.0% experienced a decrease using chemical fertilizer, followed by 43.1% who used chemical fertilizer along with organic fertilizer, 38.5% switched from chemical method of weed control to mechanical method, 36.7% changed

method of fertilizer application, 31.2% reduced times of weed control, 29.4% made fertilizer by themselves, (fertilizer group), 28.4% did not employ any method of weed control, 26.6% used no fertilizer, 23.9% replaced promoting rubber varieties with local rubber varieties, 22.0% used only organic fertilizer, 21.1% adapted themselves by grouping to buy production factors, and the least 13.8% changed weed control method from mechanical to chemicals.

**Expand production:** For the effects of COVID-19 to livelihood strategy for adaptation by rubber farmer households to expand production, (Figure 7(4)) the study found that most farmers for 29.4% expanded other economic plant areas, followed by a 24% increase in the number of raising animals/aquatic animals, and the least 21.1% expanded plantation area.

**Increase Diversify of the Production System:** For effects of COVID-19 to livelihood adaptation strategy of rubber farmer households to increase varieties of the production system (Figure 7(5)), the study found that most farmers for 38.9% increasing varieties of the production system in rubber plots (same plots), specify plants/animals, and the least 24.8% increased varieties of the farming production system (different plots), specify plants/animals.

**Using Hired Labor in the Agricultural Sector:** For effects of COVID-19 to livelihood strategy for adaptation of rubber farmer households to change using hired labor in the agricultural sector (Figure 7(6)), the study found that most farmers for 21.1% who worked more in the agricultural sector were hired (planted trees and mowed lawns), followed by 19.3% who were hired to tap rubber more in the village/nearby sub-district, 16.5% went to

the forest (to get some forest products and to hunt wild animals), 11.0% went out for fishery, and 9.2% went out to be hired for rubber tapping in a different district (within the province) and also went out to be hired for tapping rubber in a different province at the same proportions.

Non-farm employment: For effects of COVID-19 to livelihood strategy for adaptation of rubber farmer households to change to work outside the agricultural sector (Figure 7(7)), the study found that most farmers for 30.3% increased more working outside the agricultural sector (buy and sell things, food store), followed by 24.8% who were hired for any kind of works within the village, 22.0% worked as temporary employees for government units, 15.6% went out to work in a factory in village/sub-district, and the least

11.9% went out to be hired in the city (lived in the city). Household Financial Management: For effects of COVID-19 to livelihood strategy for adaptation of rubber farmer households to household financial management (Figure 7(8)), the study found that most farmers for 78.9% saved household expenses, followed by 77.1% who reduced unnecessary expenses (reduced luxury goods), 67.9% used savings for expense, 50.5% borrowed money from sources within the community (saving group, cooperative), 46.8% borrowed money from sources outside the community (bank, etc.), 45.9% adjusted plan of paying debts, 32.1% borrowed money from the outside system, 30.3% joined rotating savings, 29.4% received more money transferred from descendants, 23.9% pawned household assets (gold, car, etc.), and the least 19.3% sold household assets (land, car, etc.).

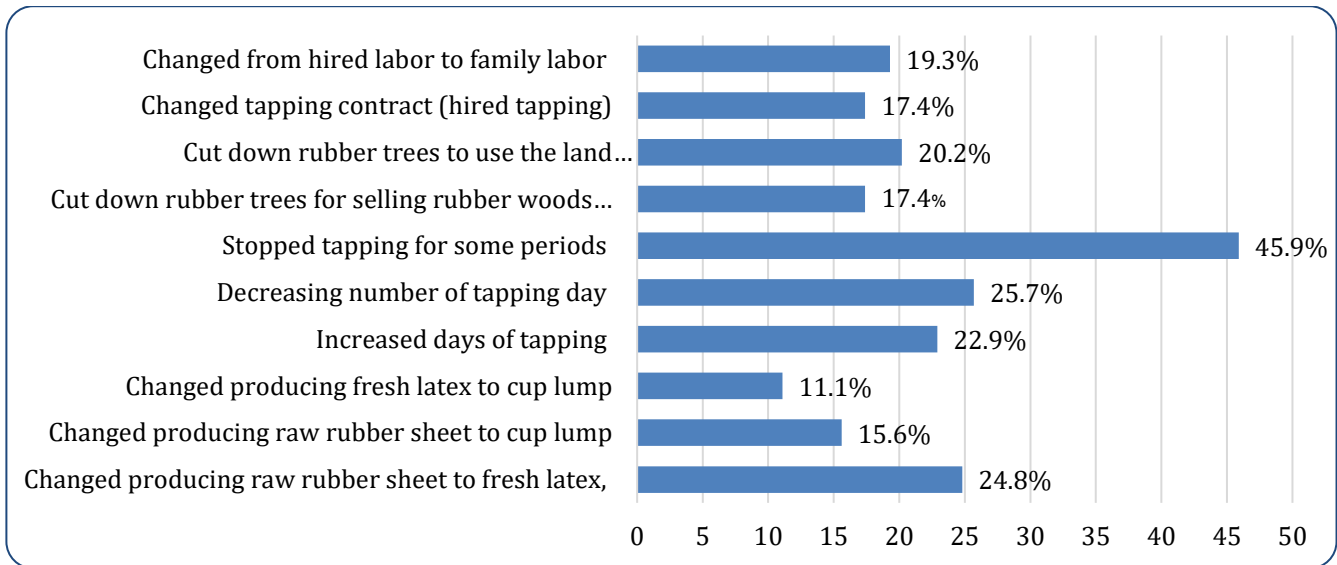


Fig (1).

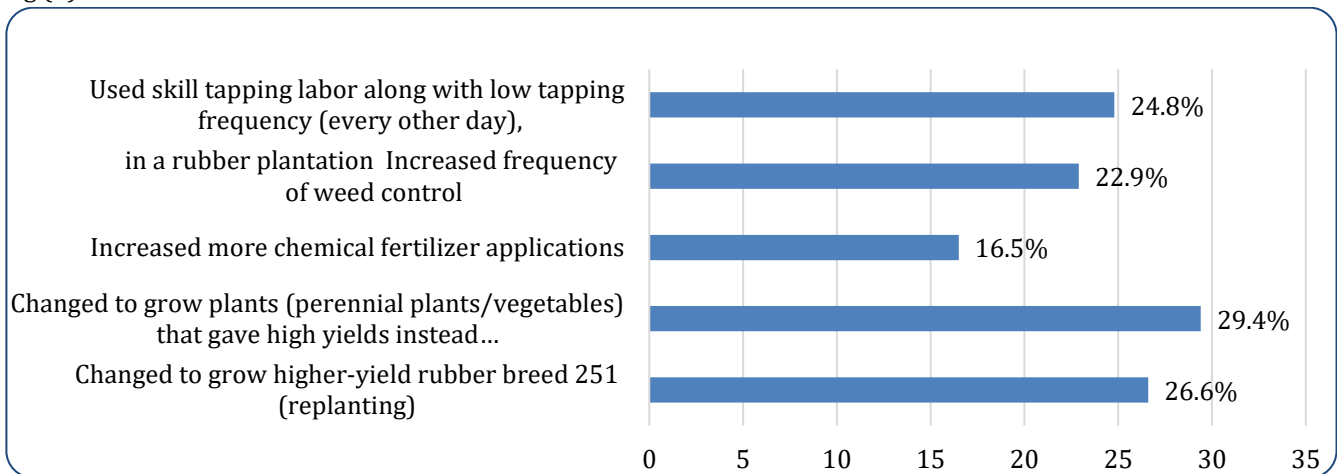


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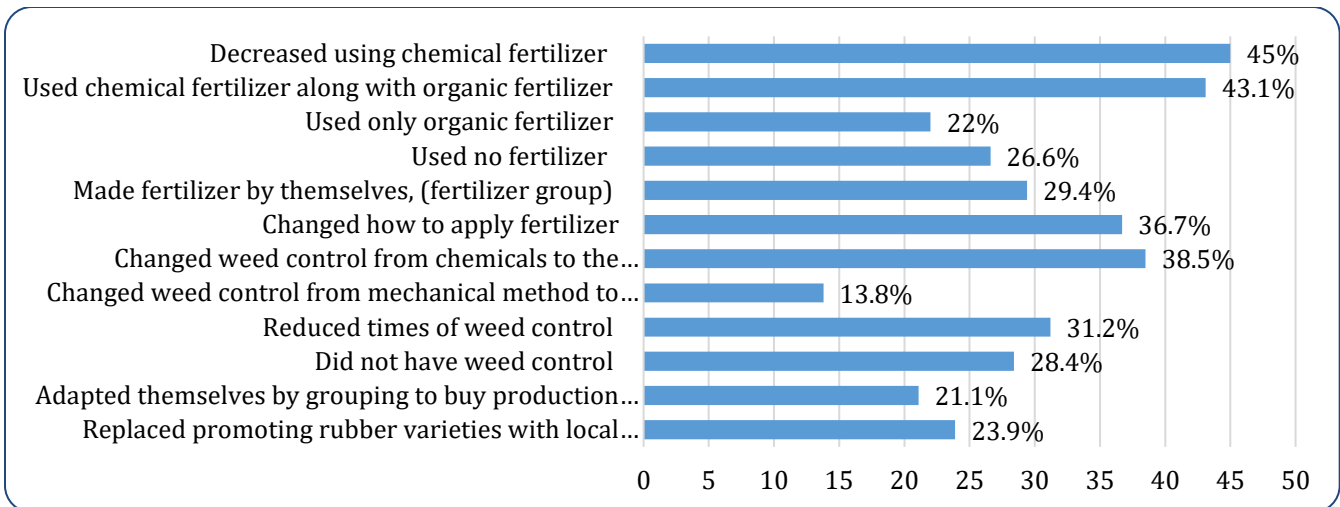


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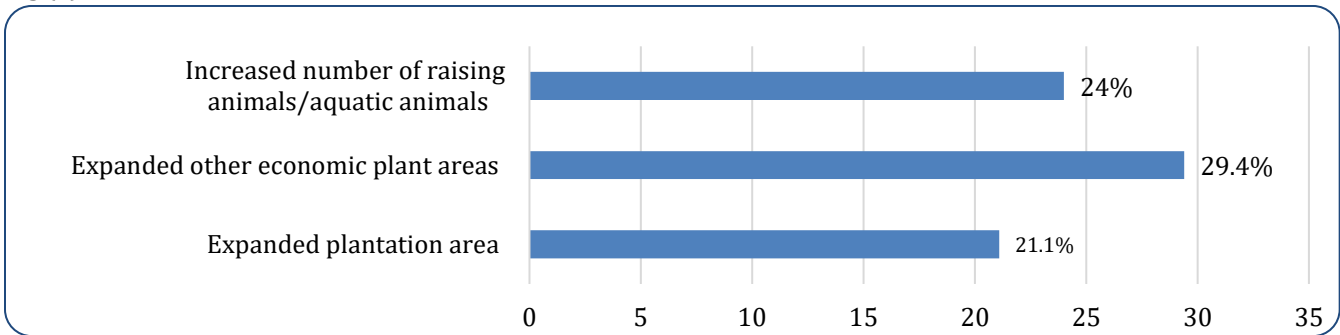


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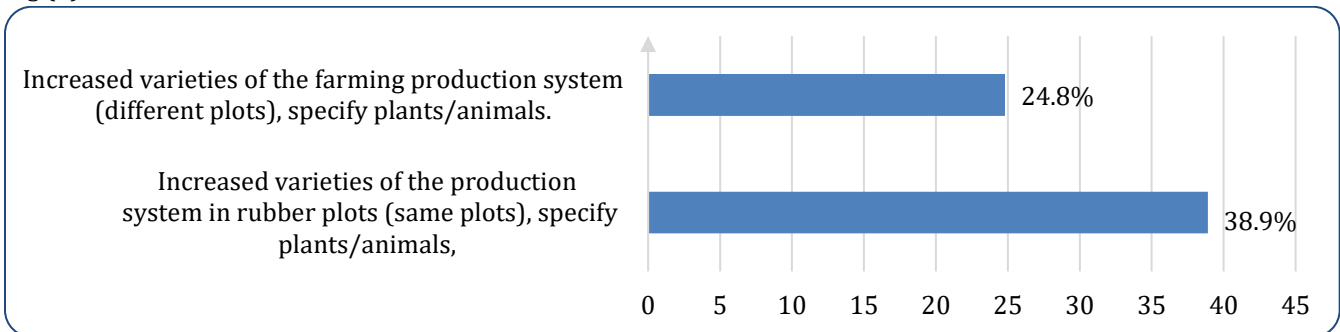


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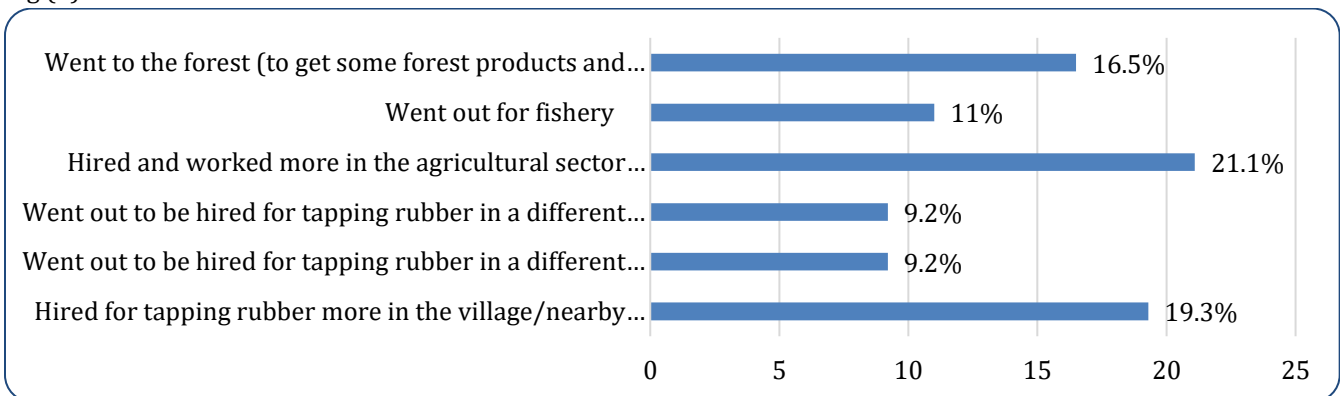


Fig (6).



Fig (7).

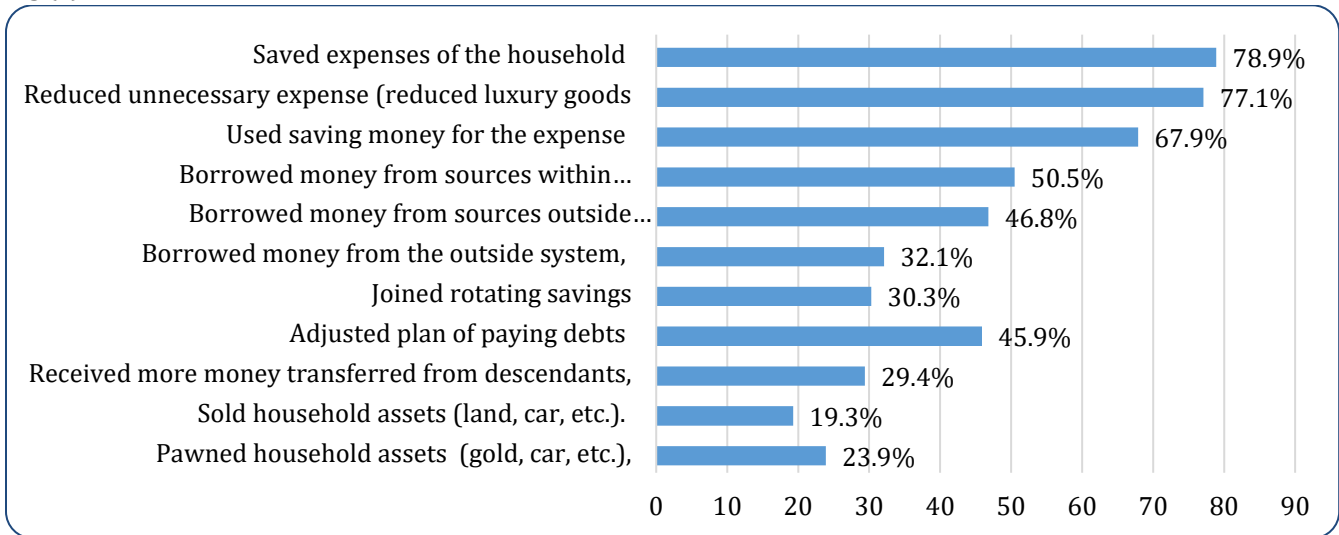


Fig (8).

Figure 7(1)-(8). Effect of Covid-19 to Livelihood Strategy for Adaptation of Rubber Smallholding Households.

Remark: Figure 7(1) Change Rubber-Producing Technique, Figure 7(2) Increase in Production Efficiency, Figure 7 (3) Reducing the Production Cost, Figure 7(4) Expand production, Figure 7(5) Increase Varieties of the Production System, Figure 7(6) Using Hired Labor in the Agricultural Sector, Figure 7(7) Work Outside the Agricultural Sector, Figure 7(8) Household Financial Management and survey from 280 Rubber smallholding households.

**Factors correlation between effects of society, economy, production technology and environment from COVID-19**

Table 1 shows that the society effects variable in the aspect of agriculture transport limitation has correlation with The Livelihood Strategies Adaptation of Rubber smallholding Households (R=0.742; P=0.01), Economic effect variable in aspect of Net household income Level has correlation with The Livelihood Strategies Adaptation of Rubber smallholding Households (R=0.635; P=0.01) and Production Technology and Environment Effect in aspect of Level of biodiversity for rubber management sustainability of household has

correlation with The Livelihood Strategies Adaptation of Rubber smallholding Households (R=0.667:P= 0.01).

**The factors influencing the livelihood strategies adaptation of rubber smallholding households**

The result below shows the Equation function model and standardized function of the dependent variable factors of society effect (X<sub>1</sub>), economic effect (X<sub>2</sub>) and Production Technology and Environment effect (X<sub>3</sub>) influencing on The Livelihood Strategies Adaptation of Rubber smallholding Households (Y)

Equation function:

$$Y=0.542+0.526X_1+0.271X_2+0.231X_3$$

Standardize equation function:

$$ZY=0.490ZX_1+0.242ZX_2+0.205ZX_3$$

$R^2=0.669$   $R^2$  adjust = 0.637, Std. Error of Estimation = 0.3702 F-Significant =20.869\*\*\* Durbin-Watson = 1.552

The result of the equation function shows that social

effect, economic effect and production technology and environment effect can explain the livelihood strategies adaptation of rubber smallholding households at 63.7% ( $R^2$  adjust=0.637). The social effect was also found to be the most explained (0.490Zx<sub>1</sub>).

Table 1. Correlation coefficient between effects of society, economy and production technology and environment from covid-19 of rubber smallholding households and the livelihood strategies adaptation of rubber smallholding households.

Variables	The Livelihood Strategies Adaptation of Rubber smallholding Households
<b>Society Effects</b>	
Educational level(x1)	.894***
Happiness in work index(x2)	.419*
Decreased social activity(x3)	.667***
Anxiety and living(x4)	.463**
Receive welfare benefit(x5)	.961*
Trajectory and interaction in community(x6)	.699*
Agricultural transport limitation(X7)	.742***
Household living problems(x8)	.347**
Modify consumption behavior(x9)	.317*
Learning and self-defense(x10)	.521***
Psychological Well-being(x11)	.581**
Total	.282*
<b>Economy Effect</b>	
Net household income Level	.635***
Present household debt level	.439**
Present household savings level	.524**
Present household expenses level	.587***
Ability to debt settlement of household's level	.487**
Household owned area	.446**
Household production expenditure level	.432***
Community Employment level	.597***
Total	.722**
<b>Production Technology and Environment Effect</b>	
Rubber technology management such as fertilizer, weed control, plant disease and pest protection e.g. of households	.475**
Labor in rubber management and rubber harvesting of household	.645***
Labor in preparing rubber product and sale of household	.417**
Level of all chemical Fertilizers utilizations in rubber management	.527***
Level of biodiversity for rubber management sustainability of household	.667***
Level of household rubber product sale	.505***
The source of purchase of rubber products of household	.457**
Sufficiency of rubber production resource level	.397**
Total	.618**

**Remark:** \*significant at 0.05 and \*\*significant at 0.01 \*\*\* significant at 0.001 and analyze from 280 Rubber smallholding households.

## DISCUSSION AND CONCLUSION

Rubber management adaptation could be concluded as the following;

A few effects on labor utilization: For the small-side rubber households, the COVID-19 pandemic had no effect on the change of labor type. Hiring local tapping labor still utilized in community except for those large plantations with hired alien workers. Due to the closure boarders at the end of April 2020, alien workers are forced to return back to their countries and could not come back to work in Thailand. Owners of rubber plantations resolved tightening labor problem by using local labor or stopped tapping in some plantation sites. Furthermore, some households had excess labor forces because of unemployment or temporary closures of businesses in the services and industry sectors. Excess laborers moved back to the agricultural sector and would be ready to move back to their previous jobs if the economic activities were carried on as usual.

No effects on the change in plantation technology: The COVID-19 epidemic had no effect on improvements in technology in rubber plantations, but it did have an impact on the rate at which agriculture and daily life became digital. This shows that a number of farmers used various online media outlets and farmers' digital markets to expand their agricultural product ranges. From March to May 2020, farmers primarily communicated through digital channels, consuming more digital content while having less in-person encounters with their neighbors.

Maintaining production and plantation management: The production continued to run normally without any COVID-19 impacts. A portion of this may be attributable to government measures, such as the installation of infrastructure that enables farmers to engage in rubber tapping and regularly transport their products to markets. Farmers dedicated more time to plantation and other agricultural tasks instead of conducting social activities. For instance, farmers managed weeds, spread fertilizer, expand fruit and vegetable areas, and raise cattle.

No effect on selling and markets: All farmers were allowed to carry their goods and sell them in the markets without any buyer stops being noticed. As a result, rubber markets might continue to sell all goods. The majority of farmers adopted the government sector's healthy activities. For instance, when farmers

arrived to sell fresh latex at the purchase locations, they wore masks.

Effect on price fluctuation: Before the COVID-19, the price of rubber was steady. Demand shock and the reduced supply of rubber due to the season of tapping panel closures were the main reasons that contributed to a decrease in rubber price. The price of rubber increased as a result of the increased demand for rubber gloves for medical purposes. After the implementation of COVID-19 measures, the price of fresh latex was still lower than the average rubber price in 2019. In the same period, raw rubber sheets (RSS) showed a downward trend in price at local markets until July 2020.

Livelihood Adaptation: The major effects of COVID-19 on the livelihood adaptation of rubber smallholder household can be classified into 4 major issues as follows; (i) household consumption patterns were adjusted for income and financial condition by the following deliberate strategies such as reducing unnecessary household expenses; cooking meals for household consumption; growing food plants/home-vegetables around the house. The majority of farmers had the opportunity to shift the patterns of consumption because of the prior rubber price crisis' feeling of risk. (ii) adjusted the financial plan and financial management: the most farmers had quite high debts and tried to keep the saving level; to be extended debt schedule; adjusted debt structure and planned to payback the debts; and increased liquidity by selling household assets (iii) Increase sources of incomes and increase the diversify of production activities: farmers should initiated plans to adopt the diversify production system which would result in higher farm income and lower household costs. Farmers sought more incomes from non-farm income.

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