AGRICULTURE TECHNOLOGY TRANSFER AND PRODUCTIVITY OF INDEPENDENT OIL PALM SMALLHOLDERS

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Abstract— Development of palm oil industry has contributed significantly to the export of agricultural sector and rural livelihoods. In order to enhance wellbeing of smallholders and the country's exports competitiveness, the palm oil productivity of needs to be improved. Palm oil smallholders have to turn to new farming and harvesting technologies to be more productive and high income. The guidance and advisory service program was held by Malaysia Palm Oil Board (MPOB) to educate and increase awareness on high yield and sustainable oil palm production among independent smallholders. This study looks at the extent to which the program seeks to transfer the technology with practicing sustainable agriculture and the impact on productivity of smallholders. Questionnaires were distributed to small farmers. Researchers and trained numerators collect the data through face to face interviews. Regression analysis was used to estimate the effects of training on the smallholder's productivity. The results confirm that effective guidance and advice leads to better of good agriculture practices and productivity.

Keywords— Adult Learning, Technology Transfer, Agriculture Knowledge and Skills, Productivity.

I. INTRODUCTION

The palm oil productionin Malaysia has been expanding continuously since country's independent 1957. Recently 5.6 million hectares planted areas have generate annual export value of MYR60 billion in 2015 (MPOB 2016).Malaysia is the second world's leading palm oil producer and produce 31.8% of the global production in 2015 (MPOB, 2016). The palm oil sector alsocontribute5% to the country's exports (MYR21.4 billion January-June 2016) and 36.5% to the GDP of agricultural sector (Department of Statistics, 2013, Matrade, 2016)). The contribution of palm oil industry to the Gross National Income (GNI) is expected to increase from MYR53 billion in 2009 to MYR178 billion in 2020 (Choo Yuen May, 2011). Palm oil exports also increased by MYR73.3 billion in 2012 (Noor Asmawati, 2013) compared to MYR59.77 billion in 2010 (Choo Yuen May, 2011).Overall, this industry employs over half million workers (World Growth 2013). The governments of Malaysia have ambitious targets both grow the palm oil industry and improve environmental quality by implementing good agriculture practices. Smallholders are key agents for improved national palm oil yields and development of the industry. Malaysian oil palm smallholders contribute 33% of the total palm oil production and 40% of the total area of planted oil palm (Vermeulen& Goad 2006; Pemandu 2016). They are two types of oil palm smallholders. First, organized smallholders, cultivate oil palm with direct support mainly from government agencies in the variety of land resettlement program and rehabilitation schemes such as FELDA, FELCRA, RISDA, SALCRA (Vermeulen& Goad 2006; Khailany 2011). Second, independent smallholders are growers who cultivate oil palm without direct assistance from organized government agencies or private companies. They were classified owned less than 40 hectare land and hold land title or customary land. In year 2015, independent smallholder hold 15.6% of oil palm planted area (MPOB 2015). Most of them are family-based producer and sell their crop to local mills either directly or through dealer fruit (DV) (Vermeulen& Goad 2006; Khailany 2011). Independent smallholders consistently display lower yields than large–scale plantation (IFC, 2013). The government targeted at independent oil palm smallholders to produce 22 tons per hectare of fresh fruit bunches (FFB) by 2020 (Che Johari, 2011). But the average yield of only 19 tons per hectare (MPOB 2015). Malaysian Palm Oil Board (MPOB) spendsMYR902 million for the period 2011-2013 to empowered smallholders through Oil Palm Guidance and Advisory Program (*Tunjuk Ajar Nasihat Sawit/TUNAS).* Up to 2015, 68,314 independent smallholders have participated in this program. A total of 1,189 technical guidance and 16,898 farm visits was undertaken (MPOB, 2012). Oil Palm Guidance and Advisoryeducateindependent smallholders in sustainable intensification of existing plantations. Most smallholderneeds ecological and agronomics knowledge of the oil palm cropping system to maximize their productivity.This intervention program has adapted adult and non-formal education to filling the gaps on ecological knowledge and misconceptions about sustainable agriculture practices. This program helps to enhance the management practices oil palm cultivation of independent smallholders. Farm management guidance and advices include soil and water management, fertilizer and nutrient management, pest and disease management, weed management, harvest

and post harvest handlings technique, and record keeping.Sustainable oil palm farming with high yield has a considerable effective strategy of poverty reduction for smallholders. As such, the aim of this study is analyzed to what extent oil palm technology delivered successfully applied by smallholders and whether the program that seeks to increase the productivity of smallholders concerned.

II. THEORETICAL FRAMEWORK

The human capital theory, particularly by Becker (1962),state that smallholders are able to enhance productivity as acquire knowledge, skills and attitude toward sustainable farming. While, Rogers (1992, 2003) stressedagricultural productivity can be enhanced through the learning process started from the awareness of the needs of newknowledge and practice the acquired knowledge. The agriculture extension program (Van den Ban and Hawkins 1996) was designed totransferring technology from researchers to smallholders. The process of transferring knowledge, skills and attitude from agriculture extension workers to smallholders requires an enabling environmentsmainly focused on solving smallholder problems (Braun & Van de Fliert 1997; Duveskog 2013; Feder, Murgai&Quizon 2004; Knowles, Holton & Swanson 1998;Stuart et al., 2011; Waddington & White 2014).Oduor (2002) and Leitgeb et al., (2011) believe that the farmers are able to learn in groups and conduct collaborative discovery and solve their problems. Studies showed the agriculture extension program was strengthening the farmers' indigenous knowledge with latest knowledge and skills for optimum farm cultivation and management practices (Abdullah et. al., 2014;Braun, Thiele & Fernandez 2000; Duveskog 2013; Hashemi, Hosseini &Damalas 2009; Waddington & White 2014). Hendra Nur Rofiq (2013), Salmiyatiiet. al, (2014) Hussain, Byerlee&Heisy (1994) and Mariyono (2009) also discovered that farm productivity improved by practicing of technological components such as good agriculture practicesacquired from extension program.Asiabaka (2002) and FAO (2001) also believe that farmer's participation of would stimulate learning, transfer and adoption of agriculture technology. Therefore, the effective guidance and advice from extension workers needed so that farmers can implement properly new technology.

III. METHODOLOGY

The field study conducted in Saratok, Sarawak and Telok Intan, Perak. The quantitative data mainly on yields (Fresh Fruit Bunches /FFB), planted land area, perceived delivery of palm oil guidance and advice program and adoption of good agriculture practices for independent smallholders was collected through field surveys.The population of this research is the independent oil palm smallholders, who had attended Oil Palm Guidance and Advisory Program (TUNAS).The total sample size was 663 smallholders, only 497 (75.0%) provided reliable feedback via the survey form. The questionnaire were designed and adapted from previous studiesand pre-tested. The study involved three mainvariables: competencies of oil palm extension workers, good agriculture practices (GAP) and oil palm productivity. Perceived competencies of oil palm extension workers consist of 26 items with 5 dimensions (communication skills, knowledge, attitude and personality, leadership and agriculture technical skills) adapted from Suvedi & Kaplowitz (2016), Scheer, Harder & Place (2011), Harder, Place &Scheer (2010), Gombeet. al., (2015), Okwoche& Asogwa (2012), Issahaku (2014) andBahua (2016).The transfer of technology was measured by famer's ability to practices of good agriculture. The good agriculture practice was measured using 22 items, mainly based on FAO-Good Agriculture Practices (FAO, 2004),RSPO Manual (RSPO, 2013a,b) and Thai Agriculture Standard(TAS, 2010).Oil palm productivity was measured by Fresh Fruit Bunches (FFB) per hectare. Reliability of the subjective constructs were α=.93 for perceived competencies and α=.86 for good agriculture practices.Researchers and trained local numerators collected the data via face to face interviews. Local numerators comprising people who are proficient in local dialect assisted by researchers conducted the survey.Multiple regression models were applied to identify the impact of guidance and advice program and adaption of good agriculture practices on independent smallholder oil palm productivity.

IV. RESULTS

Smallholder and Farm Characteristics

The findings indicate that 30.5% of the independent oil palm smallholders were aged less than forties. 36.2% of them were fifty and 33.3% were sixties and above. Thus, mostof smallholders (62.8%) between 50 and 70 years. Majority of the smallholders were uneducated with 73.6% of them received below than lower secondary educational qualification and 21.4% have upper secondary school qualification. Only 3.7% of the smallholders are diploma holder and 1.4% degree holder. Almost 68.0% indicated them self as a fulltime smallholders and 32.0% oil palm cultivation as a part time. Overall smallholders have moderate households with 4-6 (60.9%). The smallholders interviewed were typically small scale, with farm sizes averaging 2.81 hectare and 87.9% of them have their own land ownership. Only 11.1% smallholders have inherited land and 0.4% used lease land. In term of oil palm cropping system, 86.8% of them prefer triangle system, 10.3% square and 2.9% twin row system.

Perceived Extension Worker Competencies

Independent smallholders emphasizes that extension workers are able to delivering useful information with confident, using simple words with local dialect and persuade to adopt innovative technologies. An extension worker also flexible in delivery the contentto multiple smallholder's identity of educational background, ethnicity, culture and religious.Overall attitudes and pleasant personality of extension workers are good in term of create relationships and rapport with oil palm smallholders. Smallholders are comfortable to talks, ask questions, believe and feelings of trust to the extension workers.Based on Table 1 showed that,extension workers are well perform in leadership roles included stimulate motivation among the smallholders, monitoring smallholder's farm performance, facilitate them with friendly guidance. Smallholders already know a lot a bout their farming, therefore the rating of knowledge capability of extension workers on oil palm cultivation, slightly lower than others. Similarly, competence for extension workers demonstrate of land clearing & preparation, selection of high seed quality, plant nutrient and fertilizer, pest and disease control, weed control, harvest techniques, soil enrichment technique at upper moderate level.

Table 1: Farmers' Perception Competencies of the Extension Worker

Competencies	Indicator	Mean	Std Deviation
Communication skills	5 items	3.9581	.64921
Attitudes and pleasant personality	4 items	3.8828	.69450
Leadership role	4 items	3.8199	.64953
Well-versed on oil palm cultivation	6 items	3.6539	.66998
Demonstration of oil palm cultivation techniques	8 items	3.6451	.72721

Likert Scale: 1=Poor, 2=Fair, 3= Moderate, 4= Good, 5= Excellent

Implementation of Good Agriculture Practices

This section is to examine whether oil palm smallholders adopted oil palm technologies on their own farms introduced by TUNAS program. We focused the analysis on four of the main components and use simple means to indicate adopted recommended oil palm technologies.Independent smallholders are practicing in harvest mature oil palm bunches, collect all loose fruits from field plot, on time bunches delivered to dealers or factory, cut short stalk of bunches, fronds are neatly trimmed and healthy harvesting regularity.Smallholders also often practicegood fertilization techniques, which include adequate amounts of fertilizer, frequency of fertilizing, select and sowing the right fertilizer, and the fertilizing at the right duration after the purchase. Harvest roads and paths also often well maintained for fruit production. Drainage fields were built in the needed area and often well sustained by smallholders to control the optimum level of water. However, control of diseases, insects and pests effectively sometimes practiced by smallholders.

Table 2: Good Agriculture Practices among Independent Smallholders

	Indicator	Mean	Std. Deviation
Harvest and post-harvest handlings	7 items	4.0785	.54198
Fertilizer and nutrient management	6 items	3.9971	.59145
Soil and water management	5 items	3.7098	.88482
Pest, insect and disease management	5 items	3.0889	.64563

Likert Scale: 1=Never, 2=Rarely 3= Sometimes, 4=Often, 5= Always

Impacts on farm productivity

Our analysis showed that Oil Palm Guidance and Advisory Program (TUNAS) helps independent smallholderto adopted essential farm management capabilities for high yield production. The current productivity was increased 36.4%, from12.87 tonper hectare in 2015 to 17.18 ton hectare. With anaverageFresh Fruit Bunches (FFB) price MYR353.00 per ton, smallholders gross revenue will be MYR6,064.54 per hectare.

Table 3: Oil Palm Productivity (Fresh Fruit Bunches (FFB)

Farm Productivity	Mean	Std Deviation
Previous Yeild (tonnes per hectare)	12.8660	9.0385
Current Yeild (tonnes per hectare)	17.1812	10.4379

We examined factors affecting the oil palm productivity (fresh fruit bunches tons per hectare). The estimating regression equation based on integration of the two models; Cobb-Douglas production function model and the entrepreneurialperformance training model (Van Vuuren&Nieman 1999; Pretorius, Van Vuuren&Nieman, 2005; Van Vuuren& Botha, 2010). The independent oil palm smallholder'sproductivity performance is considered as an agriculture entrepreneur performance. Their performance depends on facilitator's competency, good agriculture practices,smallholder'sattribute and farm characteristics, as follows;

$Y = f(X_1, X_2, X_3, ..., X_n)$, Where: Y = output and $X_1, ..., X_n$ = production inputs.

$$LN(Y) = \ln\beta_0 + \beta_1 \ln x_1 + \beta_2 \ln x_2 + \beta_3 \ln x_3 + \beta_4 \ln x_4 + \beta_5 \ln x_5 + \beta_6 \ln x_6 + \beta_7 \ln x_7 + \beta_8 \ln x_8 \ldots\ldots + e.$$

Where; Yis the current yeild of fresh fruit bunches (tonnes per hectare); $X_1$to $X_5$is the extension workers competencies; $X_6$to X_9 is the good agriculture practices; $X_{10}$is the smallholder participation in TUNAS program; $X_{11}$and X_{12} is the smallholder's

educational level and age; X_{13} and X_{14} is the oil palm age and farm size. Results of the estimated multiple regression model in Table 4 showed that farmer's personal attribute mainly participations in oil palm extension programand educational level have a significant and positive effect on the oil palm productivity. However, personal attributes namely farmer's age is not significant. Overall the extension workers competencies (communication, knowledge, attitude and personality, leadership and demonstrate skills) in delivering the program have no significant direct effect on oil palm productivity. In terms of the good agriculture practices indicators, it was found that smallholder's practices of in pests; insects and diseases management has positive coefficient and highly significant effect on smallholder's oil palm productivity. Effect of oil palm age on productivity was observed significant at 99%. However, statistical analysis showed that the negative significant effect of farm size on the yield of fresh fruits bunches. Previous evidence show that the larger size of the plantation, the higher quantity of the harvest. But for independent oil palm smallholders who have extensive farm size can not afford to plant many trees because of rising costs.

Table 4Regression result for factors affecting the Oil Palm yield of TUNAS participants

Independent Variables	B	Std. Error	Tolerance	VIF
Constant	.644	.622		
LnCommunication (X_1)	-.107	.219	.484	2.065
LnKnowledege (X_2)	.091	.194	.486	2.060
LnAttitude (X_3)	-.092	.216	.389	2.569
LnLeadership (X_4)	.143	.236	.376	2.657
LnDemonstrate (X_5)	-.108	.187	.430	2.327
LnFertilizer (X_5)	-.096	.229	.519	1.926
LnDrainage (X_7)	.086	.102	.743	1.346
Ln Harvest (X_8)	-.164	.238	.627	1.595
LnParasite (X_9)	.549***	.128	.891	1.123
Ln Participation (X_{10})	.103**	.043	.936	1.068
Dummy Educational qualification (X_{11})	.124**	.062	.893	1.119
Ln Smallholder's age (X_{12})	.197	.126	.849	1.178
Ln age of trees (X_{13})	.451***	.048	.914	1.094
Ln Farm Size (X_{14})	-.100**	.039	.937	1.067
R^2	.227			
Adjusted R^2	.205			
F-Stat	10.120			
N	496			

Note: *, ** and * indicate significance at the10%, 5% and 1% levels, respectively.**

CONCLUSION

Overall, the technology transfer capability by extension workers to independent oil palm smallholders are good in various aspects of communications, knowledge in oil palm cultivation, friendly attitude and personality towards smallholders, leadership, and demonstration oil palm farming techniques. Whereas after received suggested technological knowledge from the oil palm guidance and advisory program, smallholders have adopted good agricultural practices at their own farms. On average, current oil palm productivity increased significantly than previous year. With thecurrentoil palm productivity, the targets 22.0 ton per hectare set by MPOB will be realized soon.However, there are someindependent smallholders mainly with low productivity are less focused on pests, insects and parasites control on their crops. Therefore, monitoring and transfer of technology on an ongoing basis by TUNAS could ensure sustainability of smallholder productivity. The results also confirm that better practices of good agriculture leads indeed to increased oil palm productivity.

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