AEXTJ AGRICULTURAL EXTENSION JOURNAL
ISSN 2521 – 0408

Available Online at www.aextj.com
Agricultural Extension Journal 2018; 2(4):227-233

RESEARCH ARTICLE

Mechanization as a Solution for Skilled Labor Shortage of Paddy Farming Sector in Wet Zone

T. B. Mallikaarachchi, G. C. Samaraweera

Department of Agricultural Economics and Extension, Faculty of Agriculture, University of Ruhuna, Kamburupitiya, Matara, Sri Lanka

Received: 10-08-2018; Revised: 01-09-2018; Accepted: 10-11-2018

ABSTRACT

Due to the limitation of productivity in dry zone paddy farmers, it is necessary to increase the productivity of paddy cultivation in the wet zone by increasing the degree of mechanization as a labor solution technology. However, the degree of mechanization in the paddy sector in Sri Lanka is lower than in other developing countries. Therefore, this research study tries to find out the potentials of increasing paddy productivity using new agricultural machinery for traditional ways of paddy cultivation in the wet zone. The main objectives of the study are to identify paddy farmers' degree of mechanization in each stage of paddy farming process, identify the significant barriers that paddy farmers faced while using agricultural machinery, identify farmers' costs and benefits gained using agricultural machinery, and finally, to suggest recommendations to uplift the mechanization in wet zone as a solution for skilled labor shortage. The data were collected using pre-tested questioner from paddy farmers in Dodangoda ds division; collected data were analyzed using one-way ANOVA test, cost-benefit analysis (CBA), and descriptive methods. The CBA indicated the lowest feasibility score for hiring machinery in both land preparation stage and harvesting and threshing stage and those scores were 0.11 and 0.13, respectively. Accordingly, hiring machinery seem beneficial for farmers. Very deeply muddy field condition (Stuck) in paddy lands avoided the usage of machinery. Farmers who had >6 years of experience, tended to use traditional ways to do paddy cultivation. Study findings further revealed that youth farmers tended to use agricultural machinery in both stages the degree of mechanization can be increased if machinery developers can build machinery that is compatible with the field condition of paddy fields, purchase own mini combine harvester (MCH) is not beneficial for individual farmer; therefore, study suggests to purchase MCH for farmer organization.

Key words: Agricultural machinery, cost-benefit analysis, degree of mechanization, labor solution technology, paddy farming, wet zone

INTRODUCTION

Sri Lanka Agriculture sector provides 7.5% of gross domestic product in Sri Lanka[22]; furthermore, about 1.8 million farm families are engaged in paddy cultivation island-wide under 560,000 ha in Maha season and 310,000 ha in Yala Season, currently Sri Lanka paddy farming sector provides 2.7 million tons per year and it fulfills only 95% of annual rice requirement, about 70% of annual production given by Sri Lankan dry zone paddy cultivation, only 30% of production given by wet zone paddy cultivation[7,17].

However, there is 1.1% annual population increment in Sri Lanka to fulfill their rice requirement, rice production needs to increase at least 2.9% per year, but the limitation of increase rice production in the dry zone, Sri Lanka needs to provide more attention to develop paddy cultivation in the wet zone[17].

When considering about wet zone paddy farming sector, availability of skilled labor in paddy farming sector shifting to the service and industrial sector due to easiness and other benefits which provide those sectors than paddy farming sector[1,15].

Wet zone, paddy farming sector, is still using old

Address for correspondence:
T. B. Mallikaarachchi,
E-mail: tbmallikaarachchi@gmail.com

and traditional ways to do their cultivation process; therefore, paddy farmers are struggling with their paddy lands to get a maximum potential harvest[12]. There also many problems that can be identified. Low skilled labor and high cost of available labor[3,5] relating to the paddy farming sector are among those problems[15,23,25]. With traditional ways, paddy cultivation required a large number of labor hours to accomplish the process[2,24]. Labor scarcity badly affects the productivity of paddy cultivation in the wet zone. Board traditional cultivation ways of paddy farming also negatively impact on the involvement of youth generation to the paddy cultivation[16].

Usage of new technologies in agriculture sector possibly helps to overcome those problems and get maximum productivity[6,8,14,21] in the wet zone while considering new technologies in paddy farming sector; new machinery take major place[7,9,11]. The using of agriculture machinery relating to the paddy cultivation is necessary to acquire maximum productivity from paddy lands[10,18,20].

To overcome the labor shortage in paddy farming sector, farmers' can replace labor with agricultural machinery as a solution.[41,3,19] According to the department of agriculture,[17] there are some machinery can be used to replace labor in each stage of paddy cultivation process [Table 1].

Therefore, this research is based on the exploration of mechanization as a solution to the skilled labor shortage in paddy farming in Sri Lanka wet zone. This research study tries to find out the potentials of increasing paddy productivity using new agricultural machinery for traditional ways of paddy cultivation in wet zone, by identifying the paddy farmers' degree of mechanization in each stage of paddy farming process, identify the key barriers that paddy farmers faced while using the agricultural machinery and identify farmers' costs and benefits which gain using of machinery.

RESEARCH METHODOLOGY

Table 1: Type of machinery use in the paddy cultivation process

Stage	Machinery type
Land preparation	4WRP, 2WRP
Sowing	Low land seeder (LS), PPT
Harvesting and threshing	MCH, CH

MCH: Mini Combine Harvester, PPT: Paddy power transplanter, 4WRP: 4 W tractor with rotary tiller, 2WRP: 2 W tractor with rotary tiller

The research study was carried out at Dodangoda DS Division to find out wet zone farmers' degree of mechanization and to identify key barriers which they faced during usage of agricultural machinery, the Dodangoda DS Division is more suitable because it locates in Kalutara District in Sri Lankan wet zone area, and there is plenty of paddy cultivation lands and farmers to access for information. The instrument was for measured above variables will be a pre-tested structured questionnaire. The single questionnaire was given for selected paddy farmers in Sinhala language. The questionnaire consists of questions that needed to be asked to measure each and every variable related to the objectives of the research study. People who cannot read or right asked questions from them and after that filled the questionnaire. The population of this research study was paddy farmers in Sri Lanka wet zone, as the sample for this research study, 100 paddy farmers were selected from 20 farmer organizations using simple random sampling method. As the secondary data, journal articles, literature reviews, research articles, books, and website information were used. The variables and measurements were used to analyze the collected data through the questionnaire. The collected data were tabulated and analyzed descriptively by graphs and charts. Collected data were analyzed also using one-way ANOVA, mean comparing method. Furthermore, collected data were analyzed using cost-benefit analysis (CBA).

RESULTS AND DISCUSSION

Degree of mechanization in each stage of paddy farming process

Findings of this study reviled that 90% degree of mechanization showed in land preparation stage, however, at the sowing stage showed 0% degree of mechanization because use of machinery in this stage required prepare of seedbeds, therefore prepare seed beds and maintain quality seedbed required extra skill, knowledge with extra cost for paddy farmers; therefore, in this stage paddy farmers were using cheaper alternative method which calling direct seeding than using of machinery. However, when it comes to the harvesting and threshing stage the findings reviled there is 30% degree of mechanization in this stage. The 70% of farmers cannot use harvesting machines due to the very deeply muddy field condition in the paddy field due to that field condition the machines got stuck in the paddy fields. However, when considering about land preparation stage already 90% of farmers replace labor with two-wheel tractor (2WRP) and harvesting and threshing stage 30% of farmers replace labor with mini combine harvester (MCH) [Figure 1].

Identifying significant barriers for mechanization as a labor solution

Age

Use of 2WRP and use of MCH showed significant relationship with age of farmers; furthermore, the highest mean value is given by 20–30 age category; however, when the age was increasing, the mean value getting decreases; therefore, when the age was increasing, farmers usage of machinery for their paddy cultivation process is decreasing; therefore, age acts as a significant barrier for degree of mechanization [Table 2].

Education level

The results revealed only use of MCH shows a significant relationship with the education level of farmers, according to mean value farmers who educated up to higher education level shows the highest mean value that means they tended to use machinery than low educated farmers [Table 3].

Land ownership

The only use of 2WRP showed a significant relationship with land availability of farmers that farmers who hired lands for their cultivation process showed the highest mean value; therefore, those farmers tended to use machinery [Table 4].

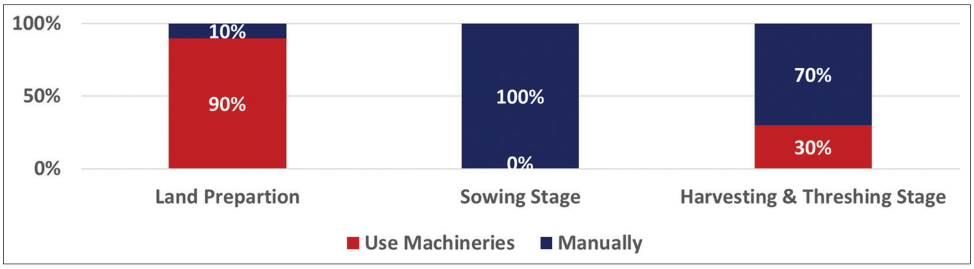

Figure 1: Degree of mechanization in each stage of paddy farming process

Table 2: Oneway ANOVA results with the use of 2WRP and MCH with age

Description	One-way ANOVA (2WRP)		One-way ANOVA (MCH)		Categories	Mean value (2WRP)	Mean value (MCH)
	F	*P*	F	*P*			
Age	2.818	0.029	5.763	0.000	20-30	1.00	0.75
					31-40	1.00	0.71
					41-50	0.97	0.41
					51-60	0.89	0.09
					>60	0.71	0.24

Significant level at P=0.05, MCH: Mini combine harvester, 2WRP: Two-wheel tractor

Table 3: Oneway ANOVA results with the use of 2WRP and MCH with Education level

Description	One-way ANOVA (2WRP)		One-way ANOVA (MCH)		Categories	Mean value (2WRP)	Mean value (MCH)
	F	*P*	F	*P*			
Education Level	1.623	0.206	8.999	0.003	Primary level	0.88	0.22
					Up to GCE O/L	0.96	0.52

Significant level at P=0.05, MCH: Mini combine harvester, 2WRP: Two-wheel tractor, GCE: General certificate of education

Table 4: Oneway ANOVA results with the use of 2WRP and MCH with Land ownership

Description	One-way ANOVA (2WRP)		One-way ANOVA (MCH)		Categories	Mean value (2WRP)	Mean value (MCH)
	F	*P*	F	*P*			
Land Ownership	5.344	0.023	1.495	0.224	Owned	0.83	0.24
					Hired	0.96	0.35

Significant level at P=0.05, MCH: Mini combine harvester, 2WRP: Two-wheel tractor

Experience

According to the findings, the use of 2WRP showed a nearly significant relationship with farmers' experience and use of MCH showed a perfect significant relationship with farmers' experience. However, farmers who had experience <5 years showed the highest mean value and tended to use machinery than more experienced farmers [Table 5].

Credit facilities

According to results, there is no significant relationship with credit facilities and use of 2WRP and MCH [Table 6].

Field condition

This finding revealed there is a perfect significant relationship with field condition and use of 2WRP and MCH. The highest mean value is given by good field condition; therefore, the degree of mechanization increased when field condition is good; therefore, field condition acts as a significant barrie for usage of machinery [Table 7].

Quality of extension service

According to this findings, there is no significant relationship with quality of extension service and use of 2WRP and MCH [Table 8].

Table 5: Oneway ANOVA results with the use of 2WRP and MCH with farmers' experience

Description	One-Way ANOVA (2WRP)		One-Way ANOVA (MCH)		Categories	Mean value (2WRP)	Mean value (MCH)
	F	*P*	F	*P*			
Experience	2.561	0.082	6.218	0.003	<5 Years	1.00	0.70
					6-10	0.97	0.36
					>10 years	0.84	0.19

Significant level at *P*=0.05, MCH: Mini combine harvester, 2WRP: Two-wheel tractor

Table 6: Oneway ANOVA results with the use of 2WRP and MCH with Availability of Credit Facilities

Description	One-way ANOVA (2WRP)		One-way ANOVA (MCH)		Categories	Mean value (2WRP)	Mean value (MCH)
	F	*P*	F	*P*			
Credit Facilities	0.011	0.916	0.234	0.630	Not Satisfied	0.91	0.36
					Extremely Not satisfied	0.90	0.29

Significant level at *P*=0.05, MCH: Mini combine harvester, 2WRP: Two-wheel tractor

Table 7: Oneway ANOVA results with the use of 2WRP and MCH with field condition

Description	One-way ANOVA (2WRP)		One-way ANOVA (MCH)		Categories	Mean value (2WRP)	Mean value (MCH)
	F	*P*	F	*P*			
Field Condition	30.336	0.000	713.224	0.000	Very Stuck	0.00	0.00
					Stuck	1.00	0.02
					Good	1.00	1.00

Significant level at *P*=0.05, MCH: Mini combine harvester, 2WRP: Two-wheel tractor

Table 8: Oneway ANOVA results with the use of 2WRP and MCH with Availability of Quality of extension service

Description	One-Way ANOVA (2WRP)		One-Way ANOVA (MCH)		Categories	Mean value (2WRP)	Mean value (MCH)
	F	*P*	F	*P*			
Quality of extension service	0.546	0.581	0.240	0.787	Moderate	1.00	0.50
					Satisfied	0.87	0.31
					Extremely satisfied	0.93	0.28

Significant level at *P*=0.05, CBA: Cost-benefit analysis, 2WRP: Two-wheel tractor

Table 9: Oneway ANOVA results with the use of 2WRP and MCH with Availability of Cheaper Alternatives

Description	One-way ANOVA (2WRP)		One-way ANOVA (MCH)		Categories	Mean value (2WRP)	Mean value (MCH)
	F	*P*	F	*P*			
Availability of Cheaper Alternatives	1.258	0.265	14.528	0.000	Not satisfied	0.92	0.18
					Extremely not satisfied	0.85	0.53

Significant level at *P*=0.05, CBA: Cost-benefit analysis, 2WRP: Two-wheel tractor

Table 10: CBA, purchased 2WRP (interest rate 5% and depreciation rate 14%) for next 12 years

Type	Cost	Type	Benefit
Purchased	247,750	Yield	5,101,056.00
Opportunity cost	444,923.40	Hire saving	648,000.00
Maintains	120,000.00	Labor saving	648,000.00
Depreciation	416,220.00	Hire earning	612,360.00
		Time-saving	* ****
Total	1,228,893.40	Total	7,009,416.00
Feasibility (TC/TB) score			0.18

Labor wage/Ac and hire cost/Ac will not change during this time period, *****: Strongly time-saving process, CBA: Cost-benefit analysis, 2WRP: Two-wheel tractor

Table 11: CBA, hire 2WRP for next 12 years

Type	Cost	Type	Benefit
Hire	648,000.00	Yield	5,101,056.00
		Labor saving	745,200.00
		Time-saving	*****
Total	648,000.00	Total	5,846,256.00
Feasibility (TC/TB) Score			0.11

Labor wage/Ac and hire cost/Ac will not change during this time period, *****: Strongly time-saving process, CBA: Cost-benefit analysis, 2WRP: Two-wheel tractor

Table 12: CBA, manual (without machineries) process for next 12 years

Type	Cost	Type	Benefit
Labor	518,400.00	Yield	2,073,600.00
Other	97,200.00	Time-saving	*
Total	615,600.00	Total	2,073,600.00
Feasibility (TC/TB) Score			0.30

Labor wage/Ac and hire cost/Ac will not change during this time period, *: weakly time saving process, CBA: Cost-benefit analysis

Availability of cheaper alternative than machinery

Availability of cheaper alternative than machinery showed a significant relationship with the use of MCH and highest mean value is given by extremely not satisfied category; therefore, low availability of cheaper alternative than machinery tended to use agricultural machinery [Table 9].

CBA

Land preparation stage (Next 12 years, average land area 2.7 acres)

This CBA done for considering about the next 12 years time, if the feasibility score <1 it is a beneficial method, according to that, those three methods were beneficial for farmers, but when considering about time-saving and labor saving, usage of 2WRP is strongly time-saving and labor method than using manual method. Considering about purchased 2WRP and hire 2WRP, hire

Table 13: CBA, purchased MCH (interest rate 5% and depreciation rate 16.5%) for next 12 year

Type	Cost	Type	Benefit
Purchased	2,522,750.00	Yield	4,935,168.00
Opportunity cost	4,530,496.55	Hire earning	648,000.00
Maintains	144,000.00	Hire saving	745,200.00
Depreciation	4,995,045.00	Labor saving	615,600.00
		Time-saving	*****
Total	12,192,291.55	Total	6,943,968.00
Feasibility (TC/TB) Score			1.76

Labor wage/Ac and hire cost/Ac will not change during this time period, *****: Strongly time-saving process, CBA: Cost-benefit analysis, MCH: Mini combine harvester

Table 14: CBA, hire MCH for next 12 years

Type	Cost	Type	Benefit
Hire	745,200.00	Yield	4,935,168.00
		Labor saving	745,200.00
		Time-saving	*****
Total	745,200.00	Total	5,680,368.00
Feasibility (TC/TB) Score			0.13

Labor wage/Ac and hire cost/Ac will not change during this time period, *****: Strongly time-saving process, CBA: Cost-benefit analysis

Table 15: CBA, manual process for next 12 years

Type	Cost	Type	Benefit
Labour	1,004,400.00	Yield	2 073 600.00
Other	194,400.00	Time-saving	*
Total	1,198,800.00	Total	2 073 600.00
Feasibility (TC/TB) score			0.45

Labor wage/Ac and hire cost/Ac will not change during this time period, *: Weakly time-saving process, CBA: Cost-benefit analysis

2WRP give the lowest feasibility score, therefore, hiring 2WRP more beneficial than the other two methods. In this CBA, there is an assumption the labor wage and hire cost is not change by year to year [Tables 10-12].

Harvesting and threshing stage (Next 12 years, average land area 2.7 acres)

Purchased own MCH

This CBA done for considering about next 12 years time, if the feasibility score <1 it is a beneficial method, according to that only hiring MCH and manual methods were beneficial for farmers, but when considering about time saving and labour saving, usage of MCH is strongly time saving and labor saving method than using manual method. Considering about purchased MCH and hire MCH, hire MCH to give the lowest feasibility score, therefore, hiring MCH more beneficial than the other two methods. In this CBA, there is an assumption the labor wage and hire cost is not change by year to year [Table 13-15].

CONCLUSION

Findings of this study revealed that the degree of mechanization varies based on different stages of paddy cultivation. The majority (90%) of farmers has shown the highest degree of mechanization in the land preparation stage. However, at the sowing stage degree of mechanization is zero, and they were using direct seeding method because it is a cheaper alternative. Harvesting and threshing stage showed only 30% degree of mechanization. Study findings revealed youth farmers tended to use agricultural machinery in both stages (Land preparation and harvesting and threshing stage). Highly educated farmers were using agricultural machinery, then low educated (Primary level) farmers. Farmers who had >6 years of experience, tended to use traditional ways to do paddy cultivation. In both stages, very deeply muddy field condition (Stuck) in paddy lands avoided the usage of machinery. The CBA indicated lowest feasibility score for hiring machinery in both land preparation stage and harvesting and threshing stage those scores were 0.11 and 0.13, according to this hiring machineries were beneficial for farmers also by hiring machinery can save labor cost RS.745,200.00 in land preparation stage and also RS.745,200.00 in harvesting and threshing stage after 12 years.

SUGGESTIONS

The degree of mechanization can be increased if machinery developers can build machinery that is compatible with the field condition of paddy fields. It is beneficial for farmers to hire machinery for their usage. The study suggests government and private organizations to conduct some programs to increase youth involvement for the paddy cultivation. Purchase own MCH is not beneficial for individual farmer; therefore, study suggests to purchase MCH for farmer organization.

REFERENCES

1. Ali MR, Hasan MK, Saha CK, Alam MM, Kalita PK, Hansen AC. Mechanized Rice Harvesting Opportunity in Southern Delta of Bangladesh. In: 2017 ASABE Annual International Meeting. Bangladesh: American Society of Agricultural and Biological Engineers; 2017. p. 1.
2. Asai H, Soisouvanh P, Sengxua P, Kimura K, Vongphuthine B, Ando M. Labour-saving practices for the external expansion of swidden agriculture for upland rice production in a mountainous area of Laos. Trop Agric Dev 2017;61:166-78.
3. Bhat SH. Study On Technological Gaps and Constraints in Cultivation of Rice in Jammu and Kashmir. Jabalpur: Doctoral Dissertation, Jawaharlal Nehru Krishi Viswavidyalaya; 2005.
4. Caffaro F, Mirisola A, Cavallo E. Safety signs on agricultural machinery: Pictorials do not always successfully convey their messages to target users. Appl Ergon 2017;58:156-66.
5. Carauta M, Latynskiy E, Mössinger J, Gil J, Libera A, Hampf A, *et al*. Can preferential credit programs speed up the adoption of low-carbon agricultural systems in Mato Grosso, Brazil? Results from bioeconomic microsimulation. Reg Environ Change 2018;18:117-28.
6. Chandran SR. Impact of agro machinery service centres on labour cost in paddy cultivation. Int J Res Hum Arts Lit 2018;6:265-8.
7. Department of Agriculture. Agricultural Machineries for Agricultural Development; 2017. Available from: https://www.doa.gov.lk/index.php/si/2017-03-13-05-17-56. [Last accessed on 2018 Sep 03].
8. Gebremariam G, Tesfaye W. The heterogeneous effect of shocks on agricultural innovations adoption: Microeconometric evidence from rural Ethiopia. Food Policy 2018;74:154-61.
9. Hormozi MA, Asoodar MA, Abdeshahi A. Impact of mechanization on technical efficiency: A case study of rice farmers in Iran. Procedia Econ Finance 2012;1:176-85.
10. Houssou N, Asante-Addo C, Diao X, Kolavalli S. Big Tractors, But Small Farms: Tractor Hiring Services as a Farmer-Owner's Response to an Under-Developed Agricultural Machinery Market No. 39. Washington, DC: International Food Policy Research Institute; 2015.
11. Just RE, Zilberman D. Stochastic structure, farm size and technology adoption in developing agriculture. Oxf Econ Pap 1983;35:307-28.
12. Mariano MJ, Villano R, Fleming E. Factors influencing farmers' adoption of modern rice technologies and good management practices in the Philippines. Agric Syst 2012;110: 41-53.
13. Mottaleb KA, Krupnik TJ, Erenstein O. Factors associated with small-scale agricultural machinery adoption in Bangladesh: Census findings. J Rural Stud 2016;46:155-68.
14. Nakano Y, Tsusaka TW, Aida T, Pede VO. Is farmer-to-farmer extension effective? The impact of training on technology adoption and rice farming productivity in Tanzania. World Dev 2018;105:336-51.
15. Pingali P. Agricultural mechanization: Adoption patterns and economic impact. Handbook Agric Econ 2007;3:2779-805.
16. Rauniyar GP, Goode FM. Technology adoption on small farms. World Dev 1992;20:275-82.
17. Rice Research and Development Institute.

Rice Cultivation; 2018. Available from: https://www.doa.gov.lk/rrdi/index.php?option=com_sppagebuilder&view=page&id=42&Lang=en. [Last accessed on 2018 Sep 03].
18. Keskin M, Sekerli YE, Say SM, Topcueri M. Farmers' Experiences with GNSS-Based Tractor Auto Guidance in Adana Province of Turkey. Turkey: Gaziosmanpaşa Üniversitesi Ziraat Fakültesi Dergisi.
19. Sengxua P, Jackson T, Simali P, Vial LK, Douangboupha K, Clarke E, Wade LJ. Integrated nutrient weed management under mechanised dry direct seeding (dds) is essential for sustained smallholder adoption in rainfed lowland rice (*Oryza sativa* L). Exp Agric 2018;55:1-17.
20. Swinton SM, Lowenberg-Deboer J. Global Adoption of Precision Agriculture Technologies: Who, When and Why. In: Proceedings of the 3rd European Conference on Precision Agriculture. Europe: CiteSeerX; 2001. p. 557-62.
21. Uaiene RN, Arndt C, Masters WA. Determinants of Agricultural Technology Adoption in Mozambique. Mozambique: Discussion Papers; 2009. p. 67.
22. Essays UK. Studying Modern Agriculture in Sri Lanka; 2018. Available from: https://www.ukessays.com/essays/environmental-sciences/studying-modern-agriculture-in-sri-lanka-environmental-sciences-essay.php?vref=1. [Last accessed on 2018 Sep 10]
23. Weyori AE, Amare M, Garming H, Waibel H. Agricultural innovation systems and farm technology adoption: Findings from a study of the Ghanaian plantain sector. J Agric Educ Ext 2018;24:65-87.
24. Yadav R, Patel M, Shukla SP, Pund S. Ergonomic evaluation of manually operated six-row paddy transplanter. Int Agric Eng J 2007;16:147-57.
25. Yukichi Y, Yukichi YM, Kazushi T, Keijiro O. Contract Farming, Farm Mechanization, and Agricultural Intensification: The Case of Rice Farming in Cote d'Ivoire Working Paper No. 157; 2017.