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Dissemination of Portable Combining Machine as Appropriate Technological Interventions for Corn Farming in Sloping Region (Study Case: Gorontalo Province, Indonesia)

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Dissemination of portable combining machine as appropriate technological interventions for corn farming in sloping region (study case: Gorontalo Province, Indonesia)

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Abstract. Corn is vital crop cultivation in Gorontalo Province and becomes major export comodity from the agricultural sector. The most of corn farms are located in hilly and mountainous area known as sloping agriculture. The main aim of this study was to analyze the advantages of portable combine machine, peeling-thresher corn as appropriate technology, to support sloping agriculture, reduce cost production, and generate farmers income. All of members of POKTAN Dusun Beringin and POKTAN Dusun Puncak in Tutuwoto Village – study case location – stated that budgetting for labour is the most expensive for corn production in their region. Dissemination of peeling-thresher machine is proven shorten of harvest and post harvest steps in the current pattern. Results revealed that the technological input decreased 34.50% operational cost of harvest and post harvest from Rp8,520,000 to Rp2,940,000. Furthermore, its application improved the farmers net profit 51.67% ha^{-1} and 85.01% ha^{-1} for own and loan capital respectively, in one growing season about 4 month. It is concluded that proper equipment implemented in hilly farming reduces cost production and its implication redoubles revenue of the POKTAN members.

1. Introduction

Gorontalo is one of the provincial centers for national corn production to food and feed consumption in which contributes 4% to corn production of total or seventh largest in national scale [1]. The farming area reaches 140,460 ha or 3.7% of total area in Indonesia [2] and with average yield 8.4 tons ha^{-1} dry grain, potentially total corn produced is about 1.18 million tons for one seasonal planting or 2.36 million tons per year. The occupation majority of people is farmer where corn is the second largest plant cultivation after rice. Furthermore, corn is the province's primary export comodity to The Philippines and Malaysia from agricultural sector that reach 135,000 ton or 21% of total production [3] with average annual production about 643,512 tons [4; 5]. Thus, corn farming for this province is extremely promising for both local and international market.

In Gorontalo, corn farming can be classified as sloping agriculture that utilized rainfed condition as irrigation. In fact, cultivation is performed in upland, mountain and hilly area (slope > 15%), due to lowland or plain area with surpass water focusing to rice. Because the crop water requirements depends on rainfed condition and effort to provide artificial irrigation system so problematic and challenging, the cultivation now is only undertaken one or two times per year. Although, several technique have been proposed in other regions to overcome this problem [6], but is still not realize yet in this region.

Scarcity of proper instruments become fundamental challenge for corn farmers specifically for sloping agriculture in marginal area and difficult topography [3]. Consequently, cost production is most costly since it require more manpower. In addition, its implication certainly influence income generation from the farmer. By the various limitations, suitable instruments and machine are believed key to overcome farming obstacles on those area [7; 8; 9].

Previous study, [10] Maikhuri et al. (2010) confirmed that adoption of specific-technological input is crucial for marginal area and extreme topography to hike economic local society and livelihood security. In other hand, economic feasibility through the technology input is needed to identify sustainability and profitability farming in rural area dealing with sloping agriculture in mountain and hilly region [11]. In addition, [12] Sianipar et al. (2013) stated that fit technology have linking function to empowering poor community in rural areas.

The objectives of this research were as followings:

1. To analyze impact of portable combine machine input, peeling-thresher corn as appropriate technology on changing harvest and post-harvest pattern.
2. To identify the comparison of farm employee cost between peeling-thresher machine and thresher machine (single function without peeling) on harvest and post-harvest corn management in sloping agriculture.
3. To identify net profit of the farmer dissemination of appropriate technology for mountain and hilly area.

2. Materials and methods

The study was carried out in the Sub-district of Tutuwoto Village, Kwandang, North Gorontalo District, Gorontalo Province. Government statistics authority noted that North Gorontalo produces 55,306 tons per year corn dry grain with the farming area 20,840 hectares [13]. In this study, the cultivation area is situated in marginal field, then the topography of the rising and falling slope such as mountain and hilly area that utilizes rainfed irrigation. This study case involves the participation of two POKTAN (farmer groups association) namely POKTAN Dusun Puncak and POKTAN Dusun Beringin, with 20 and 17 members of each.

Production cost was calculated for one hectare area in one growing season from July to October 2020 with exchange rate, Rupiah (Rp) (1$ = Rp14.26 on July 1, 2020). Existed technology in Tutuwoto village just only thresher machine (single function) and almost of the farmer still use middleman's machine. Thus, portable combine machine, peeling-thresher corn machine, as appropriate technology is used made by ®Romi Djafar unpublished data.

Figure 1. Hilly area for corn farming in Tutuwoto village

2.1. Production cost

Total cost of producing corn in the sloping region for one seasonal growing is at Rp17,461,500 per hectare that consisted of raw material, hired labour, and unexpected expenses (5% of the total) as recorded in Table 1. Raw material cost comprise pre-harvest (seed, fertilizer, herbicide, pesticide, and gauco) and at-post harvest (sack bag), Rp4,110,000 and Rp420,000, respectively. In addition, Table 1 showed that corn producers of members of POKTAN Dusun Puncak and POKTAN Dusun Beringin spent the highest cost for paying labour Rp4,000,000 (pre-harvest) and Rp8,100,000 (at-post harvest).

Corn farmers spend Rp4,000,000 in cash for farm employees (pre-harvest) include planting the seed, cow ploughing, cutting the grass, fertilizing, and spraying. Its salary of hired employee is subtle similar with raw materials expenditure. In other side, among the expenses paid in cash by the farmer, hired labour for at-post harvest accounted about 46.39% of total cost production or twice more than pre-harvest salary. Thus, three quarter of operational cost incurred by Tutuwoto corn farmer is spent for labour fee at Rp12,100,000 as implied in Table 1.

There are two capital system for corn producer such as own capital and loan capital. The different system will influence starter cost production. In current situation, most of group members both POKTAN Dusun Puncak and POKTAN Dusun Beringin have relied on loan capital to beginning farming activities.

Loan capital user about 90% for each farmer groups, 18 members of POKTAN Dusun Puncak and 15 members of others group. The loan from middleman is utilized by the farmer as initial expenses (pre-harvest need). Habitually, lending money was returned after the crop is sold or 4.5 month with rate interest 7% (Rp567,700 per month). Consequently, loan capital user spent Rp10,664,650 for pre-harvest expenses, 23.95% higher than the recorded Rp8,110,000 of own capital farmers. As a result, whole budget expand from Rp17,461,500 to Rp20,015,500 as demonstrated in Table 2.

Table 1. Cost of corn production during seasonal planting per hectare (own capital)

Item	Pre-harvest	Units	Rp/units	Total cost, Rp
	A. Raw Material			
1	Herbicide *Raxxx* (gallon)	1	340,000	340,000
2	Herbicide *Amxxx DMA*	1	80,000	80,000
3	Herbicide *Cornexxx*	1	310,000	310,000
4	Pesticide *Amxxx*	1	180,000	180,000
5	Seed (Bisi 18)	1	1,700,000	1,700,000
6	Gauco-mixture of seed	1	80,000	80,000
7	Fertilizer (sack/50 kg)	8	125,000	1,000,000
8	Fertilizer (sack/50 kg)	4	105,000	420,000
			Subtotal A	4,110,000
	B. Labour			
9	Cutting grass (4 person/ day)	4	150,000	600,000
10	Spraying –herbicide (2 person/day)	2	175,000	350,000
11	Cow ploughing (4 person/day)	4	300,000	1,200,000
12	Planting the seed (25 person/day)	25	50,000	1,250,000
13	Fertilizing (12 sack) (2 person/day)	12	50,000	600,000
			Subtotal B	4,000,000
	Total Pre-harvest (Subtotal A+ Subtotal B)			**8,110,000**

Item	Harvest and Post-Harvest	Units	Rp/units	Total Cost, Rp
	C. Raw Material			
14	Sack (piece)	140	3,000	420,000
			Subtotal C	420,000
	D. Labour and Transportation			
15	Cutting the stalk (3 person/4 days)	12	100,000	1,200,000
16	Peeling (7 person/7 days = 288 sack)	288	10,000	2,880,000
17	Distribution to thresher location	288	4,000	1,120,000
18	Thresher process (The kernel= 140 sack)	140	5,000	700,000
19	Man of thresher (10 person/ day)	10	80,000	800,000
20	Transportation to asphalt road (140 sack)	140	5,000	700,000
21	Transportation to warehouse (buyer)	140	5,000	700,000
			Subtotal D	8,100,000
	Total Harvest and Post-harvest (Subtotal C +Subtotal D)			**8,520,000**
Item	E. Unforseen Cost			
22	5% unexpected expenses	0.05	16,630,000	831,500
	Unforseen cost (subtotal E)			**831,500**
	Total Pre-Harvest			8,110,000
	Total Harvest and Post-Harvest			8,520,000
	Total unforseen cost			831,500
	Total of Production Cost			**17,461,500**

Table 2. Total cost of corn production for capital loan user (7% interest month^{-1})

Item	Detail	Units	Rp/units	Total Cost, Rp
1	Pre-harvest			8,110,000
2	Harvest and post-harvest			8,520,000
3	5% unexpected expenses			831,000
4	Interest of pre-harvest (4.5 month)	4.5	567,700	2,554,650
	Total of production cost			**20,015,500**

2.2. Corn farming activities

Table 3. Existing condition of cultivating corn from initial to sell

No	Pre-Harvest	Labour (day^{-1})	Harvest and Post-Harvest	Labour (day^{-1})	Number of sacks
1	Cutting grass	4	Cutting stalk	12	-
2	Spraying weed	1	Peeling process	49	-
3	Ploughing	4	Transport 1	-	288*
4	Planting corn seed	25	Threshing step	10	-
5	Spraying weed+pest	1	Transport 2	-	140*
6	Fertilizing	2	Transport 3	-	140*

Note: *labour fee for transportation are determined by the number of sacks not day

Table 3 illustrated that the farming activity of sloping area in Tutuwoto's POKTAN such as pre-harvest, harvest, and post-harvest condition. All activity in existing condition involve number of employment. Corn farmers need hired 37 labour day-1 to all pre-harvest activities where planting the seed with highest employee (25 labour day-1). In Other side, farmers need highest labour for peeling process (49 labour day-1). amount of salary for activities count according day with spesific activiies except transport.

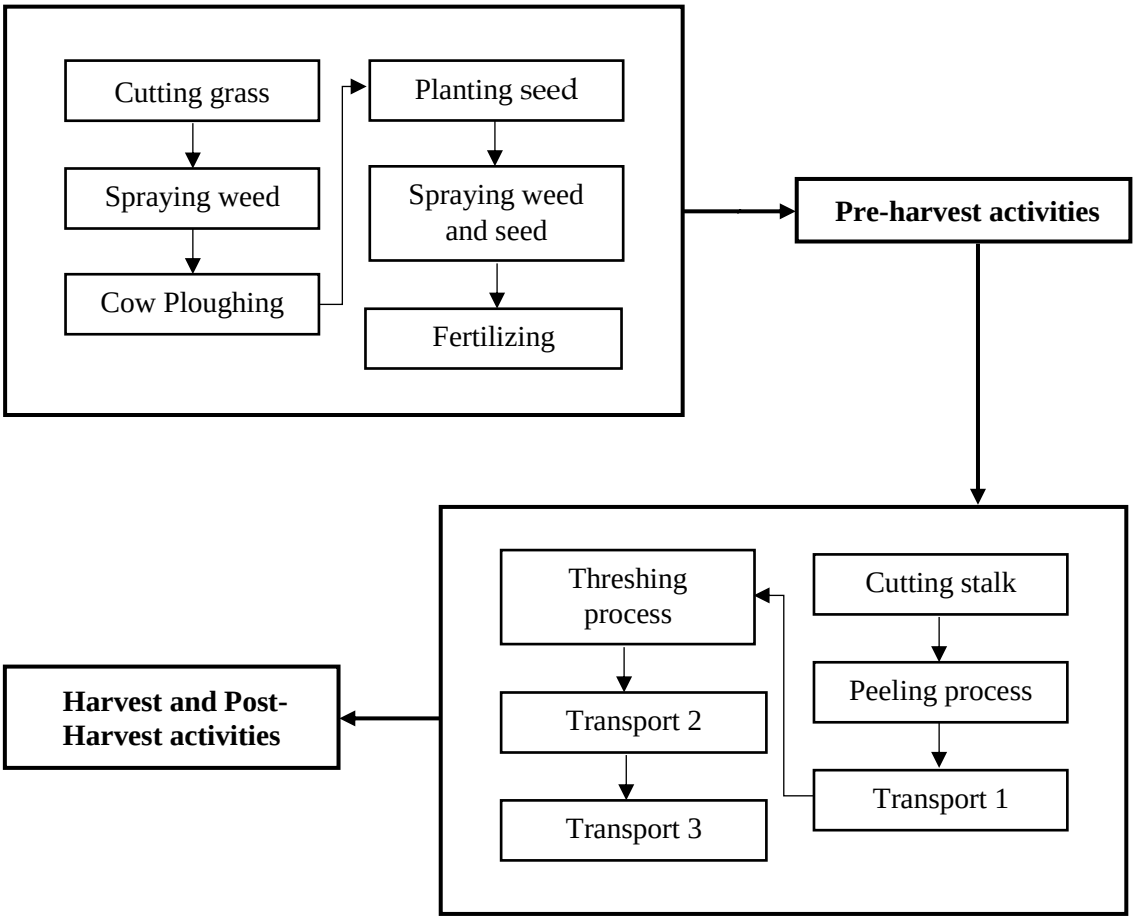

Figure 2. Activities of corn farming before peeling-thresher machine input

In Tutuwoto hilly region, there are 3 transport in one seasonal growing namely Transport 1 distribute corncob (cob+kernel) from field to thresher location, Transport 2 convey the kernel from thresher location to road, and Transport 3 bring the dry grain yield from road to warehouse. Transport 1 and transport 2 use motorcycle and transport 3 by car. For transportation si decided by amount of sack. In generally, when the harvest is successful, there are 288 sack for transport 1 and 140 sack for others (transport 2 and transport 3). For transport 1, 1 sack containing cobs/ears is paid Rp4,000 while transport 2 and 3, in 1 sack containing dry grain kernels, are at Rp5,000.

a. Cutting stalk

b. Transport 1 to thresher location

c. Preparation to thresing process

d. Transport 2 to road

e. The dry grain weighing

f. Transport 3 to warehouse

Figure 3. Several activities of the post harvesting corn in Tutuwoto Village

2.3. Corn price

Table 4. Comparative price corn based on (1) buyer and (2) moisture content (MC)

No	Buyer	Price	MC (%)	Fund
1	Authorized buyer	Rp3,200/kg	13-15	Own capital
		Rp2,700/kg	25-30	
2	Middleman/ Collectors	Rp3,000/kg	13-15	Loan capital
		Rp2,500/kg	25-30	

Source: PT Gorontalo Pangan Lestari and UD Krisna (April, 2020)

Grain yield/kernels are sold to authorized buyer at Rp3,200 per kg (MC= 13-15%) and Rp2,700 per kg (MC= 25-30%). In other side, middleman or collectors buy the kernels lower Rp200 for each moisture content classification. As an agreement between middleman and loan capital users, middlemen assess corn prices lower than authorized buyer (standard price of government). In this case, besides pre-harvest cost, the middleman also influence corn price.

2.4. Profit

Table 5. Farmers's profit to one hectare in growing season (4 month) to 25-30% MC

No	Buyer	Yield (kg)	Price (Rp)	Gross sales (Rp)	Total Cost (Rp)	Net Profit (Rp)	Fund
1	Autorizhed buyer	8,400	2,700	22,680,000	17,461,000	5,219,000	Own
2	Middleman/ Collectors	8,400	2,500	21,000,000	20,015,500	984,000	Loan

Normally, On POKTAN Dusun Puncak and Beringin, 1 hectare area potentially produce 8,400 kg (8.4 ton kernel) –*harvest is successful category*-. The POKTAN farmers receive Rp22,680,000 (own capital) and Rp21,000,000 (loan capital user) from selling the dry grain yield as gross sales. Net revenue for own capital and the loan user are Rp5,219,000 and Rp984,000 per hectare for 1 seasonal planting as shown in Table 5. Thus, benefit receiving after selling product by the loan user is very low for 1 cycle planting. Its revenue toward to break even point.

3. Results and discussion

3.1. Changing harvesting pattern

Technological intervension contributed to shortcut old harvest and post harvesting pattern. In the old pattern, harvesting start by cutting corn stalks, collecting stalks in several groups in small area, then peeling process by manpower. After the peeling process, load corn cob in sack then distribute to thresher machine location. Contrary, in the new pattern, corn harvest begin with removing corn ears from the stalks in stand position then load into sack without peeling and ready to transport towards the peeling-thresher machine. Furthermore, technological input remove employee for peeling and reduce employee when thresher process so that optimize the cost production. New approach on harvesting pattern via dissemination of peeling-thresher corn machine simplified than the old that existed in the POKTAN in Tutuwoto village.

Benefit of applying peeling-thresher machine in sloping agriculture:

1. Picking corn ears was performed on standing plants without cutting the stalk at the base (accelerate first step when harvesting process).
2. Speed up peeling process without hired labour.
3. Eliminating and reducing number of employment particularly in peeling and threshing process.

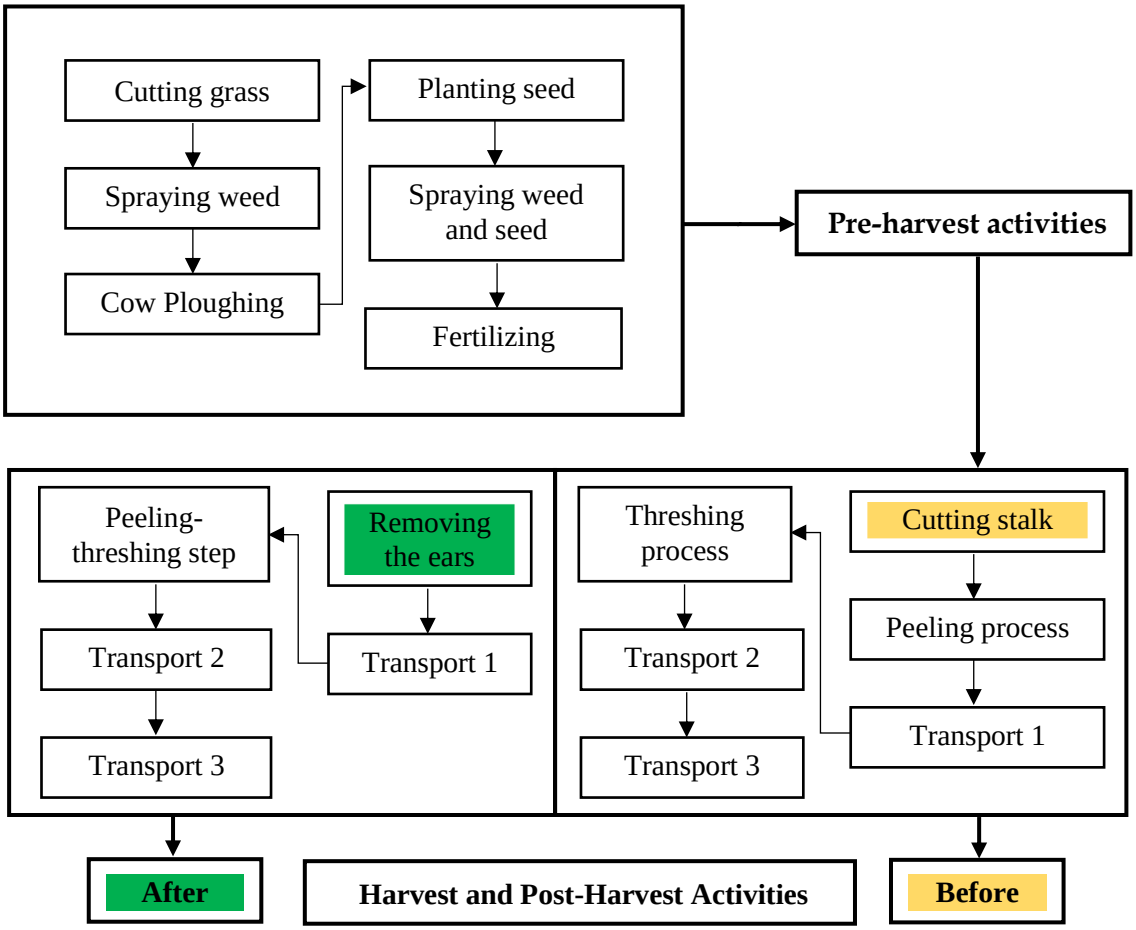

Figure 4. Changing pattern of corn farming activities before and after dissemination of portable combining machine (peeling-thresher machine)

Table 6. Comparison of harvest and post-harvest cost (before and after peeling-thresher input)

Item	Harvest and post harvest cost (before)	Units	Rp/units	Total Cost, Rp
1	Cutting the stalk (3 labour/4 days)	12	100,000	1,200,000
2	Peeling (7 labour/7 days = 288 sack)	288	10,000	2,880,000
3	Distribution to thresher location	288	4,000	1,120,000
4	Thresher process (Kernel= 140 sack)	140	5,000	700,000
5	Man of thresher process (10 labour/ day)	10	80,000	800,000
6	Transportation to asphalt road (140 sack)	140	5,000	700,000
7	Transportation to warehouse (buyer)	140	5,000	700,000
8	Price of sack (piece)	140	3,000	420,000
			Total (before)	**8,520,000**
Item	Harvest and Post Harvest (after)	Units	Rp/units	Total Cost, Rp
1	Distribution to thresher location	288	4,000	1,120,000
2	Transportation to asphalt road (140 sack)	140	5,000	700,000
3	Transportation to warehouse (buyer)	140	5,000	700,000
4	Price of sack (piece)	140	3,000	420,000
			Total (after)	**2,940,000**

	Total harvest and post-harvest cost (total before)	8,520,000
	Total harvest and post-harvest cost (total after)	2,940,000
	Capital Gain (optimizing cost)	**5,580,000**

Table 7. Optimizing cost in harvest and post-harvest after appropriate technological input

No	Item	Cost (Rp)	Changing cost
1	Pre-Harvest	8,110,000	
2	Harvest and Post-Harvest	8,520,000	8,520,000
3	Unexpected Expense (5%)	831,500	
	Before	**17,461,500**	
1	Pre-Harvest	8,110,000	
2	Harvest and Post-Harvest	2,940,000	2,940,000
3	Unexpected Expense (5%)	831,500	
	After	**11,881,500**	
	Gain		**5,580,000**

Table 8. Income generation of the corn farmer

No	Buyer	Yield (kg)	Price (Rp)	Gross sales (Rp)	Total cost (Rp)	Net-profit (Rp)
1	Autorizhed buyer	8,400	2,700	22,680,000	17,461,000	5,219,000
		8,400	2,700	22,680,000	11,881,500	10,799,000
		Profit margin of own capital				**5,580,000**
		Percentage (%)				51.67%
2	Middleman/Collectors	8,400	2,500	21,000,000	20,015,500	984,000
		8,400	2,500	21,000,000	14,435,500	6,564,500
		Profit margin of loan capital				**5,580,500**
		Percentage (%)				85.01%

3.2. Labour cost

In this study case, function of technological input is as financial support for corn producer to gain extra income through intervension farm worker cost. Table 7 illustrated that have occured significantly changing on expenditure of at-post harvest. Before presence of peeling-thresher technological input, harvest and post harvest cost is at Rp8,520,000, compared after intervension decreased at Rp2,940,000. There is optimizing cost or capital gain that reached Rp5,580,000. The optimizing cost can cover 68.80% of pre-harvest expenses.

In Table 6, after dissemination of peeling-thresher machine, Corn farmer with the help of his wife or child can finish removing the ears without hired labour for 1 hectare. Before dissemination, hiring labor is unavoidable because harvest pattern is difficult due to cutting the stalk and peeling process by manpower.

3.3. Income Generation

Finally, role of proper technology is exceedingly crucial to raise economic condition of corn farmer especially to eliminate or reduce dependence from middleman capital. Previuos study, [14] Arsyad et.

al (2018) stated that role of middleman is detrimental for farmers due to discrimination price and high interest. In addition, profit improvement will be expected reduce farmers' dependence to take debt for pre-harvest cost. Moreover, in the next growing season, multiply revenue from the loan capital user will help financial support to start cultivation.

In terms of net earnings, own and loan capital received Rp10,799,000 and Rp6,564,000, respectively. Own capital farmer recorded 51.67 % rising income, compared loan capital user by 85.01% of increasing income. Corn farmers of POKTAN members recorded multiply net earnings after dissemination of the proper insruments for sloping agriculture in mountain and hilly area in Tutuwoto village, Gorontalo Province.

4. Conclusions

The conclusions of this research were:

1. Usage of portable combine macine shorthen and simplify old pattern on harvest and post harvest.
2. Implementaion of thresher-peeling corn machine is so successful as to exert operational cost on sloping agricuture in Tutuwoto village.
3. Implication of technological input optimized labour fees and simultaneously increase corn farmers revenue drastically, mainly for loan capital users.

References

[1] Haryono 2012 Maize for food, feed, and fuel in Indonesia: challenges and opportunity *The proceedings of the International Maize confrence*, Sulawesi, Indonesia, 3-9

[2] Kementerian Pertanian 2016 *Jagung - Outlok Komoditas Pertanian Sub Sektor Tanaman Pangan*. Pusat Data dan Sistem Informasi Pertanian, Kementan

[3] Provincial Governance Strengthening Programme 2013 *Provincial Development Guideline of Province of Gorontalo 2013*. PGSP-UNDP. Gorontalo-Indonesia

[4] Badan Pusat Statistik 2015 *Statistik Tanaman Padi dan Jagung Kabupaten Gorontalo Utara 2015* BPS Kabupaten Gorontalo Utara

[5] Province Overview-Gorontalo Province 2018 *Indonesia Industrial Estates Directory 2018-2019*

[6] Zaki M K, Komariah, Rahmat A, and Pujiasmanto 2018 Organic amandment and fertilizer effect on soil properties and yield of Maize (Zea mays L.) in rainfed condition *Walailak Journal Science and Technology*, **17** 11-17

[7] Agenda M 2002 *Sustainable Development in Mountain Areas The Need for Adequate Policies and Instruments* Centre for Development and Environment (CDE), University of Berne, Switzerland

[8] Wymann, von Dach S, Romeo R., Vita A., Wurzinger M and Kohler T (eds) 2013 *Mountain Farming is Family farming* – A Contribution from mountain areas to the International Year of Family Farming 2014. Rome, Italy: FAO, CDE, BOKU, pp. 100

[9] Franco W, Barbera F, Bartolucci L, and Focanti F 2020 Developing Intermediate machines for high-land agriculture *Journal Development Engineering* **5** 1-14

[10] Maikhuri, R K, Rawat L S, Vikram S N, Bahuguna A, Sunil K A, Faroouquee N A, Phondani P and Negi C S 2010 Demonstration and dissemination of simple eco-friendly technologies for natural resource management in central Himalaya. *Indian journal of science and Technology* **3** 822-830

[11] Maikhuri R K, Rawat L S, Vikram S N, Purohit V K, Rao K S and Saxena K G 2011 Managing natural resources through simple and appropriate technological interventions for sustainable mountain development *Current science* **100** 992-997

[12] Sianipar C P M, Yudoko G, Adhiutama, A and Dowaki K 2013 *Community empowerment through appropriate technology: Sustaining the sustainable Development*. The 3rd International Conference on Sustanable Future for Human Security, SUSTAIN 2012.
[13] Badan Pusat Statistik 2015 *Produksi jagung Menurut Kabupaten/Kota di Provinsi Gorontalo* BPS Provinsi Gorontalo
[14] Arsyad M, Heliawaty, Kawamura Y and Yusuf S 2018 Agricultural Development-Marketing Nexus: Is Tengkulak Truly Enemy of Smallholders in Indonesia Rural Area? *Int. J. Agr. Syst.* **6** 60-67