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THE FINANCIAL VIABILITY OF MULTI-ROW ONION SEEDER: THE CASE OF PANGASINAN, PHILIPPINES

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ABSTRACT

A multi-row onion seeder (MROS) was designed and developed to address the inefficiencies of the current practice of direct seeding method of bulb onion. Based on field evaluation, the MROS was found to be technically feasible passing the minimum standard prescribed under the Philippine Agricultural Engineering Standard (PAES 123:2001). A technically feasible machine needs financial evaluation as it provides useful input decision to farmers and other stakeholders in adopting the technology. This paper discusses the financial viability of MROS by accounting for the direct costs and benefits associated with the use of the seeder in comparison with the traditional manual broadcasting method (MBM). These were considered from two perspectives, that is, a private investor operating the MROS as service provider analysed using investment analysis, and from the point of view of onion farmer adopting the MROS over the traditional MBM, analyzed using partial budget analysis. The study was conducted in 2017 in Pangasinan, a major onion producing province in the Philippines that predominantly practice direct seeding of onion. The adoption of MROS and replacement of the traditional MBM would provide farmer benefits coming from reduction in labor cost, reduced seed requirement and increase in average yield estimated at PhP47,973.95/ha. Investment analysis revealed that it is financially viable given an internal rate of return of 48% and BCR of 1.77. The minimum efficient level of service area that would make its operation viable is 40 hectares per season. This condition must be satisfied in areas where it will operate to attain the potential benefits of the MROS. The following information can be used for the wider adoption and promotion of the MROS in areas where MBM is still practiced.

Key words: financial viability, labor shortage, manual broadcasting method, multi-row onion seeder

INTRODUCTION

Onion (*Allium cepa L.*) is an essential condiment and is regarded as one of the high value crops strongly supported by the Department of Agriculture (DA) of the Philippines. In 2018, the country registered a total production of 172, 665 MT that was harvested in 17,904.81 ha with a recorded average yield of 9.64 MT/ha. Central Luzon is the highest onion producing region accounting for 61.53 % of the country's total production, followed by Ilocos Region and Cagayan Valley at 22.19 % and 5.12 %, respectively (PSA 2020). Onion is a capital-intensive crop to grow requiring an average capitalization of P180,000/ha/season. Of the total cost of production 42 %

accounts for the labor cost and more than half of this cost is incurred in planting (Antolin et al. 2017). Planting of onion is traditionally done manually making it costly considering the scarcity of labor in the area particularly during peak season One way to reduce labor cost in planting is through adoption of labor-saving technology and this can be done using the appropriate type of machinery (Goreppati et al. 2017) mechanizing the operation to save labor and time and even reduce the drudgery.

In 2017, the Philippine Center for Postharvest Development and Mechanization (PHilMech) of the Department of Agriculture, designed and developed a multi-row onion seeder (MROS) to address the inefficiencies of the traditional manual broadcasting method (MBM) of direct seeding. Among the major limitations associated with MBM is the scarcity of manual labor during peak planting season and high labor cost. This was corroborated by the study of Briones (2017) who had estimated that since 2011, there was a declining work force in agricultural sector with an average of 250,000 workers leaving the agriculture for other high paying jobs in other sectors.

The MROS developed by PHilMech was subjected to a series of field testing and was evaluated based on the following technical parameters: a) actual delivery/seeding rate; b) actual field capacity (AFC); c) theoretical field capacity (TFC); d) field efficiency, and e) fuel consumption, as prescribed under Philippine Agricultural Engineering Standards (PAES 123:2001) passing all the technical parameters. As a proof of innovativeness and novelty in design, the MROS application for patent was granted by the Intellectual Property of the Philippines (IPOPhil) in 2021.

While the MROS was found to be technically acceptable, another equally important aspect of the technology that must be satisfied is its financial viability. To attain this, MROS was pilot tested in Pangasinan, a major producer of bulb onion in Region I. In 2018, Pangasinan recorded a harvest of 2,488.66 MT (PSA 2020). One unique characteristic of this production area is almost all of the farmers practice the traditional MBM. One of the limitations identified in this method of planting is the relatively higher seed and labor requirement. During planting season local farmers were forced to source-out laborers from neighboring areas to address the manual labor deficit causing delays in planting operation as well as increasing expenses incurred for planting. Given this condition, Pangasinan became the appropriate study area to pilot test the MROS.

This paper discussed the financial viability of MROS in areas where MBM is predominantly practiced. Specifically, it sought to evaluate its viability from two different perspectives, that is: 1) from the point of view of onion farmer who will be adopting the MROS over the traditional MBM, and 2) from the point of view of a private investor who will invest in MROS and operate the seeder as a service provider.

METHODOLOGY

Conceptual framework. The study compared the technical and financial performance of MROS with the MBM (Fig. 1). The financial viability of MROS was assessed using the technical and financial data gathered during the pilot testing of the machine. The study performed costs and returns analysis, partial budget analysis and investment analysis. The financial viability of using MROS was evaluated from two perspectives, that is: 1) from the point of view of a farmer adopting the MROS, analysed using partial budget analysis; and 2) from the point of view of a private investor investing in MROS and operating as service provider, analysed using investment analysis.

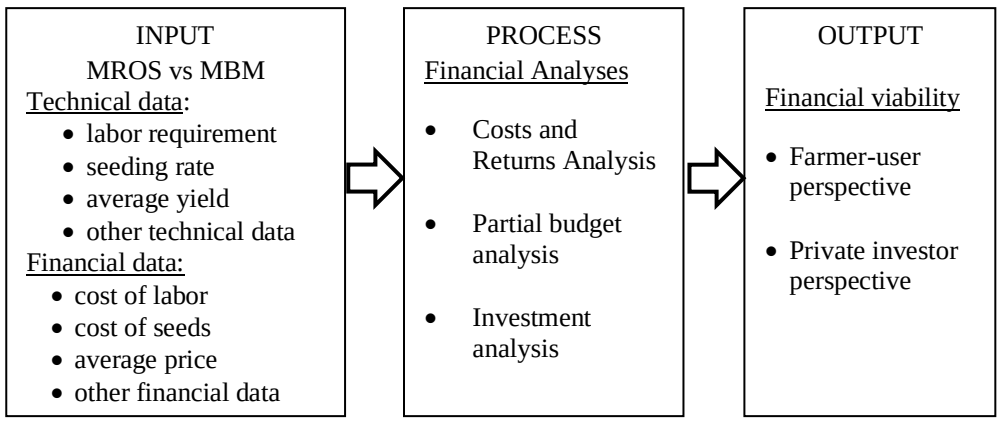

Fig. 1. Conceptual framework of the study.

Time and place of the study. The study was conducted in Pangasinan in 2017 in cooperation with onion farmers as project co-operators. The co-operators were selected based on three criteria: a regular onion farmer that practices direct seeding, willing to use the MROS and availability of required production area where both MBM and MROS can be applied at the same time for direct seeding. With only the two types of direct seeding method, that is MBM and MROS, as the only source of variation, the project cooperators applied the traditional production practice such as cropping calendar, onion varieties planted, land preparation techniques, rate of fertilizer and chemical applications, water management, and harvest practices.

Data collected. The study used primary and secondary data. Primary data were gathered from the field by actual measurement and observation of technical parameters such as labor used, seeding rate, planting density and average yield, among others. Farmers' survey with the aid of structure questionnaire was conducted to obtain information on socio-economic data and production-related practices. For financial data such as average cost incurred for seeds, fertilizers, chemicals, packaging material/red sacks, labor for land preparation, furrowing, boxing, planting, weeding, thinning, fertilizer and chemical application, harvesting, cutting and sorting as well as irrigation, food and interest on loan, average farm-gate price. The following information were obtained from actual observations, key informants interview and secondary data from the Provincial Agriculturist Office.

Manual broadcasting method. MBM is the predominant method of planting practiced by farmers in the study area (Antolin et al. 2017). This method is a quick means of sowing onion seeds. In this method, seeds are broadcasted manually in well-pulverized and equally spaced raised beds. After sowing, onion seeds are covered with thin layer of fine soil using steel hoe. Since this operation is done manually, the spacing and the density of plants are dependent on the skill of the person doing the broadcasting. This practice of direct seeding often results to uneven spacing, overcrowding and non-uniformity of growth and development of plants, leading to low yield and consequently low income (Khan et al. 2015; Khan et al. 2016). Seed requirement using MBM ranges from 6.75 to 9 kg/ha (Idago et al. 2019). Also, this practice is labor-intensive requiring 25 to 35 persons to accomplish seed sowing, covering the seeds and creation of levee. Since the density of plants is uneven, additional labor for thinning is required 35 to 45 days after sowing to attain optimum plant spacing, increasing further the manual labor required.

MROS. The multi-row onion seeder is a tractor-hitched drill type seeder that is capable of opening furrow, delivering the seed, covering the seed and firming the bed in just one passing (Idago et al. 2019). It is designed with 10 units' seed delivery system hence it is sometimes called 10-row onion

mechanical seeder. Each of the ten seed bin has a capacity of 500 grams thus in a single run it can directly sow 5kg of onion seeds in the field. The seeder has three major components, namely: soil-engaging component, seed metering system and distribution system. The seeding rate ranges from 3.60 to 4.80 kg/hectare and requires 1 to 2 persons to operate (Dela Cruz et al. 2017). This method of planting does not require thinning after planting since the onion seeds are delivered equally-spaced and seeding rate is already pre-adjusted based on the requirement.

Table 1 shows the technical performance of MROS based on the study conducted by Idago et al. (2019). Results of the study indicated that the MROS has an effective field capacity 0.41ha/hr, field efficiency of 77.23%, fuel consumption of 2.45 L/ha, and seeding rate of 4.80 kg/ha. In comparison with manual broadcasting, the MROS had higher field capacity, lower seeding rate and lower labor requirements by 2.44 person-days/ha (Table 2).

Table 1. Summary of the field performance of MROS, 2017.

Parameters	Mean values across farms
1. Area (m^2)	1,158
2. Time of operation (min)	17.58
3. Speed (km/h)	3.35
4. Effective field capacity, ha/hr	0.41
5. Theoretical field capacity, ha/hr	0.53
6. Field efficiency, %	77.23
7. Seeding rate, kg/ha	4.80
8. Fuel consumption, L/ha	2.45

Source: Idago et al. (2019)

Table 2. Comparison of MROS and MBM in Pangasinan, 2017.

Method of Direct Seeding	Actual field capacity (ha/hr)	Seeding rate (kg/ha)	Labor requirements (person-days/ha)
MROS	0.37	4.94	0.90
MBM	0.35	7.68	3.34
Difference	0.06*	-2.74*	-2.44

Note: * Significant at 5% level.
Source: Idago et al (2019)

Assumptions used in assessing the financial viability of MROS. The data used in the assessment of MROS' financial viability were based on the results of the pilot testing from farmer co-operators and the technical performance of the MROS (Table 1) from the study of Idago et al. (2019). In one of the analyses using farmer-user perspective, it is assumed that MROS will replace the traditional MBM and this will have corresponding implications on the amount of labor used, seeding rate (Table 2) as well as average yield which would determine if the adopter will be better-off using the proposed technology. In addition, the analysis using private investor's perspective assumed that the MROS will be operated as a service provider using service rate that is lower than the existing rate used for MBM. This will create incentive and will therefore facilitate its acceptance and adoption. The capacity of the seeder is 0.37 ha/hr (Table 2) and will be operated for 20 days per season.

Using MROS the cost of seeding and land preparation is reduced. The MBM needs 6.75 to 9 kg /ha and requires about 25 to 35 persons to plant and cover the seeds per hectare. MROS required 3.60 to 4.5 kg/ha and 1 to 2 persons to operate the machine. The reduced labor will be coming from

operations eliminated such as: labor from MBM, boxing and thinning. On the other hand there will be additional costs incurred from service fee for the use of MROS, furrowing, harvesting fee, tying and hauling, and cost of packaging/red bag. The material inputs (i.e. fertilizers, chemicals) are all the same except for the seed requirement.

To analyze the changes in costs and benefits associated with the use of MROS partial budget analysis was used. This method compares the marginal cost of an activity within a certain enterprise with the marginal increase in the benefit that the new activity will provide (Gittinger 1982). It measures the changes in income resulting from the proposed intervention. The partial analysis was computed using the formula below:

$$I = (Ra + Cr) - (Rr + Ca)$$

where:

I = incremental income
Ra = added revenue
Cr = reduced cost
Rr= reduced revenue
Ca= added cost

Financial viability. The financial viability of MROS was assessed from the point of view of private investor operating the seeder as service provider. It is assumed that the seeder will be operating for about 20 days/cropping. Based on its capacity its effective area coverage per year is 40 has. The cost of MROS is PhP140,000 and the minimum working capital is PhP7,000 to cover for the initial cost of fuel, operator and other incidental expenses. Other costs that were included in the financial analysis were: depreciation cost, repair and maintenance, and miscellaneous expenses which included the cost of barangay permit and other expenses. Sensitivity analyses were also performed to determine the sensitivity of this type of investment to other variables specifically by applying different levels of area coverage and service rates.

The financial viability indicators used were benefit-cost ratio (BCR and internal rate of return (IRR). The benefit cost ratio (BCR) is obtained when the current worth of the benefit is divided by the current worth of the cost (Gittinger 1982). When the BCR is less than 1, the costs of the project outweigh the benefits of a proposed project. BCR was computed using the equation below:

$$\frac{\sum_{t=n}^{t=1} \frac{B_t}{(1+i)^t}}{\sum_{t=n}^{t=1} \frac{C_t}{(1+i)^t}}$$

The internal rate of return is "rate of return on capital outstanding per period while it is invested in the project" (Merret and Skyes 1973). It is the rate of return in which the project is able to generate, computed as follows:

$$\sum_{t=1}^{t=n} \frac{B_t - C_t}{(1+i)^t} = 0$$

Where: B_t = benefit each year
C_t = cost in each year
t = 1, 2… n
n = number of years
I = interest discount rate

RESULTS AND DISCUSSION

Cost and returns analysis. The use of MROS can reduce the cost of production and increase income (Table 3). The decrease in the expenses can be attributed to the reduction in the quantity of seed requirements and labor. The seed requirement of using MROS is 2.74 kg/ha less than MBM. In a similar study, the use of mechanized planting reduced the quantity of seed requirements in comparison with MBM by 1.6 to 2 kg/ha (Austria et al. 2020).

For labor requirement, MBM needed 25 to 35 persons/ha in sowing seeds, furrowing and boxing compared to MROS wherein 1 to 2 persons were needed. Onion is a high labor intensive crop and around 50 % of total production cost can be attributed to labor cost in planting (Mahajan et al. 2017). The high labor requirement in MBM is one of the problems of the farmer-growers. The farmer-growers needed to outsource laborers to plant onion in neighboring municipalities/provinces. In Pangasinan, hired laborers from Nueva Ecija were necessary because of insufficient labor within the area. The lack of labor resulted in delayed planting and high labor cost due to transportation and meal expenses. In addition, the use of MROS eliminated the cost of labor in thinning. MBM dropped many seeds in a single place which required thinning and increased labor cost (Gorrepati et al. 2017).

The use of MROS showed equal distance of planting and consistent depth of planting. When using MBM, there is tendency for the laborer to uproot onion plant because of uneven distance. Hence, the potential yield of MROS is higher by 1.16 MT/ha. The marketable bulbs using MROS and MBM are 92.5 % and 90.7 % respectively. The total cost of producing onion in a hectare using MROS is PhP149, 717 while in MBM is PhP180, 234, difference of PhP30, 517.

Table 3. Costs and returns analysis on the use of MROS and MBM, Pangasinan, 2017.

Item	Planting Method		Difference	Percent
	MROS	MBM	A-B	Change
Materials (PhP)				
Seeds	27,599.10	46,560.40	(18,961.30)	-40.70
Fertilizer	25,780.00	25,780.00		
Pesticides	6,340.00	6,340.00		
Herbicides	2,720.00	2,720.00		
Packaging materials/red bag	10,260.00	9,792.00	468.00	4.8
Cost of labor (PhP)				
Land preparation	7,200.00	7,200.00		
Levelling	1,500.00	1,500.00		
Furrowing & boxing	1,200.00	2,400.00	(1,200.00)	-50
Planting/seeding	3,500.00	5,200.00	(1,700.00)	-32.7
Weeding	6,000.00	6,000.00		
Thinning		12,000.00	(12,000.00)	-100
Fertilizers & chemicals application	9,000.00	9,000.00		
Harvesting, cutting & sorting	25,650.00	24,480.00	1,170.00	4.8
Tying & hauling	10,260.00	9,792.00	468.00	4.8
Other expenses (PhP)				
Interest	3,750.00	3,750.00		
Irrigation	6,720.00	6,720.00		
Food		1000.00	(1,000.00)	-100
Depreciation cost	2,238.00		2,238.00	100

Item	Planting Method		Difference	Percent
	MROS	MBM	A-B	Change
Total cost/ha (TC) PhP	149,717.10	180,234.00	30,517.30	-16.9
Yield per ha (kg)	25,662.58	24,460.60	1,161.98	4.8
Price: Good @PhP23.00/kg	540,520.44	518,880.68	21,639.76	4.2
Bottleneck & pickles @PhP15/kg	31,825.47	28,508.58	3,316.89	11.6
Excess planting materials for thinning		7,500.00	(7,500.00)	-100
Gross income/ha (PhP)	572,345.91	554,889.26	17,456.65	3.1
Net Income/ha (PhP)	422,628.00	374,654.86	47,973.95	12.8
Cost/kg (PhP) (TC/PY)	5.84	7.21	1.37	-19
Net income (PhP)	16.49	15.32	1.18	7.7

Financial attractiveness of MROS to farmers. Using partial budget analysis, the effects of adopting MROS was measured particularly by the changes in the cost, its effect on yield and income. The use of MROS, provide an additional income of PhP47, 973.95 (Table 4). The increase in income emanated from reduction of expenses of around PhP30,517.30, increase in yield of around 1,161.98 kilograms valued at PhP24, 956.65 and sale of excess onion planting materials from thinning sold at PhP 7,500 Other benefits derived by the farmers in using MROS are: less time required to locate and schedule laborers to broadcast and thin out.

Table 4. Partial budget analysis of MROS and MBM of planting onion, Pangasinan, 2017.

Incremental Benefits (IB) PhP		Incremental Cost (IC) PhP	
Added benefits/ha	24,956. 65	Added cost/ha:	9,044.00
Good 28.83bags x 30kg/bag x PhP23.0/kg	21,639.76	Service fee for MROS/ha	3,500.00
Class B 6.79bags x 30kg/bag x PhP15.0/kg	3,316.89	Furrowing, 4WT	1,200.00
		Harvesting Fee, 35.62 bags x PhP32.84.00	1,170.00
		Tying & hauling, 1.78/bag x 36 bags	468.00
		Red bag, 38.73 bags x PhP12.00/bag	468.00
		Depreciation cost	2,238.00
Reduced cost/ha	39,561.30	Reduced benefits/ha	7,500.00
Boxing, 80 boxes x PhP30.00/box	2,400.00	5 sacks of excess planting material	7,500.00
Broadcasting, 80 boxes x PhP65.00/box	5,200.00	(5 sacks x P1,500.00/sack)	
Thinning	12,000.00		
Seeds, 10.95 cans x PhP1,850.00/can	18,961.30		
Other indirect expenses	1,000.00		
Subtotal	64,517.95	Subtotal	16,544.00
Net change in income (IB-IC=Δ in income)		47,973.95	

Financial analysis of MROS for custom servicing. Investing in MROS is financially viable with a BCR of 1.77 and an IRR of 48 %. A BCR of 1.77 indicates that there is a net return of 0.77 for every unit of peso invested. The IRR of 48% is higher than the existing hurdle rate which was pegged at 10% (Table 5). Sensitivity analysis showed the project must operate beyond 67% of the projected service area (40has) or equivalent to service area greater than 27 hectares per year to remain viable (Fig.2). The effect of rate of service fee on the financial viability is presented in Fig. 3. The result suggests that the minimum service fee that should be charged per hectare is PhP2, 500. Operating below this level would result to financial loss. Interestingly, this rate is reasonable since the rate of being charged using the traditional MBM to plant a hectare is PhP5, 200 which means that promotion of MROS will be easier because of the obvious incentive over the traditional method (Fig 3).

Table 5. Investment analysis of MROS, 2017.

Particular	**PhP/year**	**PhP/year**
Investment cost		147,000.00
MROS	140,000.00	
Operating capital	7,000.00	
Fixed costs		35,000.00
Depreciation	14,000.00	
Repair & maintenance	21,000.00	
Variable costs		59,200.00
Salaries and wages	44,000.00	
Miscellaneous costs	15,200.00	
Total operating costs		94,200.00
Area coverage per year		
Service area	40	
Service charge/ha (PhP/ha)	3,500.00	
Gross income		140,000.00
Net income		45,800.00
Benefit cost ratio		1.77
Internal rate of return		48%
Breakeven hectare/year		26.91
Breakeven service fee (PhP/ha)		2,355.00

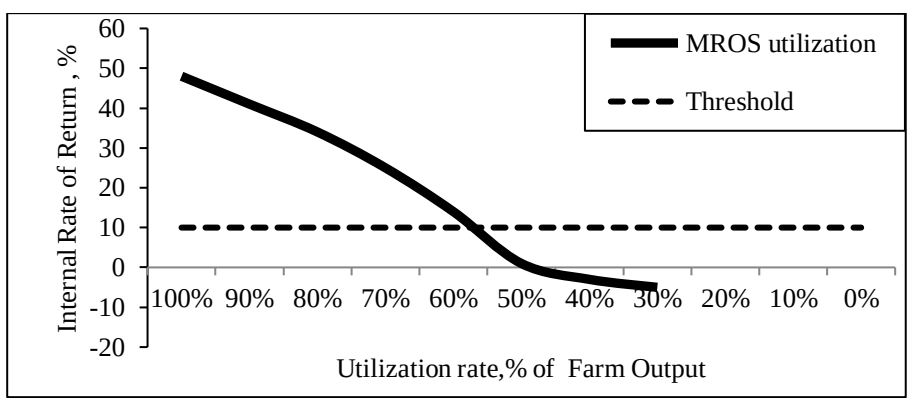

Fig. 2. Effect of utilization rate on IRR.

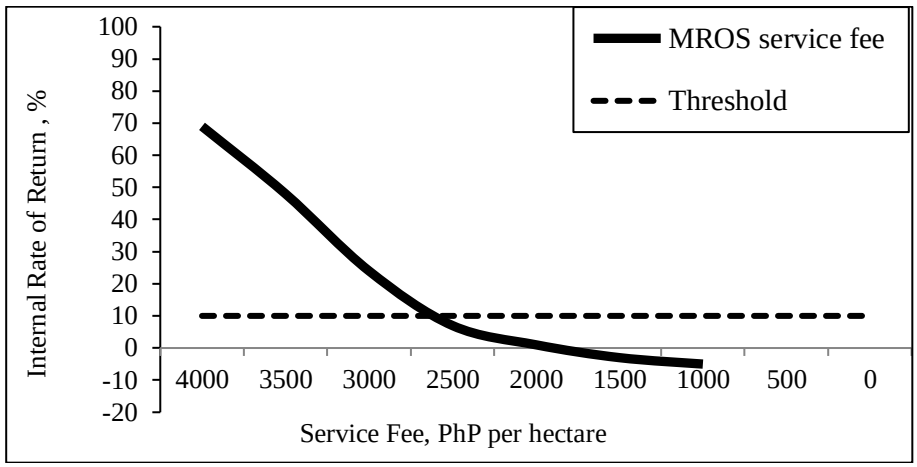

Fig. 3. Effect of service fee on IRR.

CONCLUSION AND RECOMMENDATIONS

This paper discussed the financial viability of MROS, a technology developed by PHilMech to address the inefficiencies of the current direct seeding method using the traditional MBM. The MROS was pilot tested in Pangasinan in 2017 where farmer cooperators operated the seeder for a year applying their production and cultural management techniques. The financial viability was assessed from two perspectives, that is: 1) from the point of view of farmer-user, and 2) from the point of view of a private investor operating as service provider. Using the data generated from the pilot testing and available data on technical performance, the financial viability was assessed using costs and returns analysis, partial budget analysis, and investment analysis. Farmers adopting the MROS over the traditional MBM would be better-off because of the advantages offered from reduced labor costs, reduced seed requirement and increase in average yield. From investor's point of view, investing in MROS is financially viable as indicated by an IRR of 48% and a BCR of 1.77. Based on the results of the sensitivity analyses, the minimum service coverage should not be less than 27 has and service rate of not lower than PhP2,500/ha. These conditions must be satisfied for the MROS operated as a service provider to remain viable. The information generated from this study can be valuable inputs for identifying specific onion producing areas where the potential benefits of this technology can be effectively maximized.

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