ECONOMIC VIABILITY OF DISEASES - FREE POTATO SEEDS DEVELOPED USING RAPID MULTIPLICATION TECHNIQUES

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ABSTRACT

This study aims at evaluating the viability of potato seed RMT from seed labs of Hanoi University of Agriculture and Dalat Seed Station, and to recommend measures to improve potato seed RMT in Vietnam. It was found that the cost per mini-tuber ranged from 350 to 700 VND. If the selling price is 500 VND per mini-tuber, RMT for producing potato mini-tubers has a high economic viability, especially at the Dalat lab. With improved procedures of micro-tuber and mini-tuber production, RMT can sustain potato seed production at a reasonable price. The private sector seems to produce mini-tubers more cheaply than the public one. Measures to reduce seed cost should aim at: 1) Re-designing the lab to save energy costs; 2) employing a contract based system and plastics instead of glassware to save labour and equipment costs; and 3) using newly dissolved chemical solutions and improving culture skills and lab sanitation to minimize virus infection.

Key Words: Economic Viability, Cost, Micro-tubers, Mini-tubers, Rapid Multiplication Techniques.

1. INTRODUCTION

Potato is considered as one of the important annual food crops in Vietnam after rice, maize and sweet potatoes. Potato areas fluctuated around 30,000 to 33,000 ha during 2000-2005 (General Statistical Office, 2006). However, potato production growth was slower than its potential. One of the main reasons for a slow development of potato production is seed degeneration after one or two years of multiplication. Seed cost occupied about 40-45% of total variable costs of potato production. Healthy seed potatoes are the basis for a viable sustainable potato production system in Vietnam. This is especially important if a national seed potato production system is established. The degeneration of seed potatoes along the seed flow in Vietnam is faster compared to potato production in temperate countries. Therefore, it is extremely essential to establish a seed potato production scheme with a minimum of multiplication stages under topical lowland conditions to minimize early infection with viral, fungal or bacterial diseases.

Currently, some main options for potato seed provision are being practised in Vietnam, namely farmers' own seeds, seeds imported from China, seeds imported from European countries (Potato Propagation with European seed - PPE), hybrid true potato seed method (TPS) and diseases - free seeds developed from tissue culture and rapid multiplication techniques (RMT). Due to high cost of seeds imported from European countries, one of the main strategies for provision of good seeds for farmers is to adopt RMT using European seed materials. The RMT involves tissue culture starting with single cells to become plantlets, through *in-vitro* micro propagation to micro - tuber production, mini-tuber production, pre-basic seed, and basic seed and then certified seed. Theoretically, the seed follows all these steps. In reality, the steps from mini -tubers to certified seeds may shorter to avoid degeneration processes. In Da Lat Potato Production Station, this seed flow is shorter, from mini-tubers, one may produce seeds, table potatoes or mix of seed and table potato. Ministry of Agriculture and Rural Development (MARD) is applying this strategy for seed multiplication.

Micro-tuber production, mini-tuber production as well as TPS-potato production procedures became important elements within the seed flow for the establishment of a potato seed production system. The production cost for seed potatoes of the formal seed sector like pre-basic planting material under protected environmental conditions for micro - and mini-tuber production as well as "basic" and "certified" seed potatoes are important for table potato production. The question is that can the potato seed technologies promoted by RMT be sustained to promote potato production? Can farmers obtain good quality potato seeds at a reasonable price through RMT? In answering this question, it is useful to identify and compare economic viability of the identified RMT produced by different seed producing stations.

The main objectives of this study are to evaluate a viability of the identified seed RMT from different seed production stations and to recommend measures to improve potato seed RMT in Vietnam.

2. METHODS

Site selection: At present, there are some public and private research institutions involved in RMT such as Hanoi University of Agriculture Seed station and Dalat Seed Stations. These two stations were selected as the study areas for identifying economic viability of production of micro-tubers and mini-tubers. The Hanoi University of Agriculture represents a public research institution while Dalat seed Production Station is considered as a private one.

Method of analysis: Economic viability of seed production using RMT is basically examined in terms of costs of micro-tubers and mini-tubers. Thus, if the research institution produces more cheaply these products, economic viability of that institution is more viable and its products would be widely adopted by farmers. Thus, in order to obtain information for calculating the cost of producing micro and mini-tubers from these two selected institutions, survey techniques including examining booking records and discussion with researchers working in these institutions were collected in 2003. Thus, all information presented in this paper are for the year 2003.

3. RESULTS AND DISCUSSION

Cost of a Plantlet and a Micro-tuber Produced at Hanoi University of Agriculture

a) Cost of a Plantlet and a Micro-tuber

Hanoi University of Agriculture (HUA) produces European variety micro-tubers by tissue culture starting with a single cell through *in-vitro* micro propagation to micro-tuber production and mini-tuber production. A calculation of cost of a plantlet and a micro-tuber was conducted in HUA in consultation with HUA's researchers. Some following assumptions were made in calculating the cost of a plantlet and micro-tuber at HUA:

- Seed material is the Marriella variety.
- Duration for producing a plantlet was 20 days.
- Duration for producing a micro-tuber was 80 days (2 months and 20 days).
- Fixed costs were incurred for both plantlet and micro-tuber production. Depreciation rates of labs were fixed . Assets are at normal rate. Share of fixed cost for plantlet production was 20% while that of micro-tuber was 80% of total fixed cost.
- Depreciation rate of culture containers was 0.83%.
- Price per liter of dissolved chemical solution for plantlets was 1,224.8 VND and 2,064.9 VND for micro-tuber production.
- One liter of dissolved chemical solution can serve for 30 culture containers. Each culture container cost 10 plants. Thus, plantlet output was 6000 plants. The loss ratio due to risks was 30% for both plantlets and micro - tubers.
- Each plant could bear 2 micro-tubers. The loss ratio was 30%.

With these assumptions, detailed information on the cost of a plantlet and a micro-tuber at Hanoi University of Agriculture's lab is presented in Table 1. The costs were 206 VND per plantlet and 505 VND per micro-tuber. The costs for both plantlet and micro-tuber was high due several reasons: i) design of the lab building, which needed electrical lighting all the time and limits the use of sunlight; ii) installation of some un-necessary, highly expensive equipment; iii) initial stages of *in-vitro* micro propagation; and iv) small amount of plantlets and micro-tubers produced.

Table 1. Cost of Plantlet and Micro-tuber Production in HUA Lab in 2003

	Explanation	Quantity	Unit price (000'VND)	Value (000' VND)		
				Total	Plantlet	Micro-tuber
1. Fixed Costs					**45.660**	**182.640**
Culture container sests	Depreciation rate of 0.83% x 600 containers	5	6.5	32.500	6.500	26.000
Tissue culture tools				1.500	0.300	1.200
In-vitro incubator	100,000 VND / (360 days) x (20 days + 80 days)			33.300	6.660	26.640
Clean Oven				6.000	1.200	4.800
Heater				15.000	3.000	12.000
Lamp systems	2 lamps/sys./ 200 cul. Containers	6	10	60.000	12.000	48.000
Building Depreciation				50.000	10.000	40.000
Air conditioners				30.000	6.000	24.000
2. Variable Costs					**818.496**	**2788.898**
Chemical solutions	1 liter for 30 cul. containers (10 plants/container)					
	600 cul. containers need 20 liters	20				
	Price per liter of dissolved chemical solution for plantlets		1.2248		24.496	
	Price per liter of dissolved chemical solution for micro-tubers		2.0649			41.298
Electricity						
- Lighting system	(3 lamps/ 200 containers x 40Wx16 hours/day x 600 containers)					
	(1.92 x 3 x 20 days)	115.2	1	115.200	115.200	
- Incubator (heaters)	3 heaters x 1.2 KW /100 cul. containers/hour x 600 containers	21.6	1	21.600		
	Electricity for micro-tuber about 150% of time of plantlets	32.4	1			32.400
-Gas for free virus treatment				210.000	**42.000**	**168.000**
Air conditioner	$24m^2$ x 1 KW x20 hours/day x 50 days	1000	1	1000.0	200.000	800.000
Labor Cost	80 working days x 30,000 VND/day	80	27.3	2184.00	436.800	1747.200
3. Total Costs (1+2)					**864.156**	**2971.538**
Outputs	Total outputs				6000.000	8400.000
	Loss ratio due to risks: 30%				1800.000	2520.000
4. Net Output	Net Outputs				4200.000	5880.000
5. Cost per unit (3/4)					**0.206**	**0.505**

b) The Cost of a Mini-tuber

An examination of bookkeeping found that the cost of mini-tuber production in greenhouses of HUA was 700.0 VND per tuber. The cost can be categorized into fixed costs and operating costs (Table 2).

Table 2. Cost per Mini-tuber in 2003

	Cost	
	VN Dong	%
Fixed Cost	70	10
- Variable Cost	630	90
- Electricity	350	50
- Dissolved Chemical solutions	35	5
- Labour	245	35
Total	700	100

Sources: Lab Survey in Hanoi University of Agriculture

Cost of a Mini-tuber Produced at the Da Lat Potato Production Station

Due to more favourable weather conditions, the Da Lat Potato Production Station reached a shorter way of producing potato seed. The seed flows in Da Lat Station can be summarized as follows: 1) Single cell per plant, 2) *in-vitro* micro to produce tuber lets in laboratory, 3) cuttings in the greenhouse; 4) seedlings in sand, and 5) from seedlings, nursed seedlings, mini-tubers or tuber - lets in the greenhouse, seed or table potatoes are produced. This procedure of seed production enables growers to produce seeds cheaper than those in Hanoi University of Agriculture's lab.

a) Costs per unit are as follows:

- Nursed seedling: 130 VND/nursed seedling
- Mini-tuber 200-300 VND/mini-tuber
- Top seedlings 50 VND/tuber

b) Average cost of a mini-tuber:

- Equipment	100 VND
- Labour	200-250 VND
- Operating Costs	50 VND
Total	350-400 VND
Selling price	500 VND
Profit	100-150 VND

Thus, a mini-tuber costs from 350 to 700 VND. If the selling price is 500 VND per mini-tuber, Dalat Station still gains profit while Hanoi University of Agriculture's lab loses about 200 VND. The cost of a mini-tuber produced at HUA was higher than those in the Da Lat station due to: 1) high cost of electricity due to use of lighting systems, incubators and air conditioners all the time; 2) high cost of labour and equipment (glassware), and 3) more output lost by virus infection compared with those in Dalat. Thus, possibilities for the HUA lab to profit from producing mini-tubers should aim to resolve the aforementioned issues.

Possibility to Reduce the Cost of Plantlets and Mini-tubers

Producing mini-tubers at the HUA seed lab was more expensive than at the Da Lat station. Through discussion with researchers, some recommendations to reduce the cost of a plantlet and mini-tuber are presented in Table 3.

Table 3. Constraints and Recommendations to Reduce Cost of Micro - tubers

Reason for high cost per plantlet and micro-tuber	Recommendations
High cost of electricity due to use of lighting systems all the time, incubators and air conditioners	Re-design the lab. to maximize use of sunlight (8 hours/ day). Use power-saving light systems (18W instead of 40W). Using air conditioners only during nighttime. Expose plantlets to sunlight
High cost of labour	Work assignment based on a contract
High cost of equipment (glassware)	Use appropriate plastics for plants and tubers
High loss by virus infection	Use new dissolved chemical solution. Improve culture skills and lab sanitation

4. CONCLUSIONS

Micro-tuber production and mini-tuber production procedures became an important element within the seed flow for the establishment of potato seed production systems. The production cost for seed potatoes from tissue culture to micro - and mini-tuber production as well as “basic” and “certified” seed potatoes are important for table potato production. RMT for producing potato mini-tubers has a high economic viability, especially those in the Dalat lab. With improved procedures of micro-tuber and mini-tuber production, RMT can sustain potato seed production at a reasonable price. The private sector seems to produce mini-tubers more cheaply than the public one.

Measures aimed at reducing the cost of mini-tuber production should include the followings: 1) Redesigning the lab to maximize use of sunlight (8 hours/ day) and to use power - saving light systems (5-18W instead of 40W), operating air conditioners only during nighttime and exposing plantlets to sunlight to save energy costs; 2) Employing a contract - based system to reduce labour costs; 3) Use appropriate plastics instead of glassware for plants and tubers to save equipment costs; 4) Using newly dissolved chemical solutions and improving culture skills and lab sanitation to reduce loss causes by virus infection.

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