HORTIN II Co Innovation Programme

Towards cost effective, high quality value chains

Improvement of shallot supply chains; Summarized research results of 2007 - 2010

HORTIN-II Research Report nr. 20

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The purpose of the HORTIN-II programme is to contribute to the development of cost effective high quality value chains for vegetables and fruits. Among others this can be achieved when technology development takes place in close collaboration between public institutions, farmers and private companies.

On the Indonesian side the programme is carried out by the Indonesian Centre for Horticultural Research and Development (ICHORD), Jakarta, with the Indonesian Vegetable Research Institute (IVEGRI), Lembang, and the Indonesian Centre for Agricultural Postharvest Research and Development (ICAPRD) in Bogor.

In the Netherlands the Agricultural Economics Research Institute (AEI), Den Haag, the Agrotechnology and Food Sciences Group (ASFG), Wageningen, Applied Plant Research (APR), Lelystad, and WUR-Greenhouse Horticulture (WUR-GH), Bleiswijk, all partners in Wageningen University and Research centre, are involved in the programme.

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Executive summary

In the period 2007 -2009 research has been done on different aspects of growing True Seed Shallots (TSS). Research was done in Brebes, one of the main shallot growing areas in Indonesia. In 2010 the project was continued by performing demo fields at farms on six locations, two fields in Brebes, three fields in Nganjuk and one in Yogjakarta.
The aim of the project was to improve shallot supply chains in Indonesia. Until now shallot production in Indonesia is based on crops grown from seed bulbs. Most farmers are planting their own seed bulbs which are taken from their own harvested bulbs of the previous shallot crop. It is estimated that only about 5% of the planted seed bulbs are bought. One of the problems of the shallot production is the poor quality of the seed bulbs. There is no system in Indonesia in which the seed bulbs are controlled on quality. With the seed bulbs diseases are easily transmitted.
With True Seed Shallots transmission of diseases can be avoided. There is a clear difference in growing techniques between TSS and shallots grown from seed bulbs. The aim of the project was to improve the growing techniques of TSS and to introduce these techniques on the farms. The project was focused especially on improving the nursery- and transplanting techniques.

Every year a research report was made. In this report the most important results are summarized. Also the results of the economic calculations and the most important conclusions are presented.

1 Introduction

In the period 2007 -2009 research has been done on different aspects of growing True Seed Shallots (TSS). Research was done in Brebes, one of the main shallot growing areas in Indonesia. In 2010 the project was continued by performing demo fields at farms on six locations, two fields in Brebes, three fields in Nganjuk and one in Yogjakarta. The aim of the project was to improve shallot supply chains in Indonesia. Until now shallot production in Indonesia is based on crops grown from seed bulbs. Most farmers are planting their own seed bulbs which are taken from their own harvested bulbs of the previous shallot crop. It is estimated that only about 5% of the planted seed bulbs are bought. One of the problems of the shallot production is the poor quality of the seed bulbs. There is no system in Indonesia in which the seed bulbs are controlled on quality. With the seed bulbs diseases are easily transmitted. With True Seed Shallots transmission of diseases can be avoided. In Indonesia breeding work is done to develop TSS-varieties. Especially East West Seeds Indonesia is introducing TSS varieties on the Indonesian market. There is a clear difference in growing techniques between TSS and shallots grown from seed bulbs. The aim of the project was to improve the growing techniques of TSS and to introduce these techniques on the farms. The project was focused especially on improving the nursery- and transplanting techniques.

The available TSS-varieties are adapted to the dry season in Indonesia. Normally dry season is starting in April and it is finished about the end of October. Research was done in the dry season. In 2007 research activities were started in the second half of July. Activities could not be started earlier, because commitment of the financing authorities was given in June. In 2007 some aspects were investigated, but the results were not as good as in 2008 and 2009. The main reason for the disappointing results in 2007 was the very severe attack by Spodoptera. TSS-seedlings were planted in the field at a moment that most other shallot crops in the neighbourhood of the experiments were harvested. Spodoptera was migrating on a large scale from the harvested crops to the young seedlings. In 2008 and 2009 it was possible to start research at the beginning of the dry season. So results obtained in these years are more useful than the results of 2007.

In this final report the results obtained in 2007 – 2010 are summarized. The research methods and the results are described more in detail in the Hortin II Research Reports 3, 4, 14 and 19.

Picture 1. Field with True Seed Shallots on farm in Brebes.

2 Research topics

Research was focused on two points: improving of nursery-techniques and improving of transplanting techniques. In the project TSS production is compared with production of seed bulb crops.

2.1 Research on nursery techniques

The aim of the research on nursery techniques was to find the most cost efficient method of producing seedlings. Research topics were:

- Nursery on a seedbed in the field, in trays (without or with compartments) or on press pots
- Nursery mixtures and preparation methods of seedbeds in the field
- Production of individual seedlings or clusters of seedlings on soil modules
- Protection with a shelter after sowing
- Sowing depth
- Closing the furrow after sowing with different soils/nursery mixtures
- Age of seedlings at moment of transplanting
- Control of pests and diseases
- Fertilization of the nursery
- Frequency of watering
- Seed treatments

2.2 Research on transplanting techniques and productivity of TSS

The aim of the research on transplanting techniques was to find the most cost efficient method of transplanting TSS seedlings. Production of the transplanted seedlings was compared with traditional seed bulb crops. Research topics were:

- Plant density
- Planting of individual seedlings or planting of clusters of seedlings on soil modules
- Fertilization (effect on production and quality)
- Moment of sowing and transplanting
- Direct sowing

Picture 2. Experiment with True Seed Shallots in Brebes.

3 Results

The results are summarized separately for the nurseries and for the transplanted fields.

3.3 Research on nursery techniques

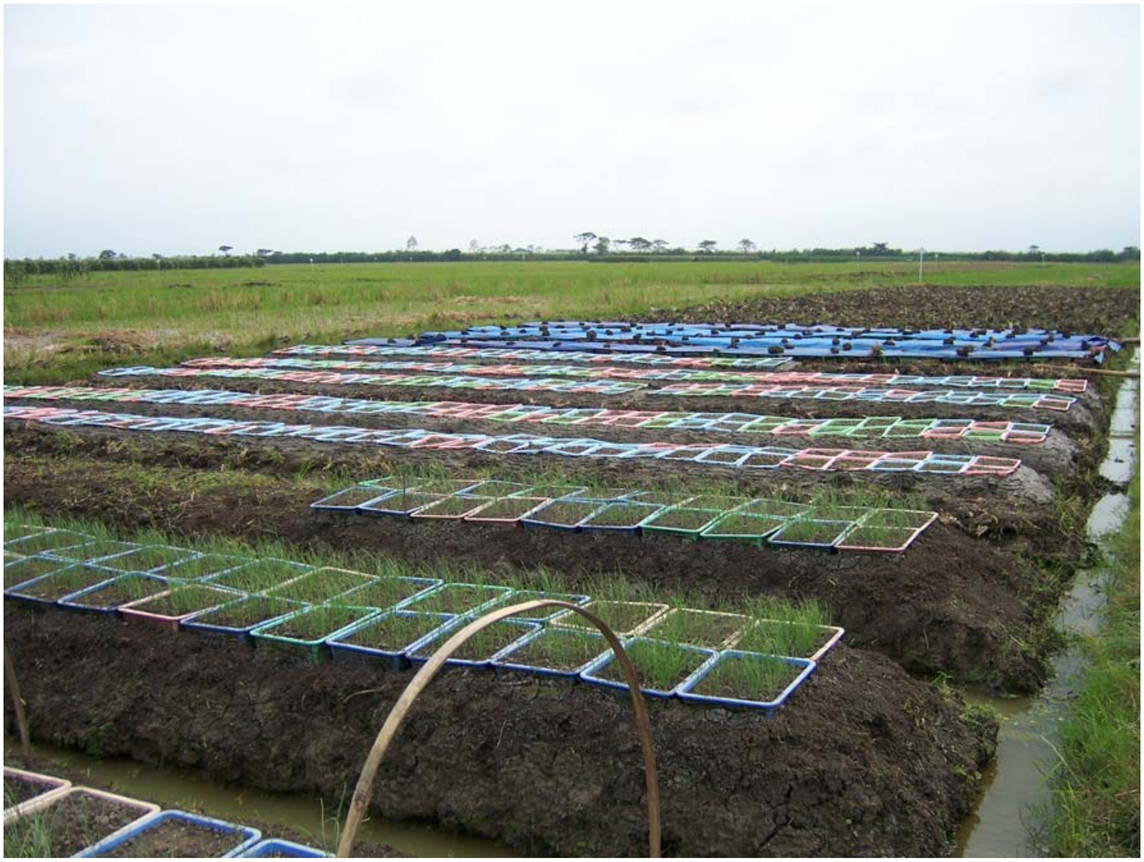
Nursery in the field or in trays; nursery mixtures

At the start of the dry season soil conditions in Brebes are very poor. During the wet season paddy is grown and at the beginning of the dry season the heavy clay soil is very wet and very hard to handle. During April the first beds are prepaired by digging the ditches. It takes at least one month of preparation of the soil before a seed bed can be made. Sometimes it is possible to improve the soil conditions by adding compost or stable manure. In general it appeared that compost was not available; the availability of stable manure was a little bit better, but the price is very high (in this project a price of 600 IDR per kg is used). The soil conditions are better if the seedbed is prepaired on other beds than those prepaired after paddy. In other regions and on some no-paddy fields in Brebes the soil conditions could be better.

Picture 3. Soil conditions at the start of the dry season.

Plastic trays without compartments, in which TSS seed can be sown in rows, are available, but the price is rather high. The number of trays needed for example for a transplanted field of 1120 m^2 (=1600 m^2 with 30% ditches) with a planting density of 100 seedlings/m^2 is high: if trays are used of 0,1 m^2 (28 cm x 36 cm) and 200 seedlings could be harvested per tray, 560 trays are needed. This is a high investment (in this project a price of 10.500 IDR per tray is used). The trays can be used more than one time, but still the costs are probably too high for the farmers. Sometimes farmers can make their own trays with local material.

In 2007 research was done on the production of seedlings in plastic bags or in trays with small compartments. It was also tried to produce press pots, but this was not successful because of lack of compost. The idea was to produce clusters of seedlings on soil modules. The advantages of such clusters could be: better survival of seedlings and less labour needed for transplanting. It appeared however that sowing by hand in plastic bags or in small compartments in trays was not as easy as sowing in rows in trays or on a seedbed. The emergence in plastic bags and compartments in trays was low. Moreover the transport of clusters of seedlings with soil modules through the ditches filled with water was more difficult than the transport of single seedlings. Another point is that survival of individual seedlings after transplanting is fairly good. Using clusters of seedlings on soil modules did not give an improvement.



Picture 4. Nursery with TSS sown in trays.

Seed emergency in trays was in general better than on a seedbed. However also in trays sometimes seed emergency was very low. In trays it ranged from 13% to 82%. On seedbeds in the field it ranged from 7% to 50%. Both on seedbed and in trays it is needed to do the sowing and watering in a very careful way. Sowing should be done at the right depth of ca. 1 cm and watering should be done in such a way that seedlings are not destroyed by heavy drops and the seedbed should not become too wet or too dry. However soil and weather conditions have a big influence. In general soil conditions on seedbed were poorer than in trays which were filled with a good nursery mixture. It appeared that nursery mixtures containing 1/3 or ½ (volume) compost or stable manure were giving the best results. Paddy field soil is too heavy to be used in high quantities in the nursery mixture. Nursery mixtures should contain sandy soils.
Results are showing that also on seed beds it is possible to have about 50% seed emergence, even with no extra organic material added to the soil. It seems that seed beds were giving a better result if the sowing was done at a later moment in the dry season. Earlier in the dry season soil conditions were poorer.

In Table 1 an overview is given of the percentages emergence obtained in the different nurseries sown in 2007-2009.

Table 1. Percentage emerged plants of Tuktuk on seedbed in the field and in trays (without compartments)

	preparation of seed beds/ nursery mixture	sowing date	seed density	% emergence
Seedbed in the field (seed sown in rows at 0,5 cm depth)				
2007	3 kg compost added per m^2	24-jul	2500 seeds/m^2	22
	ca. 2 kg compost added per m^2	24-jul	250 seeds/m^2	45
2008	no org. material added/ no cover	15-jun	320 seeds/m^2	50
	no org. material added/straw cover	25-jun	320 seeds/m^2	44
	local soil mixed with burned rice husks	23-apr	2700 seeds/m^2	21
	local soil mixed with burned rice husks	30-apr	1350 seed/m^2	33
2009	7,5 kg stable manure added per m2	11-mrt	2500 seeds/m^2	35
	7,5 kg stable manure added per m2	25-mrt	2500 seeds/m^2	7
	27,5 liter of mixture homegarden soil, sand and stable manure (1:1:1)/m^2	29-apr	530 seeds/m^2	27
	27,5 liter of mixture homegarden soil, sand and stable manure (1:1:1)/m^2	15-jul	530 seeds/m^2	17
Trays (seed sown in rows at 0,5 cm depth)				
2007	local soil: compost in 1:3 (vol)	24-jul	3309 seeds/m^2	63
2008	local soil: sandy soil: stable manure in 1:1:1	15-apr	3550 seeds/m^2	47
	Andisol soil : stable manure in 1:1	15-apr	3550 seeds/m^2	52
	home garden soil : sandy soil : stable manure in 1:1:1	15-apr	3550 seeds/m^2	31
	local soil : sandy soil : burned rice husks in 1:1:1	15-apr	3550 seeds/m^2	17
	home garden soil : sandy soil : burned rice husks in 1 : 1 : 1	15-apr	3550 seeds/m^2	16
	local soil : sandy soil in 1 : 1	15-apr	3550 seeds/m^2	13
	home garden soil : sandy soil in 1 : 1	15-apr	3550 seeds/m^2	13
	local soil (paddy field)	15-apr	3550 seeds/m^2	22
	Home garden soil	15-apr	3550 seeds/m^2	27
	sandy soil	15-apr	3550 seeds/m^2	13
	sandy soil: compost in 1:1	15-apr	3290 seeds/m^2	51
	sandy soil: compost in 1:1	15-apr	3290 seeds/m^2	60
	finesoil :burned rice husks : fine compost in 2:1:2	23-apr	3290 seeds/m^2	82
	sandy soil: compost in 1:1	29-jun	3290 seeds/m^2	50
2009	homegarden soil : sandy soil : stable manure in 1:1:1	11-mrt	2880 seed/m^2	48
	homegarden soil : sandy soil : stable manure in 1:1:1	11-mrt	2880 seed/m^2	33
	homegarden soil : sandy soil : stable manure in 1:1:1	15-apr	2880 seed/m^2	56
	homegarden soil : sandy soil : stable manure in 1:1:1	24-apr	2880 seed/m^2	21
	homegarden soil : sandy soil : stable manure in 1:1:1	29-apr	1440 seeds/m^2	33
	homegarden soil : sandy soil : stable manure in 1:1:1	29-apr	1440 seeds/m^2	25
	homegarden soil : sandy soil : stable manure in 1:1:1	15-jul	1440 seeds/m^2	20

In 2010 nurseries were sown on 6 locations. In the second sowing in rows seed emergence was 62% on one location (Kapandi) and 42% on another location (Yus). The first sowing was giving disappointing results (8 à 9%) on these locations, because of damage by rain and diseases. In Nganjuk farmers obtained also good results with broadcasting: in four nurseries seed emergences ranged from 41 – 53% and in one nursery seed emergence was 14%. One farmer in Brebes, Mr. Yus, had good experiences with soaked seed. The seed was put in water the day before sowing from 6.00 until 18.00 h. During the night the seed was dried and the seed was sown the next day. Soaked seed was giving a better emergence than non-soaked seed.

Protection with shelter or plastic sheet after sowing

After sowing the nurseries were covered with a heavy plastic sheet. The sheet was preventing the soil from loss of water during dry weather and it was protecting the seedbed from disturbance by heavy rain. It is important to remove the sheet in time and to start watering soon enough to avoid loss of seedlings because of water shortage. If the sheet is removed too late seedlings will be damaged by high temperatures.

After emergence the nurseries were protected with a shelter build with bamboe and insect nets. This is giving a protection against heavy rain and against sunlight. This protection is only needed if heavy rains are falling. It is hard to predict if heavy rains are occurring.

Control of pests and diseases

Before sowing 5 grams carbufuran per m^2 was applied in the nurseries. Sometimes it was needed to protect the seedlings against mole cricket. This was done by using a mixture of rice siftings + Dursban (5 kg rice sifting + 100 cc Dursban). This was spread on the borders of the nursery.

Sometimes it was needed to spray against Spodoptera, especially in nurseries later on in the dry season. Sometimes it was needed to spray against diseases, especially if the nursery was done at the end of the dry season, beginning of the wet season.

Picture 5. Nursery on seedbed in the field with shelter.

Fertilization of nursery

Before sowing fertilization was done by applying 50 grams KCl and 50 grams SP 36/m2. It was not known if this was needed. Probably it is not needed if the nursery mixture is containing 1/3 stable manure. In 2009 an experiment was done with different levels of nitrogen fertilization in the nursery, 0 kg N/ha and 75 kg N/ha. In Table 2 the results are presented. There were no clear visible differences in seedling performance. No difference in growth and production was found between seedling with or without nitrogen fertilization. Probably it is not needed to give nitrogen in the nursery. Only if it is visible that seedlings are suffering from nitrogen shortage it is needed to add a small amount of nitrogen.

Table 2. Experiment age of seedlings and fertilization of nursery 2009; transplanted 24 June.Survival and yield.

	% survival		Yield with leaves (ton/1600 m^2**)		Shallots without leaves (ton/1600 m^2**)	
	9 July	15-aug	5 days after harvest	20 days after harvest	5 days after harvest	20 days after harvest
6 weeks old seedling with 0 kg N	74.0	64.4	1.77	1.60	1.48	1.53
6 weeks old seedlings with 75 kg N/ha	81.0	67.9	1.96	1.73	1.63	1.60
5 weeks old seedling with 0 kg N	67.6	56.9	1.79	1.62	1.49	1.56
5 weeks old seedlings with 75 kg N/ha	74.1	63.4	1.99	1.70	1.66	1.60
Fprob	0.21	0.38	0.445	0.798	0.522	0.947
LSD 5%	13.28	14.38	0.388	0.35344	0.36304	0.33104

**: with ditches (net area 1120 $m^{2)}$

Seed preparation

In 2008 pellets of seeds were made in order to make sowing easier. Emergence of pelleted seed was rather poor. Farmers in Brebes have experiences with mixing seed with rice flour. With this seed sowing can be done easier, because the seed is better visible. Sowing is done by women and they are doing it very quickly. So the use of pellets of seeds did not give an advantage. Also the costs of making pellets were too high.

Seed treatments

In 2008 and 2009 seed was treated with insecticides and fungicides. Treating the seed with Ridomil was damaging the seed in 2009 which became visible in a low seed emergence. In one nursery there was a tendency that loss of seedlings was reduced by Ridomil. Treating the seed with Tracer was not giving an improvement of seed efficiency.

Sowing depth and closing the furrow

In 2009 some experiments were done on depth of sowing. It appeared that sowing at a depth of 1 – 1,5 cm was giving a better result than sowing at 0,5 cm. The best emergence was obtained by sowing at 1 cm and closing the furrow with soil. Closing the furrow with soil was better than closing the furrow with ash or burned rice husks. This was probably because seedlings emerging in burned rice husks were more suffering from drought than seedlings emerging in soil. In one of the nurseries of 2009 it was clearly visible that seedlings could be lost because of water shortage if the seed was not covered enough with soil.

Picture 6. Nursery experiment with different sowing depths.

In tables 3 and 4 results on sowing depth and closing the furrow with soil or burned rice husks are summarized.

Table 3. Experiments in trays.Effect of sowing depth and closing the furrow with burned rice husks or soil on percentage seed emergence

	% seed emergence in Experiment 1A in 2009		% seed emergence in Experiment 1B in 2009		% seed emergence in Experiment 2 in 2009	
depth of sowing / furrow closed with:	burned r.h. (ash)	soil	burned r.h. (ash)	soil	burned r.h. (ash)	soil
0,25 cm	23	44	-	-	-	-
0,5 cm	33	67	25	55	-	10
1,0 cm	41	75	41	61	-	25
1,5 cm	44	81	-	-	-	48
LSD 5% (within column)	14.2	14.2	11.2	11.2		12.8
LSD 5% (across columns)	15.2		11.2			

Not included in experiment: -

Table 4. Experiments on seedbeds. Effect of sowing depth and closing the furrow with burned rice husks or soil on percentage seed emergence

	% seed emergence in Experiment 1A in 2009		% seed emergence in Experiment 2 in 2009	
depth of sowing / furrow closed with:	burned r.h. (ash)	soil	burned r.h. (ash)	soil
0,25 cm	25	31	-	-
0,5 cm	27	33	-	19
1,0 cm	24	35	-	23
1,5 cm	28	43	-	25
LSD 5% (within column)	17.7	17.7		6.0
LSD 5% (across columns)	18.9			

Not included in experiment: -

Effect of watering

In 2009 an experiment was done with different levels of water supply. It appears that it is needed to do the watering frequently, at least two or three times a day. Experienced people are needed to do the watering carefully and to avoid that seedling are suffering from water shortage. It is not possible to give strict rules for this. It is important to control the nursery two or three times a day and to do the watering in a careful way, not with a basket which is normally used in the field but with a bruze which is giving the water in small drops which are not falling heavily on the seedlings.

In table 5 results of experiments with differences in water supply are summarized.

Table 5. Emergence on trays and in beds 4 week after sowing; seed efficiency experiment 2, sown 15 July 2009

	Trays		On beds	
	Without extra water	With extra water	Without extra water	With extra water
Normal 0,5 cm moving soil into furrow	10	20	19	17
Normal 1.0 cm moving soil into furrow	28	35	24	25
Normal 1.0 cm sieved soil in furrow	21	25	22	27
Normal 1,5 cm moving soil into furrow	48	55	25	26
Normal 1.5 cm sieved soil in furrow	47	57	22	25
Fprob	<0.001	<0.001	0.158	0.195
LSD 5%	12.8	13.4	6.0	9.9

Age of seedling at moment of transplanting

Seedlings could be transplanted five or six weeks after sowing. In 2009 an experiment was done with 5 and 6 weeks old seedlings (see table 2). The difference in production was not significant. In the low land with high temperatures transplanting can be done five weeks after sowing. In the high land with lower temperatures it is possible that transplanting of six weeks old seedlings is better.

3.4 Research on transplanting techniques and productivity of TSS

Survival of seedlings

In all three years seedlings were transplanted. In general, survival of seedlings after transplanting, determined 12 days after sowing, was fairly good: 95- 96% in 2007 if individual seedlings were planted one seedling per hole; if individual seedlings were planted 3 or 4 per hole survival was a little bit lower: 90-92% measured 12 days after transplanting. Later on in 2007, many plants died mainly because of the severe attack by Spodoptera and because of dry and hot weather conditions. Also in 2008 survival of seedlings was good: 94 – 98% if individual seedlings were transplanted one seedling per hole; if individual seedlings were planted 3 or 4 per hole survival was a little bit lower: 92-94% measured 18 days after transplanting in experiment 1. In experiment 2 this was 94-97% and 90-94%. In 2009 the survival in the early transplanting experiment was good in some experiments: 93-99% in second transplanting of early sowing experiment, 81-91% in fertilization experiment and 88-92 for Hybrid seedlings in plant density experiment. In other experiments survival was lower: 76 – 82% in first transplanting of the early sowing experiment , 76 – 80% for Tuktuk seedlings in plant density experiment and 81 – 91% in nitrogen fertilization experiment, 57-81% in the experiment “age of seedlings and fertilization of nursery”. In general it can be concluded that survival of transplanted individual seedlings without soil modules is most of the time rather good.

In 2007 and 2008 clusters of seedlings on soil modules were transplanted. Survival of seedlings was almost 100%. After transplanting seedlings did not wilt. Disturbance of growth did not occur. This in contrast with

Picture 7. Transplanting TSS; wilting of individual seedlings without soil modules and no wilting of clusters of seedlings on soil modules.

transplanted individual seedlings. Seedlings on soil modules were giving an earlier maturing crop in 2008: 6 – 7 days earlier. Transplanting clusters of seedlings on soil modules in stead of transplanting individual seedlings without soil modules appeared to be not interesting because of the good survival of individual seedlings without soil modules and because of the disadvantages of sowing seed in plastic bags and transport problems with clusters of seedlings on soil modules from the nursery to the production fields.

Age and size of seedlings at transplanting moment

In 2007 research was started with transplanting six weeks old seedlings. The mean number of leafs was 4,0, the length of the seedlings 33,6 cm, the diameter 4,6 mm and the fresh weight: 2,8 gram (mean of 52 representative seedlings of Tuktuk). For transplanting experiment 1 in 2008 much smaller seedlings were used: mean number of leafs was 3,0, the length of the seedlings 16,5 cm. Survival after transplanting was very good (94-98%). The seedling were small because of the poor growing conditions in the nursery. The nursery mixture was rather stiff. Production after transplanting was good. In 2009 an experiment was done to compare the production results with 5 weeks old seedlings and 6 weeks old seedlings . The differences were small. There was a tendency that 5 weeks old seedling were weaker (% survival ca. 7% lower) than 6 weeks old seedlings. There was no difference in yield. In this experiment also the effect of giving nitrogen in the nursery was tested. There was a tendency that seedlings which had got 75 kg N/ha nitrogen were stronger (% survival ca. 7% higher).There was no difference in yield.

In 2008 5 and 6 –weeks old were compared in yield. 5 weeks old seedlings gave 3,6% higher yield. The difference was not significant.

Picture 8. Transplanting seedlings of TSS.

Productivity of TSS in relation to traditional varieties grown from seed bulbs; effect of moment of transplanting

The yield obtained from transplanted Tuktuk seedlings in 2007 was very low, lower than the yield of the seed bulb crops of Bima curut and Ilokos. The main reasons for the low yields in 2007 are the severe attack by Spodoptera and water shortage.

In 2008 the experiment transplanted at the end of May was giving a very high yield. The yield of Tuktuk grown at 150 plants per m^2 was twice as high as the mean yield of the varieties grown from seed bulbs. The yield of Sanren grown at 150 plants/m^2 was even 17% higher the yield of Tuktuk grown at 150 plants/m^2. The yield of the

second experiment of 2008 was relatively low. This should probably be ascribed to damage by Spodoptera and heavy rain and may be there was some shortage of nitrogen.
In 2009 the yield was not high. This was a general trend in 2009. Also in practice the yields of traditional shallot seed bulb crops was low. TSS was giving a higher yield than the traditional seed bulb varieties, up to more than twice as high (Sanren in N-fertilization experiment grown at 180, 240 or 300 kg N/ha). The production of traditional bulb seed varieties and also the production of TSS was relatively low if transplanting was done early in the dry season. The yield of TSS was even more disappointing than the yield of traditional seed bulb varieties if transplanting was done very early in the dry season. In April the soil conditions were less favourable than later on in the dry season. Probably TSS is more reacting on less favourable soil conditions than tradition seed bulb varieties.

Table 6 is presenting an overview of yield data obtained in the experiments done in 2007, 2008 and 2009.

Table 6. Yield, weight of shallots with leaves 3- 5 days after harvest in ton/1600m^2 bruto field(1120 m^2 nett)

	Brebes 2007		Brebes 2008		Purwakarta 2008		2009			
	exp. 1	exp. 2	exp. 1	exp2	clay soil**	sandy soil***	early sowing exp.		plant density exp.	nitrogen fertilization exp.(180kgN/ha)
date of transpl.:	6-sep	26-sep	29-mei	8-aug	4-jun	4-jun	13-apr	29-apr	20-mei	27-mei
TSS Tuktuk										
Tuktuk 75 pl/m2									1.50	
Tuktuk 100 pl/m2	0.84	0.48	4.94	1.20	1.29	1.37				
Tuktuk 100 pl/m2 (5w*)					2.86	1.88				
Tuktuk 125 pl/m2									2.21	
Tuktuk 150 pl/m2			5.79	2.27	0.39	1.18	0.66	1.21		2.92
Tuktuk 150 pl/m2 (5w*)			6.00							
Tuktuk 160 pl/m2	1.27	1.37								
Tuktuk 175 pl/m2									3.10	
Tuktuk 225 pl/m2									3.18	
TSS Sanren										
Sanren 75 pl/m2									2.89	
Sanren 100 pl/m2			6.35	2.22	3.16	4.45				
Sanren 125 pl/m2									3.25	
Sanren 150 pl/m2			6.80		4.42	4.79	1.61	2.04		4.12
Sanren 150 pl/m2 (5w*)					3.14	2.86				
Sanren 175 pl/m2									3.67	
Sanren 225 pl/m2									3.67	
Seed bulb crops 33,3 b/m2										
Bima curut (store)	1.35	1.65	2.29		1.65	1.60	1.23	1.36	2.18	2.28
Ilokos (imported)	1.68	1.75							2.28	1.89
Tanduyung (imported)			3.71		2.54	2.32				
Bima curut (farmer)			2.74	1.57	2.21	2.55				
LSD 5%	0.22	0.33	0.74	0.41	1.55	1.37			0.58	

* 5 weeks old seellings in stead of 6 weeks old seedlings
**: Tuktuk 100 pl/m2: 28% survival of seedlings;Tuktuk 150 pl/m2: 27% survival of seedlings
***: Tuktuk 100 pl/m2: 54% survival of seedlings; Tuktuk 150 pl/m2: 31% survival of seedlings

Grading of TSS in relation to traditional varieties grown from seed bulbs

In all experiments it was clear that bulb size of Tuktuk was much lager than the bulb size of traditional seed bulb varieties. The bulb size of the new hybrid, Sanren, was in between. For the local market small bulbs are more preferred than big bulbs. Tuktuk is mainly produced for the export market. Table 7 is illustrating the differences in bulb size.

Table 7. Grading (weight%) in experiments in 2007, 2008 and 2009

	Grading (weight%)			
	5-15 mm	15-25 mm	25-35 mm	>35 mm
2007 experiment 1				
Tuktuk 100 plants/m2	0	41	53	6
Tuktuk 160 plants/m2	0	40	56	4
Bima curut (store) 33,3 plants/m2	13	87	1	0
Ilokos (imported) 33,3 plants/m2	10	90	0	0
LSD 5%	2.9	17.8	11.0	5.9
2008 experiment 1				
Tuktuk 100 plants/m2	0	1	17	82
Tuktuk 150 plants/m2	0	1	16	83
Sanren 100 plants/m2	0	11	67	23
Sanren 150 plants/m2	0	17	70	13
Bima curut (store) 33,3 plants/m2	3	33	56	8
Tanduyung (imported) 33,3 plants/m2	8	72	20	0
Bima curut (farmer) 33,3 plants/m2	1	24	58	17
LSD 5%	1.2	7.4	12.0	14.3
2009 plant density experiment				
Tuktuk 175 plants/m2	0	5	34	61
Sanren 175 plants/m2	0	28	70	2
Bima curut (store) 33,3 plants/m2	4	47	48	2
Ilokos (imported) 33,3 plants/m2	3	49	45	2
LSD 5%	0.6	8.1	12.5	8.5
2009 N-fertilization experiment*				
Tuktuk 150 plants/m2	0	2	41	57
Sanren 150 plants/m2	0	24	71	5
Bima curut (store) 33,3 plants/m2	4	47	48	2
Ilokos (imported) 33,3 plants/m2	3	47	48	2

* 180 kg N/ha

Earliness of ripening

The growing period of TSS is longer than the growing period of traditional bulb seed crops. The growing period of Tuktuk is about 11 weeks. The new hybrid, Sanren, is an improvement in earliness. This varieties is about one week earlier than Tuktuk. Transplanting clusters of seedlings on soil modules is giving an earlier ripening crop than transplanting individual seedling without soil modules: with Tuktuk ripening was occurring about 5 à 6 days. This effects should be ascribed to less wilting after transplanting. Table 8 is presenting the differences in length of the growing period.

Table 8. Earliness in tranplanted field (number of days between transplanting and harvest) in experiments in 2007, 2008 and 2009

	Brebes	Brebes	Purwakarta 2008		Brebes 2009			
	2007 exp. 1	2008 exp. 1	Clay soil	Sandy soil	Early trans-planting exp.		plant den-sity exp.	N fertili-zation exp.
Moment of transplanting:	6-sep	29-mei	4-jun	4-jun	13-apr	29-apr	20-5	27-mei
Tuktuk single seedlings	68	82	79	75	95	86	83	79
Tuktuk clusters on soil modules	62	78	71	66				
Sanren single seedlings		75	68	63	95	84	77	79
Bima curut	54	57	60	59	60	56	69	62
Ilokos	54						69	62
Tanduyung		56	58	58				

Plant density

There was a clear difference between Tuktuk and Sanren in reaction on plant density. Tuktuk was giving a much higher response to increasing plant density than Sanren. Especially in the plant density experiment of 2009 this was very clear. But also in the other experiments this effect was visible. Table 9 is presenting the effect of plant density on yield in different experiments performed in 2007, 2008 and 2009.

Table 9. Effect of plant density on yield. Weight of shallots with leaves 3-5 days after harvest in ton/1600 m^2 (1120 m^2 net)

	Brebes 2007		Brebes 2008		Purwakarta 2008		Brebes 2009
	exp. 1	exp. 2	exp. 1	exp2	clay soil**	sandy soil***	plant density exp.
date of transpl.:	6-sep	26-sep	29-mei	8-aug	4-jun	4-jun	20-mei
Tuktuk 75 pl/m^2							1.50
Tuktuk 100 pl/m^2	0.84	0.48	4.94	1.20	1.29	1.37	
Tuktuk 100 pl/m^2 (5w*)					2.86	1.88	
Tuktuk 125 pl/m^2							2.21
Tuktuk 150 pl/m^2			5.79	2.27	0.39	1.18	
Tuktuk 150 pl/m^2 (5w*)			6.00				
Tuktuk 160 pl/m^2	1.27	1.37					
Tuktuk 175 pl/m^2							3.10
Tuktuk 225 pl/m^2							3.18
Sanren 75 pl/m^2							2.89
Sanren 100 pl/m^2			6.35	2.22	3.16	4.45	
Sanren 125 pl/m^2							3.25
Sanren 150 pl/m^2			6.80		4.42	4.79	
Sanren 150 pl/m^2 (5w*)					3.14	2.86	
Sanren 175 pl/m^2							3.67
Sanren 225 pl/m^2							3.67
LSD 5%	0.22	0.33	0.74	0.41	1.55	1.37	0.58

* 5 weeks old seellings in stead of 6 weeks old seedlings

**: Tuktuk 100 pl/m^2: 28% survival of seedlings;Tuktuk 150 pl/m^2: 27% survival of seedlings

***: Tuktuk 100 pl/m^2: 54% survival of seedlings; Tuktuk 150 pl/m^2: 31% survival of seedlings

Picture 9. Harvest of TSS-experiments.

Optimal plant density of Tuktuk was ca. 150 – 175 plants per m^2. Sanren was producing rather well with 75 plants per m2. With increasing plant density the yield is increasing also, but less fast as with Tuktuk. Whether this increase in yield is relevant for the farmer or not is depending on the increase in cost of production and transplanting more seedlings. With expensive nurseries, for example the nursery used in 2008 with trays filled with mixtures with stable manure and shelters, the optimal plant density of the Hybrid in the experiment of 2009 was ca. 75 plants per m^2 .

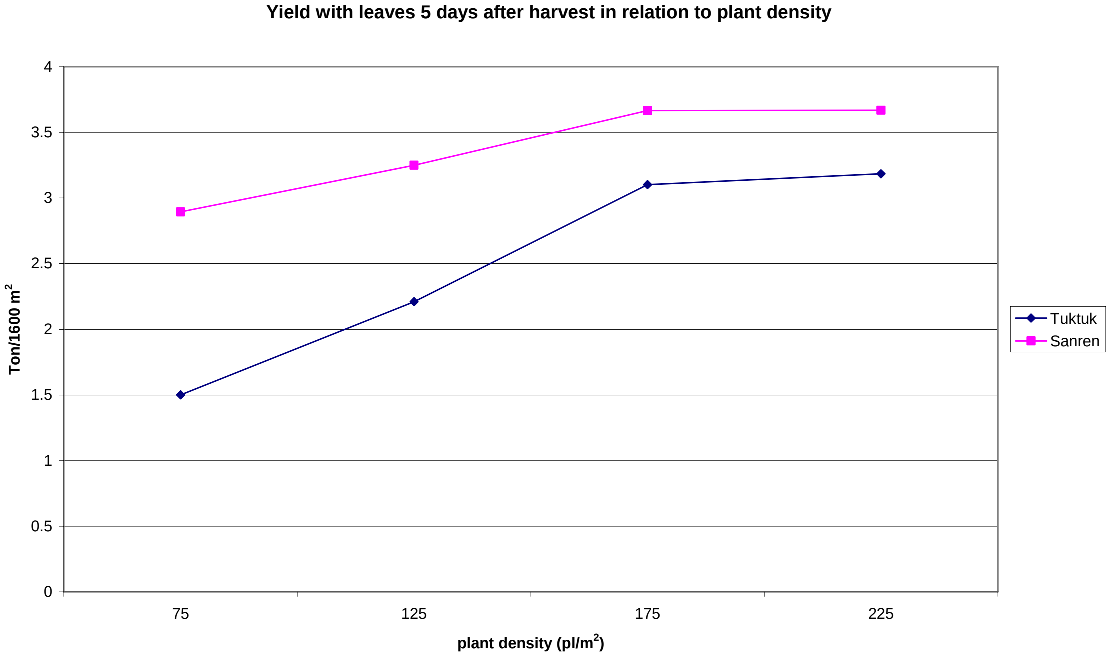


Figure 1. Effect of plant density on yield in plant density experiment of 2009

Effect of nitrogen fertilization

There was a clear difference between Tuktuk and Sanren in reaction on nitrogen fertilization. Tuktuk was not giving a higher yield with an increasing nitrogen fertilization. At the same time the quality of the harvested bulbs was decreasing. Yield of Sanren was increasing with an increasing nitrogen fertilization: Sanren grown with 300 kg N/ha yielded 29% more than Sanren grown with 120 kg N/ha. The yield was increased without a decrease in quality.

Table 10. Effect of nitrogen fertilization on yield. Weight of shallots with leaves 3-5 days after harvest in ton/1600 m^2 (1120 m^2 net); plant density 150 plants/m^2. Transplanting date: 27 May 2009

	Tuktuk	Sanren
120 kg N/ha	2.73	3.86
180 kg N/ha	2.92	4.12
240 kg N/ha	2.47	4.50
300 kg N/ha	2.41	4.97
LSD 5%	0.42	0.71

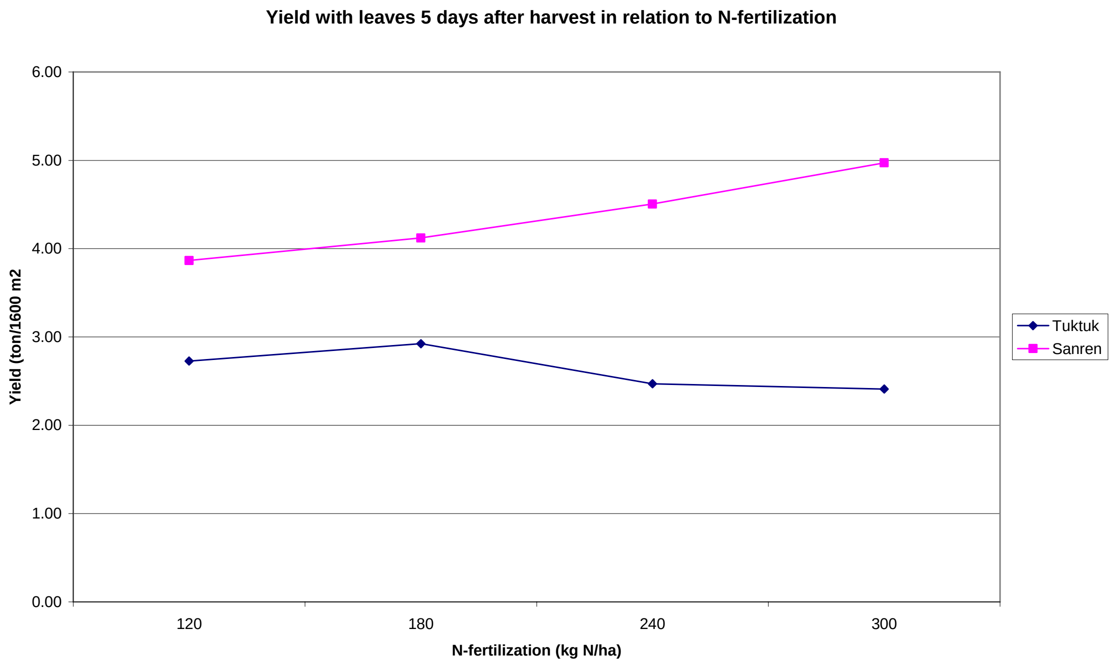


Figure 2. Effect of nitrogen fertilization on yield in fertilization experiment of 2009.

The nitrogen fertilization experiment in 2009 was harvested on 14 August. After drying bulbs were stored in normal storage facilities of East West Seed Indonesia in Purwakarta. The bulbs came in the store on 28

Picture 10. Storage experiment with Tuktuk and Sanren grown at different levels of nitrogen fertilization.

September and each month the number of healthy bulbs was determined. The number of stored bulbs was 65 – 97 bulbs per treatment. Figures 3 and 4 are presenting the percentage of healthy bulbs.

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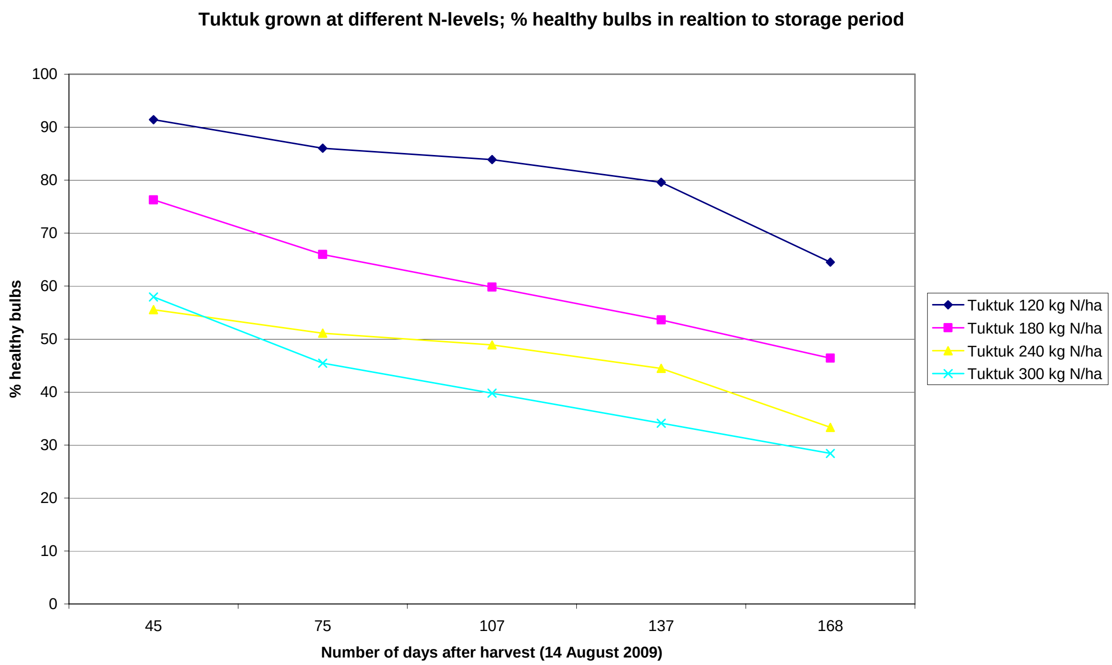


Figure 3. Storage experiment with bulbs harvested in nitrogen fertilization experiment 2009. Percentage healthy bulbs of Tuktuk in relation to storage period.

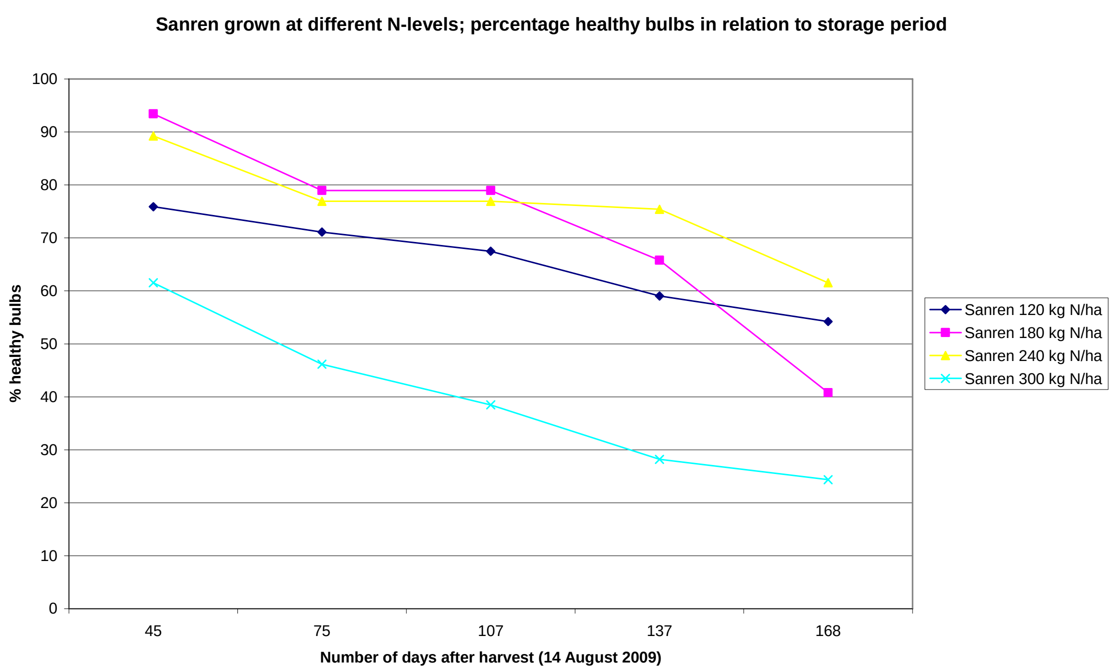


Figure 4. Storage experiment with bulbs harvested in nitrogen fertilization experiment 2009. Percentage healthy bulbs of Sanren in relation to storage period.

The storage experiment was done in one replication and the numbers of stored bulbs was low. This makes it difficult to draw conclusions. However with both varieties, it seems that the highest nitrogen level is giving the lowest percentage of healthy bulbs. This indicates that 300 kg N/ha is giving too much rot during storage. The results are also indicating that probably Sanren can be grown with higher nitrogen than Tuktuk. Storage quality of Tuktuk is decreasing more rapidly with increasing nitrogen gift than storage quality of Sanren. In the beginning of 2009 a small storage experiment was done with Tuktuk and Sanren. Also in this small experiment it appeared that storability of Sanren was better than the storability of Tuktuk.

Direct sowing of TSS

In 2008 two experiments were done with direct sowing, one with and one without covering with rice straw after sowing. Percentage emerged plant was higher without straw covering. The yield of both experiments was relatively low. It is possible that the experiments were suffering from nitrogen shortage because of a failure. The yield of the seed bulb crops was relatively high. The main problem with direct sowing is the high costs for weed control. Another point is the high risks during the first 4 or 5 weeks after sowing. Table 11 is presenting the results of the two direct sowing experiments performed in 2008.

Table 11. Direct sowing experiments 2008 with and without straw covering after sowing; Emerged plants, plantdensity and yield

	Without rice straw; sown 15 June*			With rice straw; sown 25 June**		
	% emerged plants	Number of plants per m2	Yield with leaves 3 days after harvest ton/1600m2	% emerged plants	Number of plants per m2	Yield with leaves 3 days after harvest ton/1600m2
Tuk tuk 1 cm deep furrow, closed with burned rice husks	42	135	3.2	38	120	2.7
Tuk tuk 1 cm deep furrow, closed with nursery mixture/manure	47	150	3.5	44	141	2.9
Tuk tuk 1 cm deep furrow, closed with soil	50	159	3.4	41	130	2.5
Hybrid 1 cm deep furrow, closed with burned rice husks	33	106	3.5	20	65	2.1
Ilokos (imported) 33,3 bulbs/m2	92	28	5.5	94	28	4.4
Bima curut (farmers seed bulbs) 33,3 bulbs/m2	95	29	3.8	96	29	4.2
Tuk tuk 1 cm deep furrow, closed with ashes	42	133	3.3	35	113	2.9
Tuk tuk 1 cm deep furrow, closed with ashes 888 seeds per m2				35	310	4.5
LSD 5%	7.9	17.6	0.66	8.7	35.4	0.63

*: seed bulb crops harvested 65 days after planting; TSS harvested 29 days later

**: seed bulb crops harvested 64 days after planting; TSS harvested 31 days later

Picture 11. Direct sowing experiment.

Production on demofields 2010

In 2010 yield was measured on three demofields. In the demofields the most promising cultivation methods of TSS were shown on plots in one replication. In Table 12 the yield data are presented.
The dry season of 2010 was relatively wet and the crop was suffering a lot from diseases (downy mildew and antracnose). Especially Tuktuk was very susceptible. Sanren was performing much better in this respect. In Brebes the yield of TSS-varietries was lower than the yield of the local seed bulb variety. In Nganjuk the yield of Sanren was higher than the yield of the local seed bulb variety. Tuktuk was giving a lower yield than the local seed bulb variety when grown at 75 plants per m^2.

Table 12. Yield, weight of shallots with leaves 7-8 days after harvest in ton/1600m^2 bruto field(1120 m^2 nett) on demofields in 2010

	Brebes	Nganjuk1*	Nganjuk2
Tuktuk 150 plants/m^2 and 240 kg N/ha	1.4	2.5	4.7
Tuktuk 75 plants/m^2 and 240 kg N/ha	1.1	1.8	2.8
Tuktuk 150 plants/m^2 and 120 kg N/ha	1.1	2.1	3.5
Sanren 75 plants/m^2 and 120 kg N/ha	2.0	3.1	3.7
Sanren 75 plants/m^2 and 240 kg N/ha	2.2	3.6	3.8
Sanren 150 plants/m^2 and 120 kg N/ha	2.3	2.7	4.4
Sanren 150 plants/m^2 and 240 kg N/ha	2.3	2.8	4.8
Sanren direct seeding and 120 kg N/ha	-	-	2.5
Sanren 62,5 plants/m^2 and 120 kg N/ha	2.9	-	-
Local seed bulb variety and 120 kg N	3.0	1.9	3.6
Sanren tuber seed and 120 kg N/ha	-	3.6	4.9

"-" no such treatment included
* estimated from weight after 22 days drying

Picture 12. Demo field in Brebes in 2010.

4 Economic calculations

Costs of nursery

In 2007 -2009 registrations have been done of the costs of materials and labour costs needed for nurseries. These registrations have been done as good as possible. However, it should be realized that these registrations were performed in experiments. It is possible that costs of nurseries for large scale production fields are different. For example, it is possible that less man/womandays are needed in nurseries for large scale production field, while activities could be done more efficient.

Table 13 gives an overview of the costs of two nurseries, one on a seedbed in the field and one in plastic trays. The calculations are made for a situation of sowing 3000 seeds per m^2 and a seed efficiency of 40%.

Table 13. Costs of nurseries (in Indonesian Rp) for transplanting 1600 m2 production field (1120 m2 nett, 150 seedlings/m2) nursery size 140 m2, sowing density 3000 seeds/m2, assumed seed efficiency 40%

		Nursery on seedbed in the field		Nursery in plastic trays	
	Price/unit	quantities	Total costs	quantities	Total costs
Seed	1200	1260 gr	1,512,000	1260 gr	1,512,000
Stable manure seedbed (2 kg/m2)	600	280 kg	168,000		
Satable manure trays (1,8 kg/tray of 0,1 m2)	600			2520 kg	1,512,000
Labour:					
Land preparation (man)	25000	14.6 days	365,000		
Land preparation (woman)	13000	1.6 days	20,800		
Filling trays with nursery mixture (man)	25000			4.7 days	116,750
Sowing (woman)	13000	4.7 days	60,580	4.7 days	60,580
Sowing (man)	25000	2.0 days	50,000	2.0 days	50,000
Watering (man)	25000	7.0 days	175,000	7.0 days	175,000
Spraying (man)	25000	0.2 days	4,714	0.2 days	4,714
Weeding (woman)	13000	1.9 days	24,512	1.9 days	24,512
Fertilizing (man)	25000	0.8 days	18,889	0.8 days	18,889
Installing shelter (man)	25000	13.6 days	340,000	13.6 days	340,000
Materials:					
Trays (10500 Rp/tray, used 10x)	1050			1400 trays	1,470,000
Bambo	7500	17 stems	127,500	17 stems	127,500
Wire for shelter	15000	1.7 kg	25,500	1.7 kg	25,500
Plastic net for shelter, used 10x)	1000	332 m	332,000	332 m	332,000
Dursban	7000	3.4 btl	23,800	3.4 btl	23,800
Rice sifting	5000	1.7 paks	8,500	1.7 paks	8,500
Traser	870000	0.09 l	73,950	0.085 l	73,950
NPK	9500	3.4 kg	32,300	3.4 kg	32,300
Subtotal			3,363,044		5,907,994
Landrent (8 weeks 200 m2 with ditches)	26	1600 m2*weeks	41,600	1600 m2*weeks	41,600
Total, including landrent			3,404,644		5,949,594

Based on these calculations the costs per seedling can be calculated. For example the costs per seedling produced on a seedbed in the field is 20,27 Rp/seedling, while the costs per seedling produced in trays is 35,41 Rp/seedling. The costs are, of course, depending on several factors, such as seed price, seed efficiency, costs of materials. For the two examples in table 13 it can be calculated that seed efficiency in trays should be 69,9% to get the same costs per seedling as on a seedbed in the field.

The influence of seed price can be described as follows: the cost price per seedling is increasing 3,75 IDR if the seed price is increased with 500.000 IDR/kg, assuming that there is no difference in thousand kernel weight and seed efficiency.

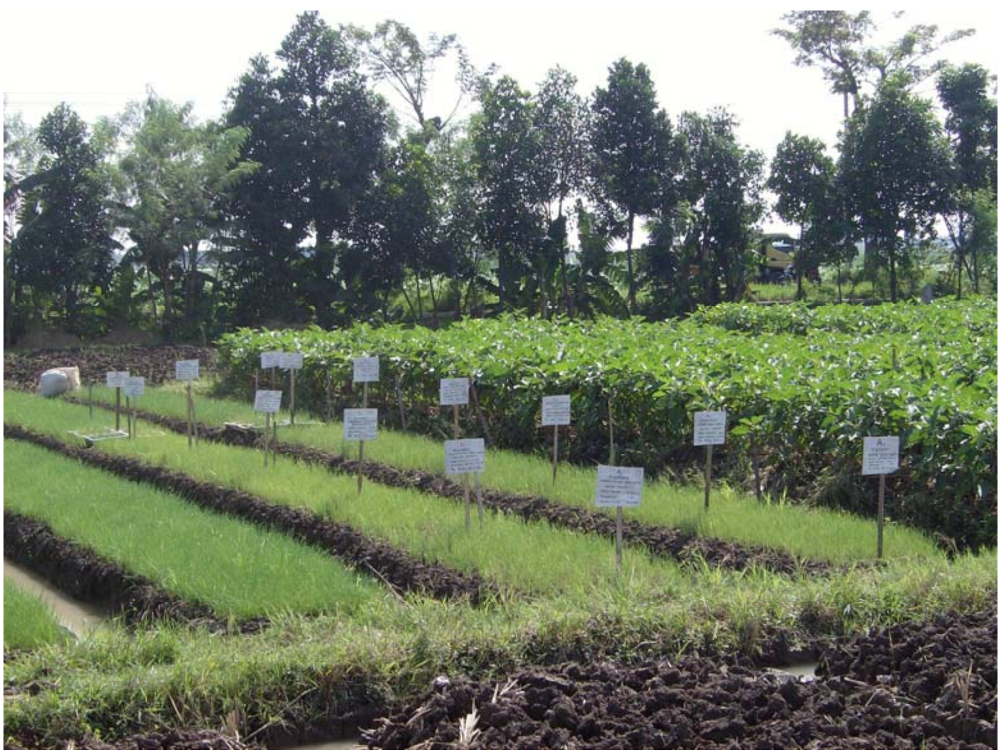
Compared with seed bulbs bought on the market the total costs of TSS seedling production is comparable or lower. For a production field of 1600 m^2 (1120 m^2 net) it is estimated that 326 kg seed bulbs is needed. This means With a price of 15.000 IDR/kg this means 4.890.000 IDR. Farmers who are using their own seed bulbs these costs are lower, but the yield will also be lower.

In 2010 demofields were performed at farmer's level on six locations. The costs of three nurseries were calculated. Compared to nursery costs at farmer's level nursery costs calculated in the experiments of 2008 and 2009 were relatively low. The most important difference are the costs of maintenance (watering, spraying and weeding). On average costs of maintenance were ca. 458.000 IDR higher at farmer's level. In total costs the nurseries at farmer's level were 450.000 IDR higher than the nursery costs based on the experiments of 2008 and 2009. If this is taken into account the costs per seedlings is 22,94 IDR in stead of 20,27 IDR. Table 14 is presenting the costs of the nurseries at farmer's level.

Table 14. Costs of nursery in 3 locations at farmer's level in comparison with estimated costs nurseries 2008 - 2009 Brebes; Costs for 140 m^2 nursery

	Kapandi Brebes 2010	Wono Nganjuk1 2010	Puji Nganjuk2 2010	Average nurseries 2010	Experiments Brebes 2008/2009
Amount of seed sown on 140 m2 in grams	1400	2167	1400	1619	1260
Labour					
Land preparation	299,250	466,667	264,062	331,524	385,800
Sowing (rowing beds, sowing, covering with soil, putting cover)	332,500	100,000	86,154	157,143	110,580
Making shelter	105,000	133,333	215,385	161,905	340,000
Maintenance (watering, spraying and weeding)	910,000	693,750	533,077	681,548	223,114
Total labour costs	**1,646,750**	**1,393,750**	**1,098,677**	**1,332,119**	**1,059,494**
Materials					
Bamboo and plastics (to be used for twice)	271,250	685,833	375,577	435,833	485,000*
Pesticides (pestisida)	233,888	102,450	309,023	229,557	106,250
Fertilizer (pupuk)	42,000	633,333	214,308	287,143	200,300
Total material costs	**547,138**	**1,421,617**	**898,908**	**952,533**	**791,550**
Other costs					
Land rent (2 months); (sewa lahan per 2 bulan)	**40,000**	**100,000**	**40,000**	**57,143**	**41,600**
Total cost of nursery (excl. seed costs)	**2,233,888**	**2,915,367**	**2,037,585**	**2,341,795**	**1,892,644**

* Bamboo and wire to be used one time, plastic net 10 times



Picture 13. Nursery demo in Brebes in 2010.

Costs of production fields

Table 15 is giving a comparison between TSS and seed bulb corps in costs of production. If the seed price of TSS is 1.000.000 IDR per kg and the price of the seed bulbs is 15.000 IDR per kg the production costs of TSS and seed bulb crops is rather small (only 3% higher). It depends on the yield level and the price of the harvest bulbs if the margin between financial yield and total costs is positive or negative. In the table it is shown that the yield of TSS can be much higher than the yield of seed bulb crops.

Table 15. Costs (IDR) of production fields, 1600 m2 (1120 m2 met); TSS compared with seed bulb crops.

		TSS 150 seedlings/m2		Seed bulb crop 33,3 plants/m2	
	price/unit	quantities	Total costs	quantities	Total costs
Seedlings	20.27	168000 seedl.	3,405,360		
seed bulbs	15,000			326 kg	4,890,000
Labor costs (excl. harvest):					
(Trans)planting (woman)	13,000	46.4 days	603,200	7.5 days	97,500
Watering (man)	25,000	16.8 days	420,000	11.6 days	289,800
Fertilizing (man)	25,000	4.6 days	115,000	4.6 days	115,000
Fertilizing (woman)	13,000	4.6 days	59,800	4.6 days	59,800
Spraying (man)	25,000	9.2 days	230,000	6.3 days	158,700
Pest picking (woman)	13,000	65.0 days	845,000	44.9 days	583,050
Weeding	13,000	52.6 days	683,800	36.5 days	474,500
Labour costs harvest:					
Harvesting (man)	25,000	7.0 days	175,000	7.0 days	175,000
Harvesting (woman)	13,000	16.0 days	208,000	16.0 days	208,000
Drying for 5 days (man)	25,000	2.0 days	50,000	2.0 days	50,000
Night guard 5 days (man)	37,500	5.0 days	187,500	5.0 days	187,500
Fertilizer					
60 kg N/ha from Urea (46%)	1,500	14.6 kg	21,913	14.6 kg	21,913
60 kg N/ha from ZA (21%)	1,500	32.0 kg	48,000	32.0 kg	48,000
125 kg P2O5/ha from SP36	2,000	38.9 kg	77,778	38.9 kg	77,778
200 kg K2O/ha from KCl	10,500	37.3 kg	392,000	37.3 kg	392,000
Insecticides					
Tracer	870,000	2.10 l	1,827,000	1.66 l	1,440,666
Dursban	60,000	0.28 l	16,734	0.22 l	13,388
Hostathion	114,000	0.84 l	95,386	0.67 l	76,309
Tumagon	550,000	1.23 l	673,926	0.98 l	539,141
Rampage	440,000	1.42 l	623,219	1.13 l	498,575
Fungicides:					
Antracol	57,000	3.63 kg	206,670	2.90 kg	165,336
Score	350,000	0.30 kg	106,230	0.24 kg	84,984
Daconil	120,000	1.14 kg	136,828	0.91 kg	109,463
Dithane	50,000	0.98 kg	48,809	0.78 kg	39,047
Total variable costs			11,257,153		10,795,448
Fixed costs:					
Land preparation	25,000	117.1 md	2,927,500	117.1 md	2,927,500
Land preparation	13,000	13.1 wd	170,300	13.1 wd	170,300
Fortifying beds	25,000	16.8 md	419,681	16.8 md	419,681
Landrent	555	1600 m2	888,000	1600 m2	888,000
Total costs			15,662,633		15,200,928
In comparison:					
Tuktuk:					
Yield mean exp. 2008/2009	5000	3830	19,150,000	2250	11,250,000
Yield exp. 2008	5000	5792	28,960,000	2288	11,440,000
Yield plant dnsity exp. 2009	5000	2656	13,280,000	2179	10,895,000
Yield N-fertilization exp. 2009	5000	2923	14,615,000	2277	11,385,000

Based on the mean results of experiments done in 2008 and 2009 productions costs of Tuktuk, Sanren and Bima curut are compared. The mean yield data are obtained from the experiments mentioned in Table 16. In figure 5 the production costs (including nursery costs) and the financial value of the harvested bulbs are presented (assumptions: seed efficiency 40%, price of all varieties 5.000 IDR/kg). The yield of Tuktuk was 70% higher than the yield of Bima curut. The yield of Sanren was 113% higher than the yield of Bima curut. The total production costs of TSS are only 3- 5% higher than production costs of the seed bulb variety Bima curut. This means that the costs price of harvested bulbs is reduced from 6762 IDR/kg (Bima) to 4095 IDR/kg (Tuktuk) and 3340 IDR/kg (Sanren).

Table 16. Yield (with leaves in ton/1600 $m^{2)}$ in experiments 2008 and 2009

	2008	2009	
	Transplanting experiment	Plant density experiment*	Nitrogen fertilization experiment
Tuktuk 150 pl/m2	5.8	2.7	2.9
Sanren 150 pl/m2	6.8	3.4	4.1
Bima Curut	2.3	2.2	2.3

* Yield calculated as a mean from yield at 125 and 175 plants/m^2

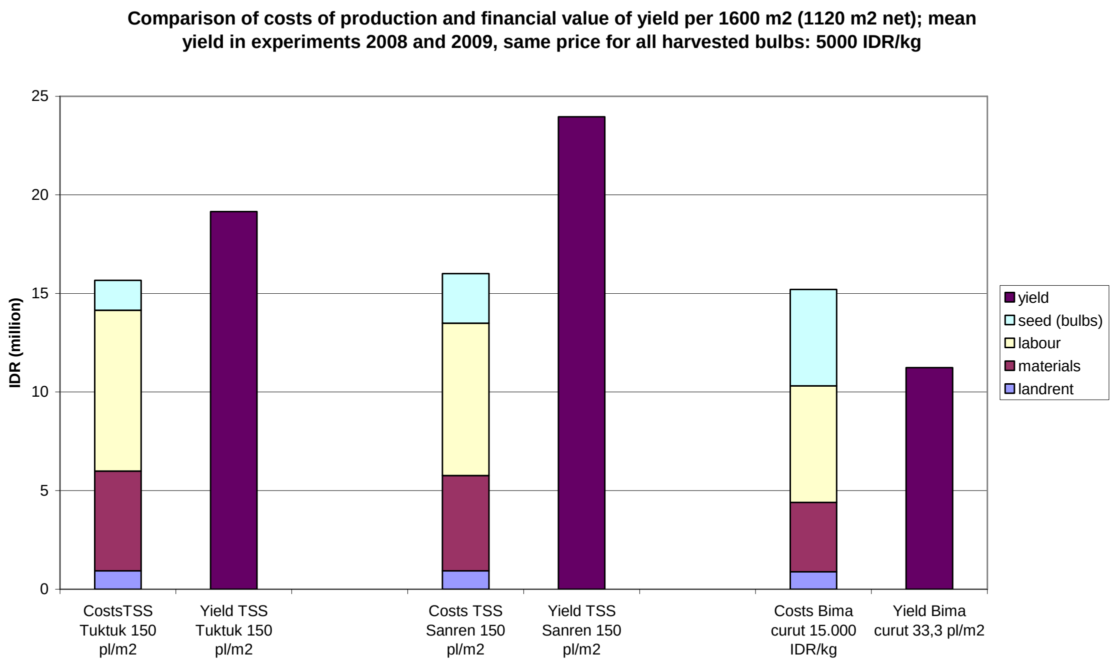


Figure 5. Comparison of costs of production and financial value of yield per 1600 m2 (1120 m2 net); mean yield in experiments of 2008 and 2009; seed efficiency TSS 40%, same price for all harvested bulbs; 5000 IDR/kg.

On the demo fields performed at farmer's level on six locations costs of production are also estimated. Table 17 is presenting the costs of the transplanted production fields at farmer's level (excluding costs of seedlings). There are several differences between these costs and the costs estimated in the experiments of 2008 and 2009. Labour costs for transplanting are higher at farmer's level than in the experiments performed in 2008 and 2009. The same is true for the costs of fertilizer. It is possible that farmers have used more organic manure in their fields. On the other hand the costs of harvesting and the costs of pesticides are higher in the experiments of 2008 and 2009.

In total costs the difference between costs at farmer's level and costs estimated in the experiments of 2008 and 2009 is not large.

Table 17. Costs of transplanted field in 2010 in comparison with estimated costs of transplanted fields 2008 - 2009 Brebes; Costs for 1600 m^2 (1120 m^2 net); costs of seedlings are not included

	Kapandi Brebes 2010	Wono Nganjuk1 2010	Puji Nganjuk2 2010	Average transpl. fields 2010	Experiments Brebes 2008/2009
I. Labour					
1. Land preparation (persiapan lahan)	2,258,824	2,608,696	1,285,356	2,050,958	3,097,800
2. Planting (tanam)	800,000	1,519,022	1,108,787	1,142,603	603,200
3. Weeding (penyiangan)	1,882,353	353,261	460,251	898,622	683,800
4. Watering (penyiraman)	836,601	135,870	334,728	435,733	420,000
5. Spraying (penyemprotan)	784,314	443,841	228,954	485,703	230,000
6. Fortifying beds (perbaikan bedengan)	470,588	394,022	242,678	369,096	419,681
7. Fertilizing (pemupukan)	156,863	135,870	117,155	136,629	174,800
8. Harvesting: (panen)	282,353	434,783	401,674	372,936	620,500
Cost of labour (biaya tenaga kerja)	**7,471,895**	**6,025,362**	**4,179,582**	**5,892,280**	**6,249,781**
II. Materials					
1. Fertilizer: (pupuk)	1,072,941	978,261	1,088,315	1,046,506	539,691
2. Pesticides (pestisida)	1,678,431	2,364,891	1,829,088	1,957,470	3,734,802
Cost of materials (biaya bahan)	**2,751,373**	**3,343,152**	**2,917,403**	**3,003,976**	**4,274,493**
III. Other cost					
- Land rent (4 months) (sewa lahan)	**640,000**	**1,600,000**	**640,000**	**960,000**	**888,000**
Total cost of field production (excl. costs of seedlings	**10,863,268**	**10,968,514**	**7,736,984**	**9,856,256**	**11,412,273**

Picture 14. Harvested bulbs of different varieties.

Effect of plant density

Table 18 is presenting the effect of plant density on the production costs for the variety Sanren. The calculation is based on the plant density experiment of 2009. It appears that the financial result of Sanren is hardly improved if plant density is increased from 75 plants per m^2 to 125 plants per m^2. The increase in yield has more or less the same value as the increase in production costs. Table 19 is presenting the effect of plant density on production

costs for the variety Tuktuk. In figure 6 the gross margins (difference between financial value of harvest bulbs – costs of production) for the two varieties are shown for different levels of plant density. It is clear that in this experiment the optimal plant density of Tuktuk is 175 plants per m^2.
In this experiment the optimal plant density is depending on the price per seedling, especially with the variety Sanren. If the costs per seedlings are higher, for example 33% higher than 26,27 IDR/seedling (seed efficiency is 30% instead of 40%), than the optimal plant density is 75 plants per m^2. Figure 7 is showing this. This means that for farmers it could be better to grow Sanren at a plant density of 75 plants per m^2. Additional research is needed to prove if the reaction of Sanren on differences in plant density is the same as in the experiment of 2009, for example in experiments with a higher yield level like in 2008.

Table 18. Costs (IDR) of production fields, 1600 m^2 (1120 m2 net), experiment with different transplanting densities of Sanren.
Assumed seed price: 2.000.000 IDR/kg, seed efficienct nursery 40%

		75 seedlings/m^2		125 seedlings/m^2		175 seedlings/m^2		225 seedlings/m^2	
	price/unit	quantity	Total costs	quantity	Total costs	quantity	Total costs	quantity	Total costs
Seedlings Sanren	26.27 seedl.	84000	2,206,680	140000	3,677,800	196000	5,148,920	252000	6,620,040
Labour costs (excl. harvest)									
(Trans)planting (woman)	13000 days	23.2	301,600	38.7	502,667	54.1	703,733	69.6	904,800
Watering (man)	25000 days	15.8	394,390	15.8	394,390	15.8	394,390	15.8	394,390
Fertilizing (man)	25000 days	4.6	115,000	4.6	115,000	4.6	115,000	4.6	115,000
Fertilizing (woman)	13000 days	4.6	59,800	4.6	59,800	4.6	59,800	4.6	59,800
Spraying (man)	25000 days	8.6	215,976	8.6	215,976	8.6	215,976	8.6	215,976
Pest picking (woman)	13000 days	61.0	793,476	61.0	793,476	61.0	793,476	61.0	793,476
Weeding	13000 days	49.3	641,511	49.3	641,511	49.3	641,511	49.3	641,511
Labour costs harvest:									
Harvesting (man)	25000 days	7	175,000	7	175,000	7	175,000	7	175,000
Harvesting (woman)	13000 days	16	208,000	16	208,000	16	208,000	16	208,000
Drying for 5 days (man)	25000 days	2	50,000	2	50,000	2	50,000	2	50,000
Night guard 5 days (man)	37500 days	5	187,500	5	187,500	5	187,500	5	187,500
Fertilizer									
60 kg N/ha from Urea (46%)	1500 kg	14.6	21,913	14.6	21,913	14.6	21,913	14.6	21,913
60 kg N/ha from ZA (21%)	1500 kg	32.0	48,000	32.0	48,000	32.0	48,000	32.0	48,000
125 kg P2O5/ha from SP36	2000 kg	38.9	77,778	38.9	77,778	38.9	77,778	38.9	77,778
200 kg K2O/ha from KCl	10500 kg	37.3	392,000	37.3	392,000	37.3	392,000	37.3	392,000
Insecticides									
Tracer	870000 l	1.972	1,715,598	1.972	1,715,598	1.972	1,715,598	1.972	1,715,598
Dursban	60000 l	0.262	15,714	0.262	15,714	0.262	15,714	0.262	15,714
Hostathion	114000 l	0.786	89,570	0.786	89,570	0.786	89,570	0.786	89,570
Tumagon	550000 l	1.151	632,833	1.151	632,833	1.151	632,833	1.151	632,833
Rampage	440000 l	1.330	585,218	1.330	585,218	1.330	585,218	1.330	585,218
Fungicides:									
Antracol	57000 kg	3.405	194,068	3.405	194,068	3.405	194,068	3.405	194,068
Score	350000 kg	0.285	99,753	0.285	99,753	0.285	99,753	0.285	99,753
Daconil	120000 kg	1.071	128,485	1.071	128,485	1.071	128,485	1.071	128,485
Dithane	50000 kg	0.917	45,832	0.917	45,832	0.917	45,832	0.917	45,832
Total variable costs			9,395,693		11,067,879		12,740,066		14,412,253
Land preparation	25000 MD	117.1	2,927,500	117.1	2,927,500	117.1	2,927,500	117.1	2,927,500
Land preparation	13000 WD	13.1	170,300	13.1	170,300	13.1	170,300	13.1	170,300
Fortifying beds	25000 MD	16.8	419,681	16.8	419,681	16.8	419,681	16.8	419,681
Landrent	555 m2	1600	888,000	1600	888,000	1,600	888,000	1600	888,000
Total costs			13,801,173		15,473,360		17,145,547		18,817,733
In comparison:									
Sanren in experiment 2009	5000	2894	14,470,000	3250	16,250,000	3,666	18,330,000	3669	18,345,000

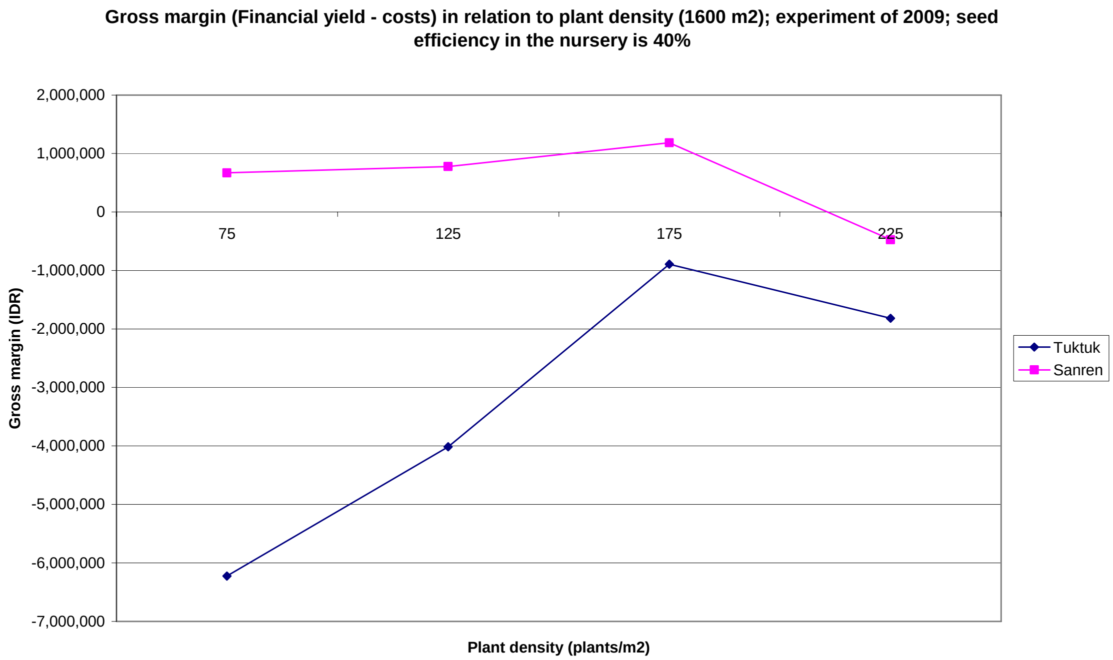


Figure 6. Gross margin of Tuktuk and Sanren at different plant densities; seed efficiency is 40%.

Table 19. Costs (IDR) of production fields, 1600 m^2 (1120 m2 net), experiment with different transplanting densities of Tuktuk. Assumed seed price: 1.200.000 IDR/kg, seed efficiency nursery 40%

		75 seedlings/m^2		125 seedlings/m^2		175 seedlings/m^2		225 seedlings/m^2	
	price/unit	quantity	Total costs	quantity	Total costs	quantity	Total costs	quantity	Total costs
Seedlings Tuktuk	20.27 seedl.	84000	1,702,680	140000	2,837,800	196000	3,972,920	252000	5,108,040
Labour costs (excl. harvest)									
(Trans)planting (woman)	13000 days	23.2	301,600	38.7	502,667	54.1	703,733	69.6	904,800
Watering (man)	25000 days	17.0	425,122	17.0	425,122	17.0	425,122	17.0	425,122
Fertilizing (man)	25000 days	4.6	115,000	4.6	115,000	4.6	115,000	4.6	115,000
Fertilizing (woman)	13000 days	4.6	59,800	4.6	59,800	4.6	59,800	4.6	59,800
Spraying (man)	25000 days	9.3	232,805	9.3	232,805	9.3	232,805	9.3	232,805
Pest picking (woman)	13000 days	65.8	855,305	65.8	855,305	65.8	855,305	65.8	855,305
Weeding	13000 days	53.2	691,498	53.2	691,498	53.2	691,498	53.2	691,498
Labour costs harvest:									
Harvesting (man)	25000 days	7	175,000	7	175,000	7	175,000	7	175,000
Harvesting (woman)	13000 days	16	208,000	16	208,000	16	208,000	16	208,000
Drying for 5 days (man)	25000 days	2	50,000	2	50,000	2	50,000	2	50,000
Night guard 5 days (man)	37500 days	5	187,500	5	187,500	5	187,500	5	187,500
Fertilizer									
60 kg N/ha from Urea (46%)	1500 kg	14.6	21,913	14.6	21,913	14.6	21,913	14.6	21,913
60 kg N/ha from ZA (21%)	1500 kg	32.0	48,000	32.0	48,000	32.0	48,000	32.0	48,000
125 kg P2O5/ha from SP36	2000 kg	38.9	77,778	38.9	77,778	38.9	77,778	38.9	77,778
200 kg K2O/ha from KCl	10500 kg	37.3	392,000	37.3	392,000	37.3	392,000	37.3	392,000
Insecticides									
Tracer	870000 l	2.126	1,849,280	2.126	1,849,280	2.126	1,849,280	2.126	1,849,280
Dursban	60000 l	0.282	16,938	0.282	16,938	0.282	16,938	0.282	16,938
Hostathion	114000 l	0.847	96,549	0.847	96,549	0.847	96,549	0.847	96,549
Tumagon	550000 l	1.240	682,145	1.240	682,145	1.240	682,145	1.240	682,145
Rampage	440000 l	1.434	630,819	1.434	630,819	1.434	630,819	1.434	630,819
Fungicides:									
Antracol	57000 kg	3.670	209,190	3.670	209,190	3.670	209,190	3.670	209,190
Score	350000 kg	0.307	107,526	0.307	107,526	0.307	107,526	0.307	107,526
Daconil	120000 kg	1.154	138,497	1.154	138,497	1.154	138,497	1.154	138,497
Dithane	50000 kg	0.988	49,404	0.988	49,404	0.988	49,404	0.988	49,404
Total variable costs			9,324,349		10,660,536		11,996,722		13,332,909
Land preparation	25000 MD	117.1	2,927,500	117.1	2,927,500	117.1	2,927,500	117.1	2,927,500
Land preparation	13000 WD	13.1	170,300	13.1	170,300	13.1	170,300	13.1	170,300
Fortifying beds	25000 MD	16.8	419,681	16.8	419,681	16.8	419,681	16.8	419,681
Landrent	555 m2	1600	888,000	1600	888,000	1,600	888,000	1600	888,000
Total costs			13,729,830		15,066,016		16,402,203		17,738,390

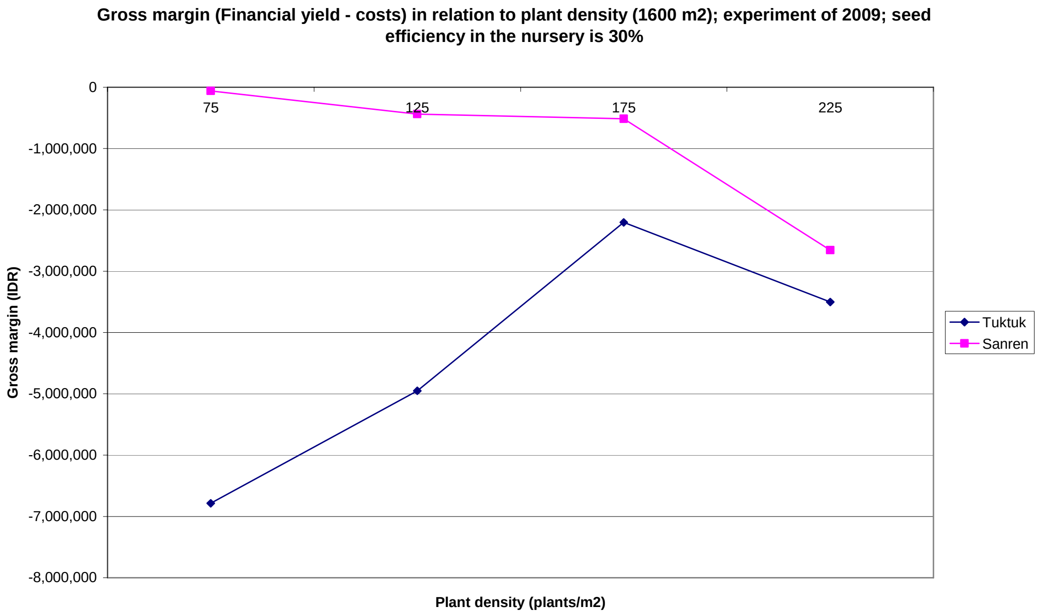


Figure 7. Gross margin of Tuktuk and Sanren at different plant densities; seed efficiency is 30% (price per seedling is 33% higher compared to a seed efficiency of 40%).

Effect of nitrogen fertilization

Table 20 and table 21 are presenting the costs of production at different levels of nitrogen fertilization for the varieties Tuktuk and Sanren respectively. Figure 8 is presenting the gross margin for both varieties at different levels of nitrogen fertilization. In the experiment of 2009 is appeared that the gross margin of Sanren was improved by increasing the nitrogen gift, while this was not occurring with the variety Tuktuk. Results from the storage experiment done with bulbs harvested in this experiment are indicating that 300 kg N/ha for Sanren is giving a poorer storability. Storability of Sanren is not decreasing if the nitrogen fertilization is increased from 120 kg N/ha to 240 kg N/ha.

Table 20. Costs (IDR) of production fields, 1600 m2 (1120 m2 net), experiment with different nitrogen fertilization levels; Variety: Tuktuk; assumed seed price 1.200.000 IDR/kg; seed efficiency 40%

			120 kg N/ha		180 kg N/ha		240 kg N/ha		300 kg N/ha	
	price/unit		quantity	Total costs	quantity	Total costs	quantity	Total costs	quantity	Total costs
Seedlings Tuktuk	20.27	seedl.	168000	3,405,360	168000	3,405,360	168000	3,405,360	168000	3,405,360
Labour costs (excl. harvest)										
(Trans)planting (woman)	13000	days	46.4	603,200	46.4	603,200	46.4	603,200	46.4	603,200
Watering (man)	25000	days	16.2	404,634	16.2	404,634	16.2	404,634	16.2	404,634
Fertilizing (man)	25000	days	4.6	115,000	4.6	115,000	4.6	115,000	4.6	115,000
Fertilizing (woman)	13000	days	4.6	59,800	4.6	59,800	4.6	59,800	4.6	59,800
Spraying (man)	25000	days	8.9	221,585	8.9	221,585	8.9	221,585	8.9	221,585
Pest picking (woman)	13000	days	62.6	814,085	62.6	814,085	62.6	814,085	62.6	814,085
Weeding	13000	days	50.6	658,173	50.6	658,173	50.6	658,173	50.6	658,173
Labour costs harvest:										
Harvesting (man)	25000	days	7	175,000	7	175,000	7	175,000	7	175,000
Harvesting (woman)	13000	days	16	208,000	16	208,000	16	208,000	16	208,000
Drying for 5 days (man)	25000	days	2	50,000	2	50,000	2	50,000	2	50,000
Night guard 5 days (man)	37500	days	5	187,500	5	187,500	5	187,500	5	187,500
Fertilizer										
60 kg N/ha from Urea (46%)	1500	kg	14.6	21,913	21.9	32,870	29.2	43,826	36.5	54,783
60 kg N/ha from ZA (21%)	1500	kg	32.0	48,000	48.0	72,000	64.0	96,000	80.0	120,000
125 kg P2O5/ha from SP36	2000	kg	38.9	77,778	38.9	77,778	38.9	77,778	38.9	77,778
200 kg K2O/ha from KCl	10500	kg	37.3	392,000	37.3	392,000	37.3	392,000	37.3	392,000
Insecticides										
Tracer	870000	l	2.023	1,760,159	2.023	1,760,159	2.023	1,760,159	2.023	1,760,159
Dursban	60000	l	0.269	16,122	0.269	16,122	0.269	16,122	0.269	16,122
Hostathion	114000	l	0.806	91,896	0.806	91,896	0.806	91,896	0.806	91,896
Tumagon	550000	l	1.180	649,270	1.180	649,270	1.180	649,270	1.180	649,270
Rampage	440000	l	1.365	600,418	1.365	600,418	1.365	600,418	1.365	600,418
Fungicides:										
Antracol	57000	kg	3.493	199,108	3.493	199,108	3.493	199,108	3.493	199,108
Score	350000	kg	0.292	102,344	0.292	102,344	0.292	102,344	0.292	102,344
Daconil	120000	kg	1.099	131,822	1.099	131,822	1.099	131,822	1.099	131,822
Dithane	50000	kg	0.940	47,023	0.940	47,023	0.940	47,023	0.940	47,023
Total variable costs				11,040,192		11,075,148		11,110,105		11,145,061
Land preparation	25000	MD	117.1	2,927,500	117.1	2,927,500	117.1	2,927,500	117.1	2,927,500
Land preparation	13000	WD	13.1	170,300	13.1	170,300	13.1	170,300	13.1	170,300
Fortifying beds	25000	MD	16.8	419,681	16.8	419,681	16.8	419,681	16.8	419,681
Landrent	555	m2	1600	888,000	1600	888,000	1,600	888,000	1600	888,000
Total costs				15,445,672		15,480,629		15,515,585		15,550,542
In comparison:										
Yield N-fertilization exp. 2009	5000		2726	13,630,000	2923	14,615,000	2,409	12,045,000	2410	12,050,000

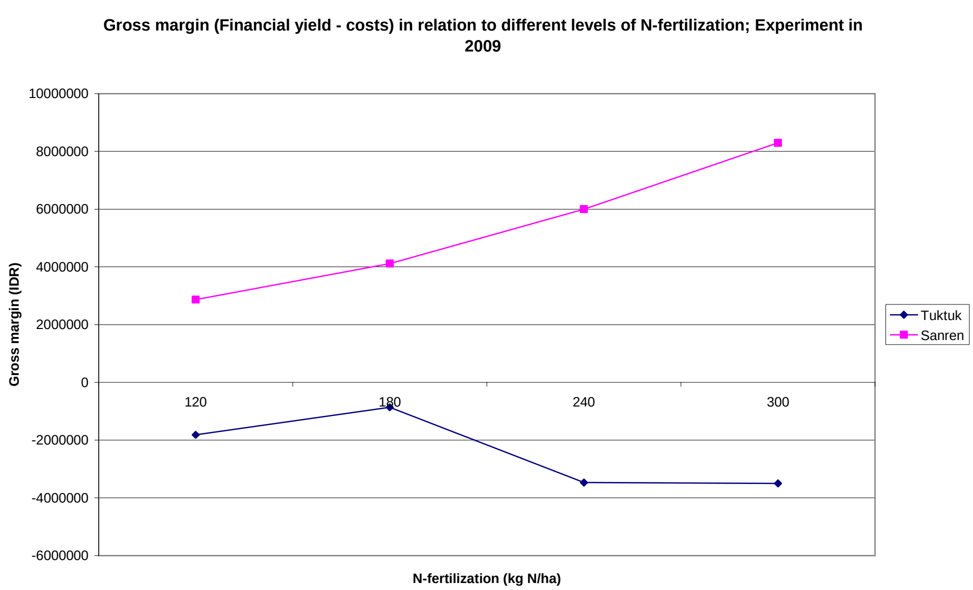


Figure 8. Gross margin of Tuktuk and Sanren at different levels of nitrogen fertilization in an experiment performed in 2009.

Table 21. Costs (IDR) of production fields, 1600 m^2 (1120 m2 net), experiment with different nitrogen fertilization levels; Variety: Sanren; assumed seed price 2.000.000 IDR/kg, seed efficiency nursery 40%

	price/unit		120 kg N/ha quantity	120 kg N/ha Total costs	180 kg N/ha quantity	180 kg N/ha Total costs	240 kg N/ha quantity	240 kg N/ha Total costs	300 kg N/ha quantity	300 kg N/ha Total costs
Seedlings Sanren	26.27	seedl.	168000	4,413,360	168000	4,413,360	168000	4,413,360	168000	4,413,360
Labour costs (excl. harvest)										
(Trans)planting (woman)	13000	days	46.4	603,200	46.4	603,200	46.4	603,200	46.4	603,200
Watering (man)	25000	days	16.2	404,634	16.2	404,634	16.2	404,634	16.2	404,634
Fertilizing (man)	25000	days	4.6	115,000	4.6	115,000	4.6	115,000	4.6	115,000
Fertilizing (woman)	13000	days	4.6	59,800	4.6	59,800	4.6	59,800	4.6	59,800
Spraying (man)	25000	days	8.9	221,585	8.9	221,585	8.9	221,585	8.9	221,585
Pest picking (woman)	13000	days	62.6	814,085	62.6	814,085	62.6	814,085	62.6	814,085
Weeding	13000	days	50.6	658,173	50.6	658,173	50.6	658,173	50.6	658,173
Labour costs harvest:										
Harvesting (man)	25000	days	7	175,000	7	175,000	7	175,000	7	175,000
Harvesting (woman)	13000	days	16	208,000	16	208,000	16	208,000	16	208,000
Drying for 5 days (man)	25000	days	2	50,000	2	50,000	2	50,000	2	50,000
Night guard 5 days (man)	37500	days	5	187,500	5	187,500	5	187,500	5	187,500
Fertilizer										
60 kg N/ha from Urea (46%)	1500	kg	14.6	21,913	21.9	32,870	29.2	43,826	36.5	54,783
60 kg N/ha from ZA (21%)	1500	kg	32.0	48,000	48.0	72,000	64.0	96,000	80.0	120,000
125 kg P2O5/ha from SP36	2000	kg	38.9	77,778	38.9	77,778	38.9	77,778	38.9	77,778
200 kg K2O/ha from KCl	10500	kg	37.3	392,000	37.3	392,000	37.3	392,000	37.3	392,000
Insecticides										
Tracer	870000	l	2.023	1,760,159	2.023	1,760,159	2.023	1,760,159	2.023	1,760,159
Dursban	60000	l	0.269	16,122	0.269	16,122	0.269	16,122	0.269	16,122
Hostathion	114000	l	0.806	91,896	0.806	91,896	0.806	91,896	0.806	91,896
Tumagon	550000	l	1.180	649,270	1.180	649,270	1.180	649,270	1.180	649,270
Rampage	440000	l	1.365	600,418	1.365	600,418	1.365	600,418	1.365	600,418
Fungicides:										
Antracol	57000	kg	3.493	199,108	3.493	199,108	3.493	199,108	3.493	199,108
Score	350000	kg	0.292	102,344	0.292	102,344	0.292	102,344	0.292	102,344
Daconil	120000	kg	1.099	131,822	1.099	131,822	1.099	131,822	1.099	131,822
Dithane	50000	kg	0.940	47,023	0.940	47,023	0.940	47,023	0.940	47,023
Total variable costs				12,048,192		12,083,148		12,118,105		12,153,061
Land preparation	25000	MD	117.1	2,927,500	117.1	2,927,500	117.1	2,927,500	117.1	2,927,500
Land preparation	13000	WD	13.1	170,300	13.1	170,300	13.1	170,300	13.1	170,300
Fortifying beds	25000	MD	16.8	419,681	16.8	419,681	16.8	419,681	16.8	419,681
Landrent	555	m2	1600	888,000	1600	888,000	1,600	888,000	1600	888,000
Total costs				16,453,672		16,488,629		16,523,585		16,558,542
In comparison:										
Yield N-fertilization exp. 2009	5000		3864	19,320,000	4120	20,600,000	4,504	22,520,000	4971	24,855,000

5 Conclusions

With respect to nursery techniques the following conclusions could be drawn from the research done in 2007-2010:

- In Indonesia nurseries on a seed bed in the field are probably most suitable. Plastic trays are too expensive and in many areas not enough stable manure and light sandy soil is available for making a nursery mixture. Preferably nurseries should be done immediately after paddy, because of the poor soil conditions.
- Seed efficiency on trays filled with a good mixture of sandy soil and stable manure (1/3 or ½ volume-based) was better than on a seedbed in the field.
- In experiments and in nurseries performed by farmers seed efficiency on a seedbed in the field ranged from 3% to 82%.
- Mixing stable manure or compost into the soil will give better condition for a good seed emergence.
- The most optimal sowing technique was: sowing in furrows at a depth of ca. 1 cm and closing the furrow after sowing with soil or with a mixture of sandy soil and stable manure (in stead of dry material like burned rice husks).
- If watering is done frequently, twice or three times a day, and if it is done carefully, avoiding heavy drops, seed efficiency will be improved.
- Protection of the nursery with a shelter, for example with insect net, against heavy rain fall and sunlight is needed.
- Incidently control of pest (Spodoptera) and diseases (antracnose) is needed.
- In general, if the seedbed is prepared by mixing stable manure or compost into the soil no nitrogen fertilization is needed.
- Mixing the seed with rice flour in a way that the seed is more visible is helpful for getting a good spreading of the seed over the furrow.
- Total costs of TSS seedling production for 1600 m2 (1120 m2 net) are estimated at 3,400.000 till 3.950.000 IDR (based on seed efficiency of 40% and seed price of 1.200.000 IDR/ kg seed). This is comparable with the financial value of 300 kg seed bulbs bought with a price of 11.300 – 13.200 IDR per kg.

With respect to transplanting techniques and productivity of TSS the following conclusions could be drawn from the research done in 2007- 2010:

- Survival of seedlings without soil modules was fairly good: in general more than 90%.
- Transplanting clusters of seedlings was not giving an improvement in survival of seedlings. Production of clusters of seedlings on soil modules is more expensive and transport of seedlings on soil modules from the nursery to the field is difficult.
- There was no clear difference in yield between transplanting 6-weeks old seedlings and 5-weeks old seedlings.
- Yield of TSS was fluctuating very much from one experiment to another in 2007 -2010. In some experiments that suffered a lot from pest and diseases and in experiments transplanted very early in the dry season the yield was lower than the yield of seed bulb varieties. In other experiment the yield was much higher than the yield of seed bulb varieties, up to twice as high with Tuktuk grown at 150 plants per m2.
- The growing period of TSS is longer than the growing period of seed bulb crops (Tuktuk about 3 weeks longer)
- Compared to Tuktuk the new variety Sanren is an improvement in yield (up to 17%), in earliness (ca. 1 week), in bulb size, resistance to diseases in the field and in storability.
- There was a clear difference between Tuktuk and Sanren in optimal plant density. In the experiment of 2009, optimal plant density of Tuktuk was ca. 175 plants per m^2. The optimal plant density of Sanren was depending on the price of the seedlings. With a seedling price of 26,27 IDR per seedling the optimum was 175 plants /m2, but with a higher price of the seedlings the optimum was 75 plants per m^2. Probably it is better to advice farmers to grow Sanren at 75 plants/ m^2.

- There was a difference between Tuktuk and Sanren in optimal nitrogen fertilization. In the experiment of 2009, optimal nitrogen fertilization of Tuktuk was 180 kg N/ha. The optimal nitrogen fertilization of Sanren was 240 kg N/ha (compared to 180 kg N 9% higher). Storability was decreasing if nitrogen fertilization was increased up to 300 kg N/ha.
- Based on the mean results of experiments in 2008 and 2009 the yield of Tuktuk grown at 150 plants/m^2 was 70% higher than the yield of the traditional seed bulb variety Bima curut bought from store. The yield of Sanren grown at 150 plants per m^2 was 113 % higher than the yield of Bima curut.
- The costs of production of TSS were 3 – 10 % higher than the costs of production of Bima curut bought from store with a seed bulb price 15.000 IDR per kg.
- The introduction of TSS is a realistic option to improve the shallot supply chain. The cost price of the harvested bulbs can be decreased (based on mean results of the experiments estimated cost price of harvested bulbs from Bima curut bought from store: 6762 IDR/kg; Tuktuk 150 plants/ m^2: 4095 IDR/kg and Sanren 150 plants/ m^2: 3340 IDR/kg).