

Udayana University

Summary Report

Republic of Indonesia

Pilot Survey for Disseminating SME's
Technology for Disaster Prevention and
Environmental Regeneration in Indonesia

February, 2016

Japan International Cooperation Agency

Takino Filter Inc.

1. BACKGROUND

In FY2012, the "Project Formulation Survey" under the Governmental Commission on the Projects for ODA Overseas Economic Cooperation was conducted by Takino Filter Inc. In this project, the effectiveness of Takino filter sheets and seed bags (hereinafter referred to as the "Product(s)") were verified in terms of prevention of erosion and fertilization of the soil for the purpose of regeneration for the devastated land beneath Mt. Batur in the north of Bali, Indonesia, based on the support from Yamaguchi University and Udayana University and the recognition of Forestry Research and Development Agency (FORDA), the Ministry of Forestry of Indonesia.

The possibility of deployment of the Products to other types of lands, i.e.; seacoasts, mining sites and slopes of motor way, besides the devastated land by eruption, has been also recognized through the "Project Formulation Survey"

In Indonesia, the spread of the effective technology for disaster prevention and environmental regeneration, such as manufacturing technology utilizing the material of the spot, tree planting technology utilizing the trees and the microbe of the spot, etc., has been considered to be indispensable and it has been a pressing subject.

2. OUTLINE OF THE PILOT SURVEY FOR DISSEMINATING SME'S TECHNOLOGIES

(1) Purpose

The purpose of this survey is firstly to establish the manufacturing technology utilizing the materials of the spot and secondly to conduct pilot studies in a variety of fields, such as seacoasts, mining sites and slopes of motor way, in Indonesia and thirdly to contribute to education and human resource development in the fields of manufacturing technology, microbe culturing technique, soil conservation technology, environmental regeneration technology, and so on, on the basis of the cooperation with Takino Filter Inc., Yamaguchi University, Udayana University and FORDA.

(2) Activities

① Manufacturing facility installation

A building for installing the manufacturing facility was firstly built in Udayana University and then the manufacturing facility was installed there.

Once the installation was complete, pilot production of Takino filter sheets and seed bags using locally available materials were started to establish manufacturing capability.

After that, acquisition of technique for manufacturing Takino filter sheets and seed bags by students of Udayana University were performed through training exercises.

- ② Research and development of a locally available material used Takino filter sheet which has a higher performance in terms of the erosion prevention function and the water retention function.

The research and development were performed in cooperation with Yamaguchi University and Udayana University.

- ③ Research and development of identification, culturing and application of the local microbe (mycorrhizal fungi) for promoting tree planting.

The research and development were performed in cooperation with Yamaguchi University and Udayana University.

- ④ Expansion of the pilot study

Pilot studies on the Products using locally available materials in a variety of fields, such as seacoasts, mining sites and slopes of motor way, in Indonesia, were conducted.

- ⑤ Participation in Mt Batur oriented planting activities by Bali Ethical Eco Planning

Takino Filter Inc. participated in planting activities by offering Takino filter seed bags using local materials.

- ⑥ Holding a symposium once a year and establishing a workshop on disaster prevention and tree planting

Takino Filter Inc., Yamaguchi University, Udayana University and FORDA leaded a symposium and promoted participation of other organizations who were involved in pilot studies or who were interested in using the Products in order to raise the awareness and knowledge of the disaster prevention and tree planting in Indonesia further.

(3) Information of Product/ Technology to be Provided

- ① A "Takino filter sheet" is a sheet which has high validity in prevention of the soil erosion by rain water etc.

The mechanism which demonstrates the effect comes from maintaining stability of nonwoven fabric which consists of two or more water-repellent fibers of which one kind is the adhesion fiber which carries out heat welding.

The structure keeps its size and allows 97% or 98% of water permeability of the nonwoven fabric for a long period of time.



Photo 1 SP-60

- ② A "Takino filter seed bag" is a special vegetation bag which consists of seeds, vegetation base material, and mycorrhizal fungi*.

Because of its composition, the seed bag allows vegetation in sterile or devastated land.

Furthermore, since the bag is quite flexible, it has more effectiveness for sticking even at a rugged place and keeps draining top soil from the bag minimized, that raises the capability of the bag for taking root of vegetation.



Photo 2 Seed bag

*Mycorrhizal fungi

Mycorrhizal fungi colonize into plant roots, make the plants to increase the uptake of phosphorus, mineral and water etc. in soil, enhance the resistance of the plants for drought and promote plant growth and soil aggregation.

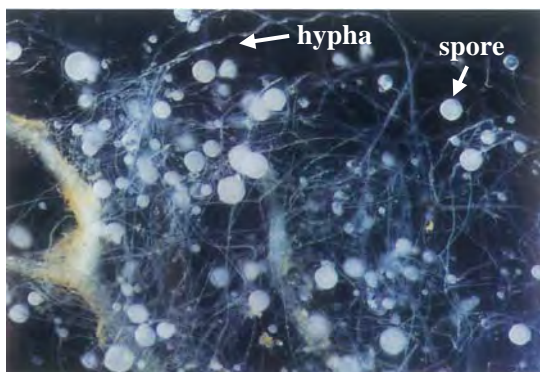


Photo 3 Endomycorrhizal fungi

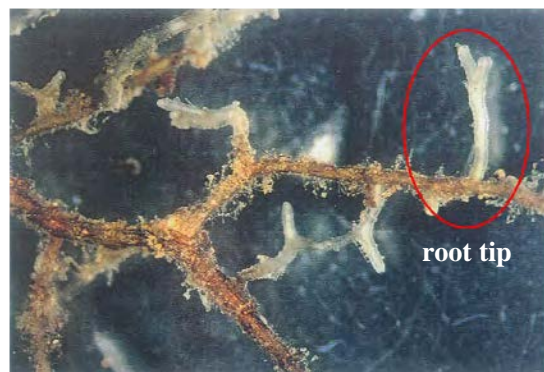


Photo 4 Ectomycorrhizal fungi

(4) Counterpart Organization

Udayana University

Universitas Udayana Kampus Bukit Jimbaran Badung-BALI

(5) Target Area and Beneficiaries

【Target Area】

Kintamani area including the devastated land beneath Mt. Batur, Bali, Indonesia

【Beneficiaries】

As the main activity is planned to be conducted in Kintamani area including the devastated land beneath Mt. Batur, in the north of Bali, Indonesia, for the purpose of enlightening the local residents and the improvement of their lives, based on activities related with disaster

prevention, prevention from soil erosion, vegetation restoration and the spread of cash crops, the followings are target groups:

Direct Beneficiary: Residents near the area where the Takino filter sheets will be applied, approx. 100 households (500 people) (as a target)

Indirect Beneficiary: Residents in Kintamani area, approx. 2,000 people (as a target)

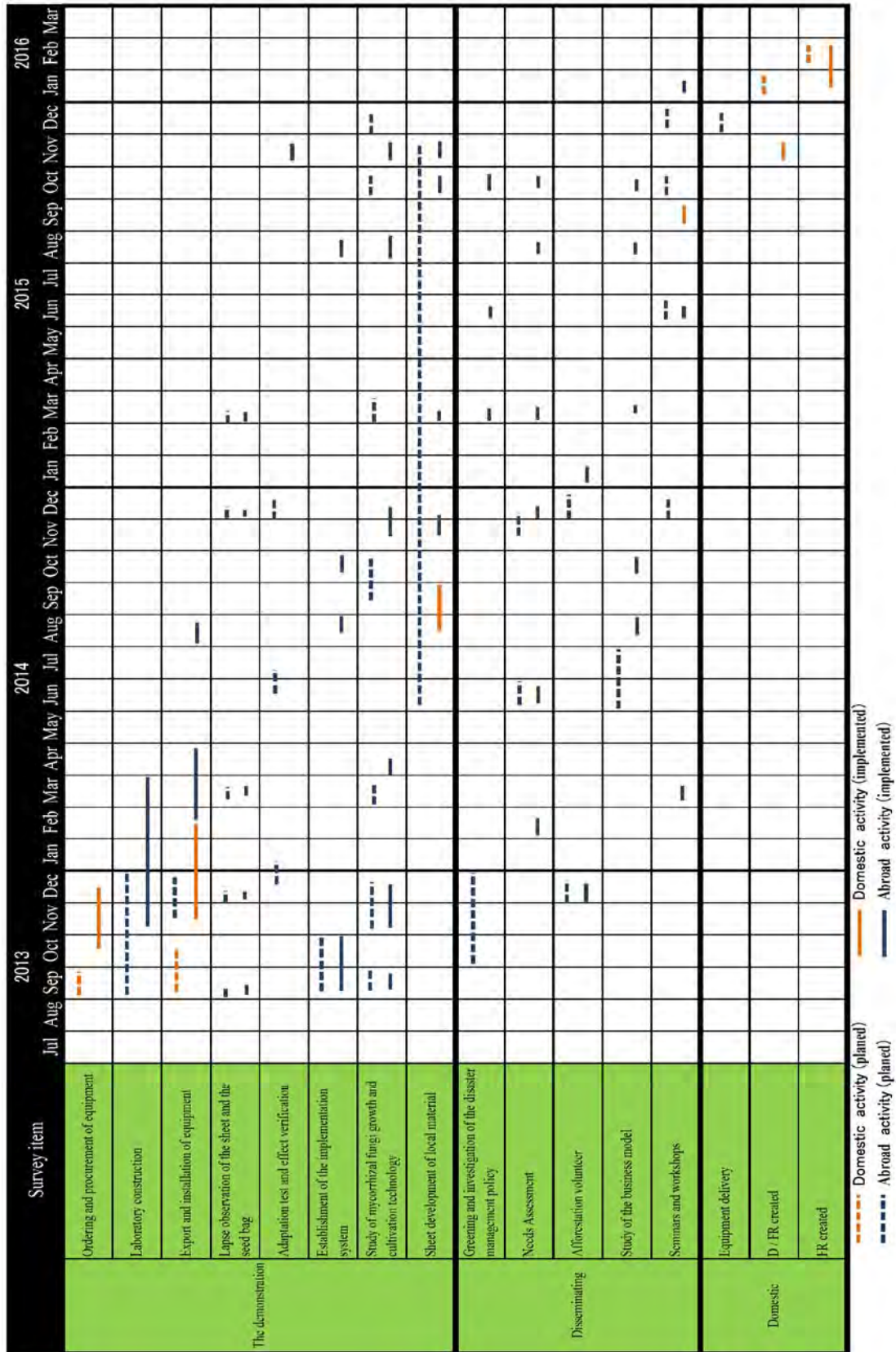
Residents in Denpasar city, approx. 50,000 people (as a target)

(6) Duration

From September 2013 to February 2016

(7) Progress Schedule

Table 1 Work process



(8) Manning Schedule

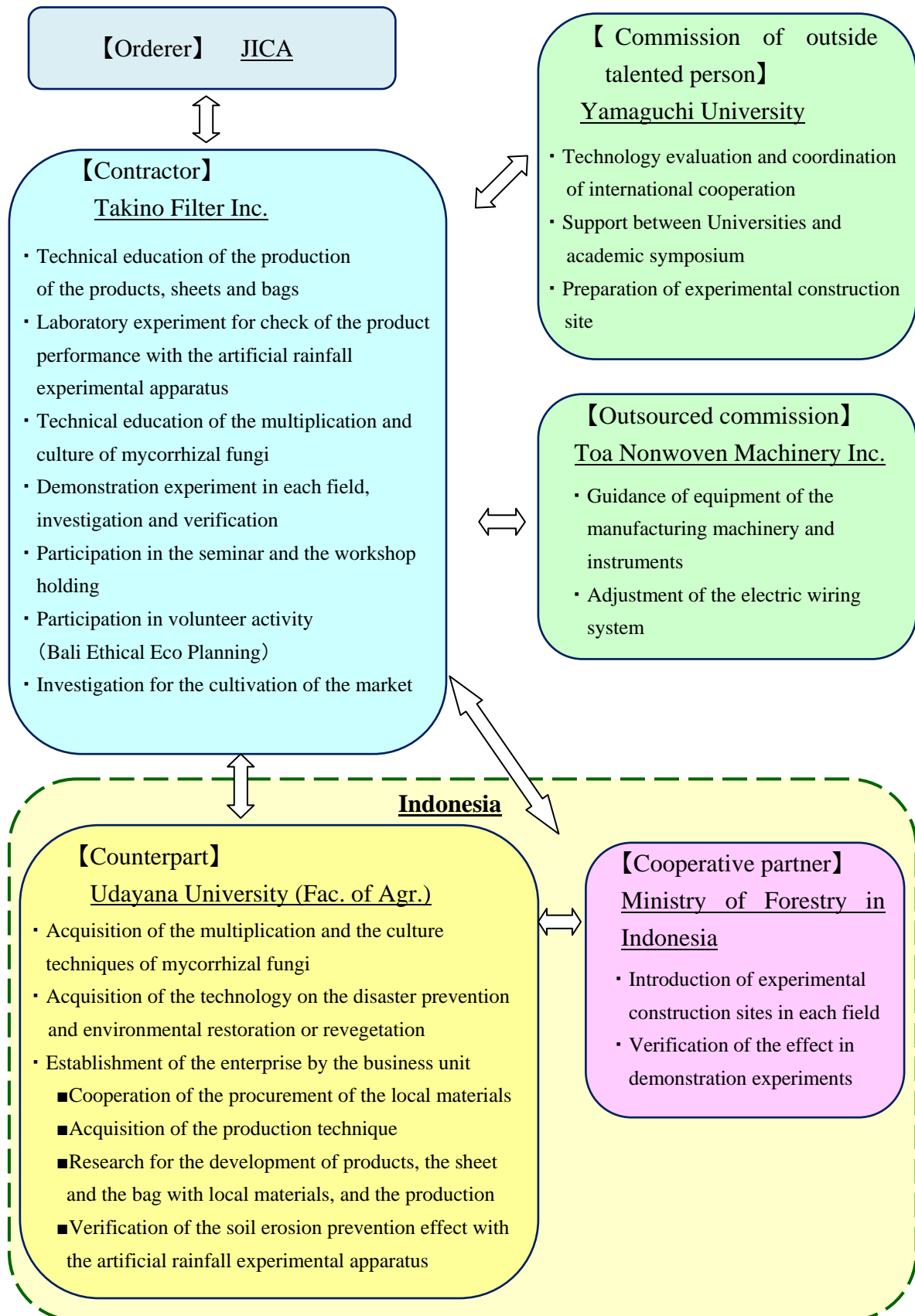
Table 2 Personnel plan

Work in Charge	Name	Affiliation	P/A ※	2013												2014												2015												2016																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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※ P Planning schedule
A Actual schedule

Abroad Activity
Domestic Activity

(9) Implementation System



3. ACHIEVEMENT OF THE SURVEY

(1) Outputs and Outcomes of the Survey

① Pilot Survey

(a) Laboratory construction (borne by Takino Filter Inc.) and installation of equipment

It was decided that the laboratory would be built in the agricultural field of the Faculty of Udayana University. The construction was ordered in December of 2013, and the construction work was completed in March 2014. A series of equipment was installed on March 20, 2014 and the layout of the equipment installed is as follows. The laboratory then has been operated for developing the products using local materials for the business in Indonesia.

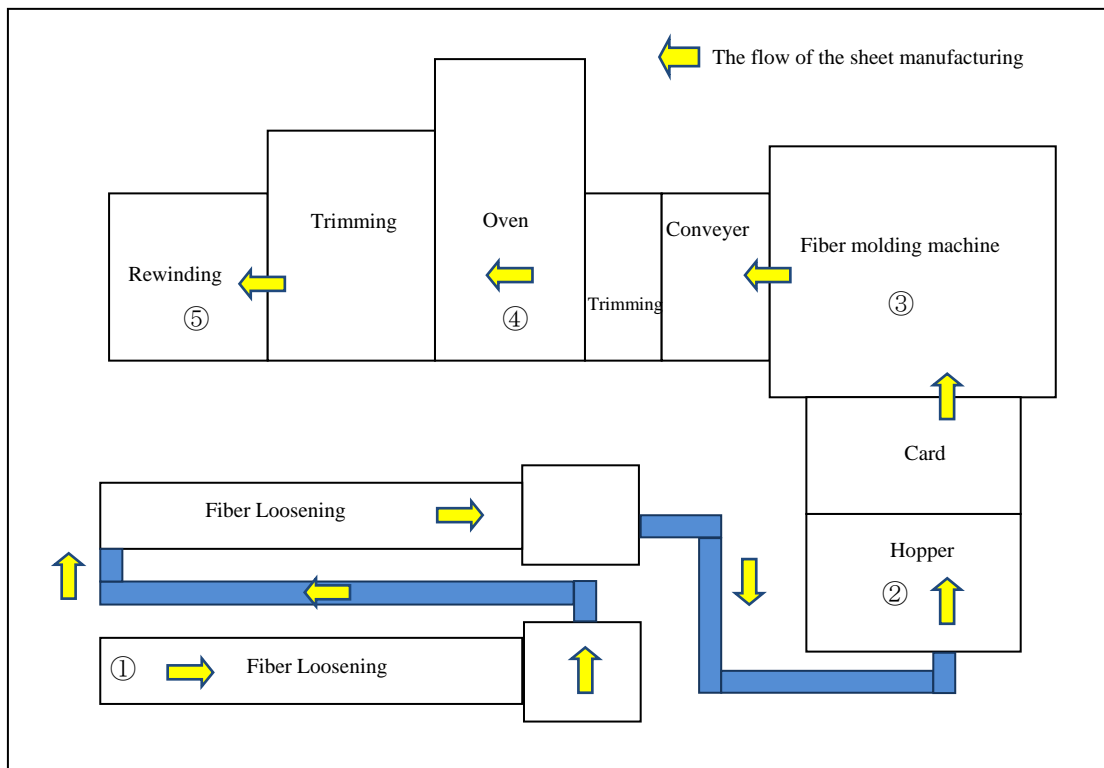


Figure 1 The layout of equipment

(b) On-going monitoring of the Takino Filter sheet (SP-60) and seed bag applied to a pilot field

The on-going evaluation for the 2,500m² of the pilot field where Takino filter sheet and seed bag applied in the devastated area on the foot of Mt. Batur in December 2012 was conducted five times, i.e.; April 2013, September 2013, December 2013, March 2014 and March 2015. The monitoring demonstrated the efficiency of the sheet and seed bag for the surface of Scoria (dark colored basaltic pumice stone).

(i) Erosion prevention effect

Eroded height in the quadrat set up on the border between the area where the sheet was applied and the bare area at 12 months later from the construction resulted in 30mm in average for Site A and 150mm in average for Site B. Because this means that approximately 0.03 to 0.15m³ per 1m³ of the soil erosion was prevented for the area where the sheet applied, it was verified that the sheet was effective for the soil erosion prevention.

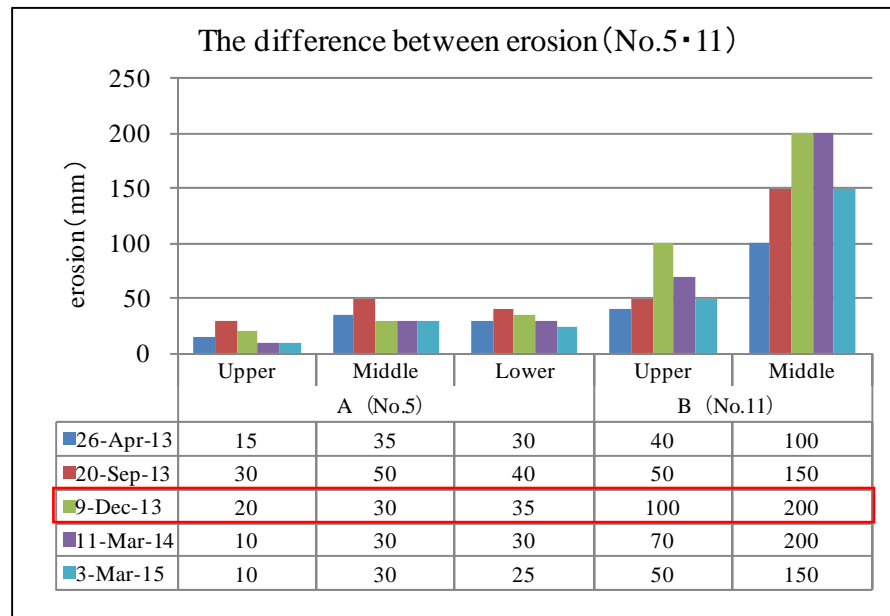


Figure 2 Site A and B follow-up survey

(ii) Vegetation effect

As for the percentage of vegetation cover in the quadrat in Site A at 27 months later from the construction, it was 31% in average for the bare area and 56% in average for the area protected by the sheet respectively. It was considered that the gap came from the function of water keeping and adhesiveness with soil of the sheet as those functions are effective for causing the fixing and sprouting of the seeds which come from flying.



Photo 5 April, 2013



Photo 6 March, 2015

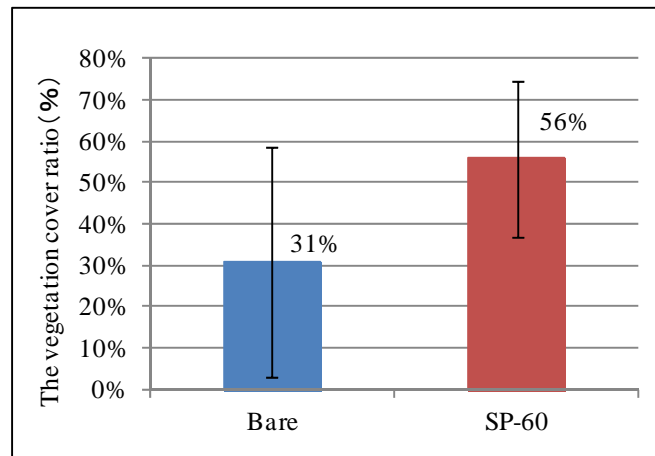


Figure 3 Vegetation cover ratio (March, 2015)

(iii) The effect of tree growth by the Seed Bag

Due to the no anticipation of sprouting of the seeds which come flying, the use of both the Sheet and the seed bag applied to Site B. 33 seed bags (T-1) made of bio-degradable PE and 34 seed bags (T-2) made of palm fiber and nonwoven were prepared and were set up in the 67 different places. Three different types of the seed, i.e.; Teak (Jati), Lead tree (Lamtro Gung), and Jack fruit (Nangka), were used for each seed bag. The highest plant height measured on March 3, 2015 was 53cm (ave. 38cm) for Teak, 60cm (ave. 21.4cm) for Lead tree, respectively. Moreover, as for surviving number, which means whether or not one or more of each type of seed are survived, 11 bags out of 33 bags (surviving rate: 33%) for T-1 and 11 bags out of 34 bags (surviving rate: 32.4%) were resulted.



Photo 7 Seed bag (Lead tree)



Photo 8 Seed bag (Teak)

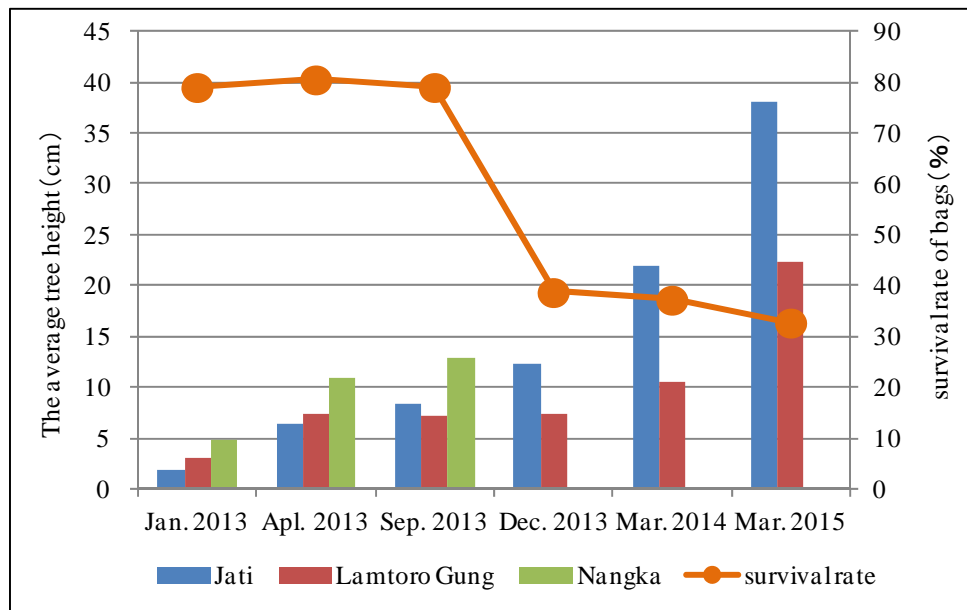


Figure 4 Site A and B follow-up survey

(c) Acceptance test and effectiveness confirmation for the current product with soil in Indonesia

In order to confirm the effectiveness of the application of the current products for the red soil and sticky soil covering the entire Indonesia, pilot application tests were conducted for the Industrial estate A, Industrial estate B and a slope of the high way in Jakarta. The tests resulted in the effectiveness for fixing the soil of the slope and it was utilized for considering the specifications of a new product using local materials. Specially, as far as a comparison test using a competitor's sheet conducted in the Industrial park B was concerned, because there was a huge gap on performance for erosion prevention between Takino filter sheet and competitor's one, the effectiveness of the erosion prevention of the sheet was proved.









Photo 9 The soil outflow situation
(SP-60)



Photo 10 The soil outflow situation
(Other company sheet)

Table 3 Investigation summary

	Industrial estate A	Highway	Industrial estate B
Soil property	Red soil	Clayey soil	Clayey soil
Time construction	Feb.2014 : 50 m ² Dec.2014 : 160 m ²	Sep.2014 : 25 m ²	Sep.2014 : 185.6 m ²
Construction situation			
Mar.2015			
Investigation result (Mar.2015)	<ul style="list-style-type: none"> ▪ Maintained erosion prevention function. ▪ There is a growing Vegetation cover rate ▪ Amount of erosion : maximum 20cm 	<ul style="list-style-type: none"> ▪ Maintain slope protection function of the sheet ▪ Often gully erosion in bare land section 	<ul style="list-style-type: none"> ▪ Maintaining adhesion of the sheet ▪ Growth of the plant is good ▪ Vegetation cover rate is high ▪ Amount of erosion : maximum 20cm

(d) Development of the sheet using local materials

(i) Structure of nonwoven

For the development of the new sheet using local materials, locally available kenaf, cotton and waste paper were mixed with nonwoven to make a sheet. The effectiveness of the erosion prevention of the newly made sheet was tested under the condition of 100mm/h of rainfalls for 60 minutes using rainfall equipment. As for the concentration of SS at 60 minutes later, the sheet containing kenaf resulted in 172mg/l which is equivalent with the result (177mg/l) for the current products SP-45 (45g/m²). Compared with result (74mg/l) of the current product SP-60 (60g/m²), it was relatively weaker. However, it was acceptable result. In addition, the same tests were conducted for the sheet containing cotton and for the sheet containing waste paper and the results were 78.3 mg/l and 54.4mg/l respectively, which were equivalent

results with the current product SP-60.

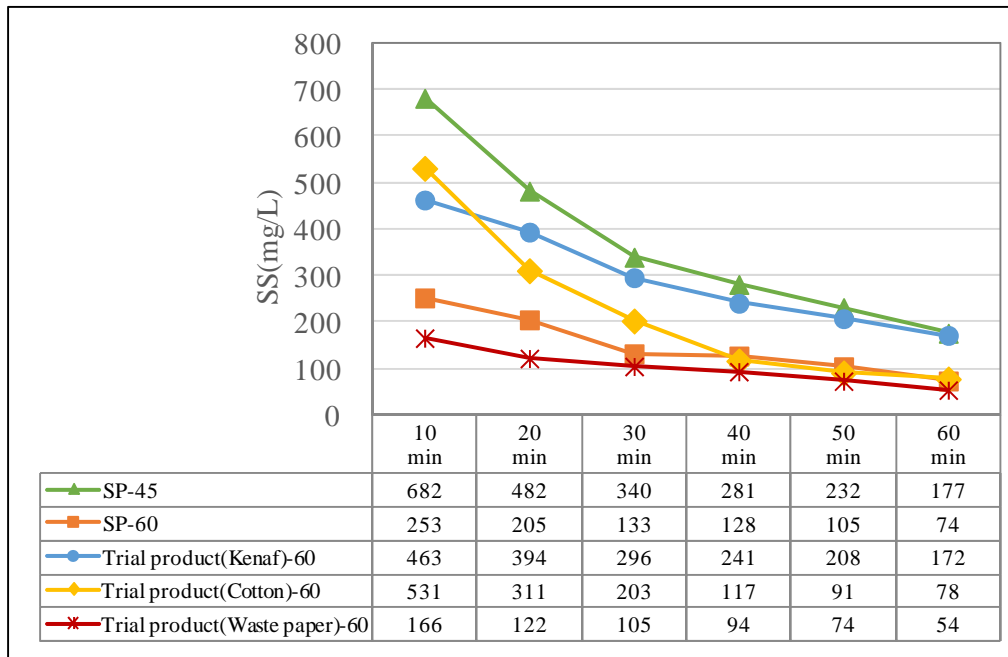


Figure 5 Result of artificial rain test

Firstly, the sheet containing kenaf was developed and then the product's adhesion with the soil in Site B of the Mt. Batur was evaluated. Because the layer of the nonwoven of the sheet became thinner and its voidage became lower, the adhesion with soil particles was lost. Because the result stemmed from its less flexibility of the kenaf fabric, the development of the sheet containing kenaf was suspended. Based on this result, a pilot field test was conducted for all newly developed products except for kenaf contained one at Site C of Mt. Batur. Specifically, 100m² of SP-60, 250m² of cotton contained sheet and 250m² of waste paper contained sheet were constructed in the field and the effectiveness of erosion prevention of each product and adhesion of the soil particles were confirmed on March 3, 2015.

• Erosion prevention effect

In the border between the sheet covered plot and the bare plot where the sheet is not covered, the level difference occurred by the erosion by the rainfall resulted in 21.7mm on average for the sheet including the waste paper and 35.0mm on average for the sheet including the local cotton respectively, so that the level difference by the erosion for above sheets was bigger than that for the SP-60 sheet. It is considered that the difference is caused by the difference of the slope gradient, that is while the slope gradient in the site of which the

quadrat was set for the SP-60 sheet was loose as 15° the slope gradient in the site of which the quadrats were set for above sheets was steep as 30°.

- Cohesion with soil grains

After one year from the construction, each sheet sample of 1m² was sampled from two sites and the weight of soil grains attached with the nonwoven fabric was measured. As a result, those were 1.58kg/m² on average of two samples for the SP-60 sheet, 1.96kg/m² on average of two samples for the sheet including the waste paper and 2.18kg/m² on average of two samples for the sheet including the local cotton. Thus, it was shown that the sheet including the local cotton has a superior cohesive function with the soil grains.

Based on the verification result of the erosion preventive function and the cohesion with the soil grains, it was decided that the local cotton fiber was adopted in the nonwoven fabric in the development of the sheet with the local materials.

Table 4 Measurement result

Sheet type	Soil erosion situation	Soil particle situation
Existing product SP-60	Average 4.3 mm	1.58kg/ m ²
Waste paper mixed sheet	Average 21.7 mm	1.96kg/ m ²
Cotton mixed sheet	Average 35.0 mm	2.18kg/ m ²



Photo 11 Test construction (October, 2015)

From the left, SP-60,
Waste paper sheet, Cotton sheet



Photo 12 Cotton mixed sheet

Adhesion status of the soil particles

Table 5 Selection of the materials for nonwoven fabric

Local material	Processing molding	Strength	Resiliency	Remarks
Polyester	◎	◎	◎	Existing product
Palm	×	—	—	The fiber is thick and the flexibility is poor.
Hemp palm	×	—	—	It does not entwine with the other fiber, so that it cannot be formed.
Kenaf	△	○	△	The fiber is hard and it has no flexibility.
Waste paper	△	△	○	The manufacturing process is increased.
Cotton	◎	○	◎	It entwines with the other fibers easily and it is rich in crimp.

(ii) Composition of the net

As a result of the examination of the bamboo and the straw cords as the net material, the fiber of bamboo cord is too hard to twist, so that the net with the straw cord was manufactured experimentally and it was mounted on the nonwoven fabric.

Because the straw cord is the natural fiber, the experiment to investigate the durability performance for the ultraviolet degradation etc. was implemented in the experimental site C of Mt. Batur. As a result of the investigation after 3 months, the degradation by the rainfall and the ultraviolet was not observed and the shape and the protective function were maintained.

The sheet material with the straw net of 1 m² was sampled and the ultimate tensile strength of it was measured. As a result, the strength of 700 N was kept on average. This is not the strength which can be easily cut by pulling by hands, so that it is judged that it can be kept for half year which more than 50% of the ground is covered by the naturally intruding plants. In future, the condition after 6 months is planned to investigate and the adoption of the straw net will be considered. Therefore, there is hope that our company can develop the sheet with the local materials.

Table 6 Selection of the net materials

Local material	Processing molding	Strength	Weather resistance	Remarks
Polyethylene	☉	☉	☉	Existing material
Palm	×	—	—	The fiber is thick and the flexibility is poor.
Bamboo	×	—	—	It has no flexibility and cannot be twisted.
Straw	○	○	○	It has the flexibility and can be processed easily

Table 7 The ultimate tensile strength (UTS) of the straw net (N)

	UTS (N)
1st	540
2nd	879
3rd	689
Total	2,108
Average	702.7



Photo 13 The nonwoven fabric including the local cotton and the straw net



Photo 14 Durability test in the site C of Mt.Batur

(iii) The sheet with the local materials

Table 8 Product specifications

Standard (dimensions)	Width=1 m length=50 m weight=11 kg
Main material	Nonwoven fabric made of polyester and cotton 60g/m ²
Secondary material	Straw NET Mesh size 25mm×30mm
Design prices	@400yen/m ² ~@500yen/m ² (Assumption)

When the manufacturing cost of the sheet developed this time is compared with that of the existing product, it is assumed that the cost reduction of 25.2% for the material cost, the cost reduction of 41.5% for the total cost when the labor cost is included and the cost reduction of 24.2% for the total cost when the material transportation cost is included are achieved respectively. In future, our company will consider the further cost reduction of the manufacturing cost.

Table 9 Reduction rate and procurement ratio

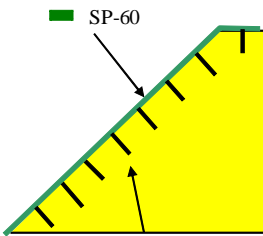
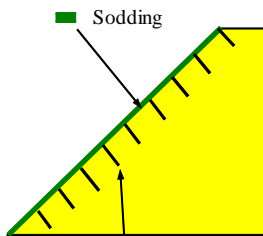
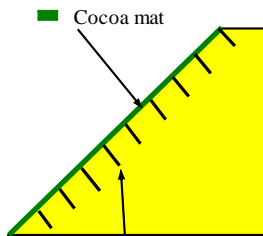



Item	Type	Development product	
		Cost reduction rate for the existing product	Ratio of local procurement
Main materials	Net	23.8%	100%
	Nonwoven fabric	28.9%	20%
	Paste cloth	0.0%	0%
Packing materials	Paper tube	8.0%	
	Polyethylene bag	46.2%	100%
Materials total		25.2%	55%
Labor cost		44.4%	100%
Others		73.6%	100%
Total		41.5%	70%
Total cost including transportation cost (export)		24.2%	

The ratio of local procurement which constitutes the manufacturing cost of the developed product showed 100% for the net, 20% for the nonwoven fabric, 100% for the packing bag, 55% for total materials respectively and it showed 70% for total matters including the labor and the other costs.

As the design price, 400 to 500 yen/m² is assumed, but the present competitive

construction method in Indonesia is the sodding method which is the main stream as the slope protection method. The total cost of the sodding method is cheap as 170 yen/m² and because the density of raw sod is high and the base material is thick, the erosion preventive function for the rainfall is superior, but when the stable rooting of sod is not achieved, the corrosion resistance decreases. Particularly, in the red soil and the expansive soil (clayey soil), the slope collapse and the erosion occur during the rainy season frequently, so that it is considered that the sodding method is the method adaptive to the flat ground.

Table 10 Comparison of each construction method

	SP-60 (Indonesia Version)	Sodding work	Cocoa mat
	Standard W=1m L=50m	Standard (30cm×30cm)	Standard W=1m L=20m
Schematic	 <p>SP-60</p> <p>Bamboo skewer: L=200 mm (441pins/100m²)</p>	 <p>Sodding</p> <p>Skewer</p>	 <p>Cocoa mat</p> <p>Skewer</p>
Image	 <p>After construction</p>	 <p>After construction</p>	 <p>After construction</p>
Overview	Sheet made using local materials in order to prevent erosion.	Lay turf	Mat consisting mainly of palm
Erosion resistance	Sheet will stick to the soil. Sheet prevents the erosion of the soil.	◎ If the root is not established, it reduces the effect of erosion resistance.	△ Decomposition is faster. Erosion is facilitated.
Landscape	Sheet is in harmony with nature by vegetation.	◎ It is greening immediately after construction. Native species does not grow.	○ Early greening method. The plant will decline by fertilizer shortage.
Workability	Only construction directly to the slopes	◎ This construction takes time.	△ Only construction directly to the slopes
Economy	Direct cost @550yen/m ² ~@650yen/m ² Cost of product @400yen/m ² ~@500yen/m ² (supposition)	△ Direct cost @250yen/m ² Cost of product @170yen/m ²	◎ Direct cost @400yen/m ² Cost of product @200yen/m ²
Evaluation	◎	○	△

(e) Research of culture and propagation techniques of mycorrhizal fungi

While the lecture of general education concerning the basic knowledge of culture and propagation of mycorrhizal fungi for 90 minutes was implemented for the graduate or

undergraduate students in Faculty of Agriculture, Udayana University in seven times, in the education of culture and propagation techniques of endomycorrhizal fungi, the morphological identification of collected each spores was implemented and two kinds of spores among them were propagated by making them colonize into the gramineous grass plants and the propagated spores were utilized by putting in the seed bags used in the planting festival.

Concerning the research of culture and propagation techniques of ectomycorrhizal fungi, the education of the three step culture process of agar, liquid and solid cultures was implemented and the propagated solid culture materials were inoculated into the Sumatran pine and Eucalyptus seedlings and after the seedlings were raised for 4 to 5 months, some of them were planted in Mt. Batur.

While culture and propagation techniques of mycorrhizal fungi contributed to the improvement of knowledge for students, it is considered that the extensive wide utilization ways were understood. In the future, while the investigation of woody plants grown from the seed bags and seedlings planted is implemented by the students in Udayana University, the effect is planned to investigate and verify.

② Dissemination activities

(a) Investigation of the local needs

As a result of hearing investigation for the local Japanese affiliated companies and consultants in Java Island, it was recognized that there are many sites where the soil runoff occurs by the rainfall although the protection measure by the sodding is taken in the red soil and the soft ground (clayey soil) in the industrial estate and the road slope etc, where the soil foundation is not stable and is difficult for the slope protection.

In the plan of infrastructure development that is the policy of the Joko administration, the infrastructure project for the private companies, in which the complete budget of 52 billion dollars is taken, is planned and the needs for the environmental conservation such as the prevention of the sediment runoff and the inflow of the muddy water into the river etc. is increasing.

Table 11 Main infrastructure project

Business item	Business content
Road system	Preparation of the mass transport in the 6 metropolises of Jakarta, Medan, Makassar, Semarang, Bandung and Surabaya <ul style="list-style-type: none"> • Construction of the express highway in the coastal site in Java Island (Total length of 1,000km) • Construction of a new road (Total length of 2,600km)
Railroad system	Preparation of the railroad in Java Island, Sumatra Island, Kalimantan Island, Sulawesi Island and Papua Island(3,258km)
Airport	In present, there are 297 airports of various large and small sizes, but 15 new airports are planned to construct.
Harbor	New construction and the expansion of the harbor neighboring the industrial estate and the power plant are planned in 24 sites.
Dam	25 dams needed for the water supply to the agricultural area are planned to construct for 5 years.

While, the violent change of the climate condition of rainy and dry seasons and the natural disaster such as volcanic eruption, earthquake, Tunami, flood and landslide etc. occur frequently and according to the statistics in National Disaster Management Authority (BNPB), the loss by the disaster for 10 years from the Sumatra-Andaman earthquake on December, 2004 to the volcanic eruption in Mt. Sinabung in January, 2014 amounts to about four trillion Japanese Yen. Thus, the loss brought by the disaster becomes the large loss including the economic loss.

Thus, in order to make the dichotomic of the economic growth and the environmental remediation proceeding simultaneously, the slope protection in mountainside, road, coastal line and mine site is needed and it is considered that there are many chances of the utilization of the sheet and the seed bag.

(b) Tree planting volunteer

In December, 2013 and January, 2015, as the regeneration by the development of thick growth of trees in the devastated site of Mt. Batur and part of the environmental education, the tree planting ceremonies with the seed bag were implemented with the local residents and high school students. Concerning the progress after tree planting, the tree growth condition is shared with the local high school students.

(c) Consideration of the business model

The establishment of the business unit in Udayana University was agreed and the development and the manufacture of the sheet with the local materials were implemented.

And, concerning the business for the future business development in Indonesia, the memorandum among Takino Filter Inc., Udayana University and the local company in Bali was concluded and the negotiation for the conclusion of agency contract with the Japanese trading company located in Jakarta is proceed.

(d) Seminar and workshop

On 24th, April, 2014, our company participated in the forum for the woodland creation in Kalimantan area located in the east part of Indonesia and gave the presentation on the environment remediation technology with the sheet and the seed bag in the devastated lands and the mine site.

And in June, 2015, our company participated in the construction conference held in Jakarta and gave the presentation.

In September, 2015, our company accepted persons concerned in Badan Pengkajian dan Penerapan Teknologi (BPPT), Bandung Institute of Technology (ITB) and Udayana University (UNUD) in Japan and held the workshop in the main office of Takino Filter Inc. and Unzen. In the meetings, it was understood that in the revival rehabilitation in the site where the slope collapse occurred by the heavy rainfall disaster and in the slope protection and the initial forestland creation, the Takino Filter product was adaptable even in Indonesia and it was needed.

In January, 2016, our company held the final meeting for the report of project and the business development for the government officials and the Japanese affiliated companies in Jakarta.

(e) Test construction in East Timor

The experiment to investigate the possibility of the slope protection with SP-60 of the existing product on the cut slope of the national road in East Timor was implemented in November, 2015 prior to the rainy season. The future investigation is planned to be utilized in the business development.

Table 12 Outline of the test construction

Construction Date	18,19 Nov.2015
Construction site	Tibar-Gleno A04 (32+260)
Conditions	Slope length : 11.0m, Slope gradient : 40°, Slope facing east direction, Soil hardness : 16~35mm, pH : 6.2
Material	SP-60 : 100 m ² , Seed bag : 9 bags
Construction method	Slope protection : SP-60 (48 m ²) Revegetation : Seed dispersal + SP-60 (48 m ²), Seed bag (9 bags)
Used seeds	Woody plants : Aicoffee seeds, Tephrosia seeds Grass plants : Perennial Ryegrass, Annual Ryegrass, Creeping Red Fescue, Unhulled Couchgrass

As the result obtained through the above activities, after the laboratory was constructed in the Faculty of Agriculture, the equipments for manufacturing the sheet, the sewing machine for the Seed bag and the equipment for the artificial rainfall test were arranged and the education for students lead to the acquisition of manufacturing technique for the sheet and the seed bag and the development of the sheet with the local materials, in which the local cotton was mixed in the non-woven fabric and the local straw was replaced as the protection net, could be implemented.

In the developing process of the sheet with local materials, the test constructions with the existing products with the equal function with the developed sheet were implemented in the industrial estate where many Japanese affiliated companies had been constructed, the local highway site and the river bank slope where there are numerous red soil and expansive soil (clayey soil) subject to the severe erosion in Java Island and the effect was verified and there has been hope that our company can disseminate the products. Particularly, in the industrial estate, the slope collapse is remarkable in the made land in the rainy season and the sheet with superior erosion preventive function is expected strongly and it is considered that it leads to sales after the completion of the project.

(2) Self-reliant and Continual Activities to be Conducted by Counterpart Organization

Assuming the preparation of a mechanism for the business construction with Udayana University, the division of roles was discussed with Udayana University. As the manufacturing base, it is considered that the efforts by Udayana University become the important point after the development of the sheet with the local materials. After the completion of this project, the business model by the business unit in Udayana University is considered based on the

agreement written on 17th, September, 2013, in which our company and Udayana University administer the manufacturing equipments collaboratively. The business unit in Udayana University is given the manufacture of the sheet and the seed bag in trust by our company as the manufacturing company of them and the business and the sales are taken charge of by our company. The implementation system, that the business unit in Udayana University consigns the acceptance of materials and the transportation of products to the local company in Bali responsible to the works and our company support the administration of the company, is currently under discussion.

4. FUTURE PROSPECTS

(1) Impact and Effect on the Concerned Development Issues through Business

Development of the Product/ Technology in the Surveyed Country

① Future development

Because the registration of the material with National Standardization Agency of Indonesia (BSN) was needed in Indonesia, it was agreed that our company put the joint research group with Agency for the Assessment and Application of Technology (BPPT), the investigation organization in Ministry of Public Works and People's Housing (PU), Ministry of Energy and Mineral Sources (ESDM), Environment and Forestry Research and Development Agency (FORDA) in Ministry of Environment and Forestry and Bandung Institute of Technology (ITB) and the demonstration experiment with the sheet made of the local materials is implemented, the verified result is concluded and the registration of the sheet material (SNI) is supported by BPPT. In this joint research, by obtaining the technical verification, the reliability of the sheet product is obtained in the design matter by the government-affiliated organs and the registration of the sheet material enables the design which it is incorporated in the government office and that leads to the sales promotion in the business development.

② Effect of natural environmental remediation in the devastated lands

In Mt. Batur where the natural vegetation such as the forest had resulted in destruction by the great eruptions occurred in 1917 and 1926, 98 years have passed from the latter eruption and the recovery by the natural plants has advanced and the tree planting by the volunteer activities has implemented, but the desert where the volcanic rocks are exposed and the grassland where the gramineous grass plants colonize are extending even now. When the present vegetative state is adapted to the schematic diagram of general plant succession, it corresponds to the grassland period of 50th year and it is equivalent to the state which it loses 48 years. The construction method with the sheet and the seed bag including the mycorrhizal fungi that was implemented for the natural remediation effect in this area had been developed

by Nagasaki Prefecture as the afforestation construction for the disaster measures in Mt. Unzen's Fugen-dake, Nagasaki Prefecture. In this site, the diverse plant community which grass plants and shrubs etc. are intermixed was formed after 20 years and the vegetative state is judged as the state of about 70 years later from the start of plant succession when it is adapted to the schematic diagram. This matter means that the construction method with the seed bag shortened an amount of time corresponded to the woodland creation for about 50 years. Thus, it is considered that the construction method with the sheet and the seed bag is useful for the remediation work in the devastated lands and the revegetation work in mine site in Indonesia.

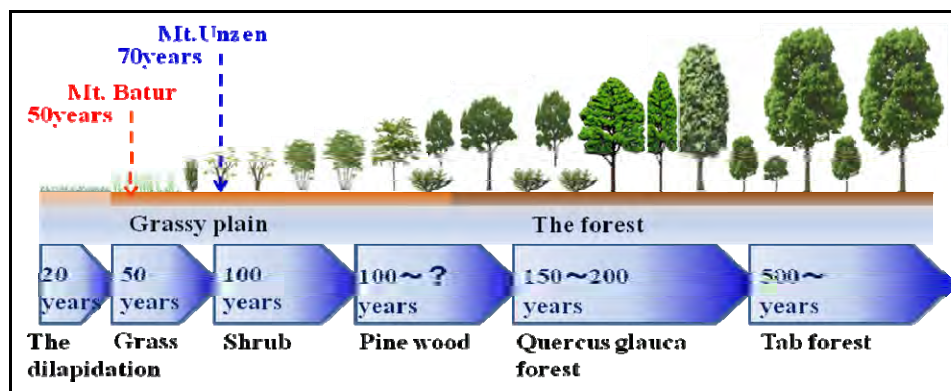


Figure 6 Schematic diagram of shortening of plant

③ Effect of the total cost reduction by the sheet

In the sodding method which is the main stream as the slope protection work in Indonesia, the initial curing term in which the sands are broadcast on sod after sodding, the joint soil is put and the sod roots grow down into the soil and the rooting is achieved takes 2 to 3 months and a lot of time and labor such as water sprinkling in the term, so that when the rainy season sets in before the rooting is achieved, the protection function by the sodding on the slope is hindered and the phenomenon which the erosion and the collapse of the slope occur is concerned. By the erosion prevention effect which is characteristics of the sheet, the slope protective function is fulfilled immediately after the construction and irrespective of the slope gradient, it enables the construction even in the steep slope such as 73°, it can save the work trouble in comparison with the sodding, the construction period is shortened and it is considered that the apprehension of the slope collapse in the rainy season can be also eliminated, so that the great effect by the construction with the sheet is expected.


Sodding work 	Leveling⇒ Cover with soil and soil conditioner⇒ Construction ⇒Rolling compaction⇒Spraying of joint soil (72days) ⇒Sprinkle water⇒Lawn care (60~90days)
SP-60 	Leveling⇒Construction (40days) <div style="border: 1px dashed red; padding: 5px; display: inline-block;"> To shorten the work period (about 1 month) </div> ⇒ Maintenance free

Figure 7 Construction term of sodding and covering

(2) Lessons Learned and Recommendation through the Survey

① Future implementation system

In association with the establish of the business unit, towards the industrializing of the laboratory it is required to clarify the roles of the Udayana University and Takino Filter Inc. For developing production capacity of the business unit, it is important to keep in mind that it will take time for the machine operators and the quality control staff to enhance their skills and know-hows, and thus, their continuous allocation is necessary.

② Utilization of the equipment for the artificial rainfall test

The development of the sheet and the utilization of the equipment by the civil engineering professional staff are concerned because the business unit is organized as a part of the Faculty of Agriculture. In future, it is recommended that a new joint research system among our company, Udayana University and Bandung Institute of technology (ITB) is built. Roles that the handling of the equipment in the development of the sheet, and the vegetation test with the trial sheet product are taken charge of by ITB and Udayana University respectively.

③ Business of the mycorrhizal fungi

It is considered that the continuous works, that the remained propagules are propagated by using the equipment for the propagation. In addition, the development of a material with the mycorrhizal fungi is recommended to further studied.

ATTACHMENT: OUTLINE OF THE SURVEY

