IMPLICATIONS OF SALINITY RESEARCH IN ACEH FOR INDONESIAN RICE GROWING
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Abstract
Salinity problems have become common in recent times, due to climate change and natural disasters. Several hundred thousand hectares of irrigated land are abandoned as a result of salinisation every year. Despite the fact that salinity has been destroying the productive capacity of land in Indonesia for decades, it is only relatively recently that we have recognized the extent of the problem. However, there are fewer efforts on a national scale to slow down the process; wide areas of lowland areas along the northern coast of Java and along the western coast of Sulawesi islands were abandoned because of sea water intrusion to the inland. In addition, expertise and staff dealing with soil salinity are scarce.

The tsunami of December 26, 2004 destroyed agricultural land along the western and eastern coast of NAD. As a result, many crops established and yielded poorly due to salinity, water logging, and nutrition problems. There is a need to have experienced staff available to solve problems, to transfer techniques and knowledge on salinity remediation and to evaluate management strategies which at least restore productivity to pre-tsunami levels.

To solve the problems, the ACIAR project, LWR/2005/118 aimed at restoring livelihoods through the re-establishment of annual cropping – especially rice cropping, and reducing the reliance on food aid in tsunami-affected areas of NAD. Several activities have been completed for this project and some results implemented with farmers in NAD. Capacity building through workshops and training, research and variety trials – especially on rice cropping and demonstration of crop management packages have been completed and evaluated in tsunami-affected areas. Rapid progress with re-establishment of rice farming is being made in response to this project. It is proposed that similar activities would be conducted in other locations affected by a tsunami.

Rice is a major food crop in Indonesia and compared with other crops such as wheat and barley, sensitivity to saline soil conditions that can dramatically reduce rice yields. Results of this project in NAD, along with the trials and communication strategies could be used in other locations affected by salinity in Indonesia, especially for rice cropping.

Key words: soil salinity, tsunami-affected soil, soil and crop productivities, rice cropping
INTRODUCTION

Salinity problems are becoming more widespread. Data from FAO shows that nearly 50% of irrigated lands had some degree of salinity problem. Every year several hundreds of thousands of hectares of irrigated land are abandoned as a result of salinisation (Abrol 1986). In Australia, salinity is a major environmental crisis; according to recent surveys, some 2.5 million hectares of land has already been affected by salt rising from the water table. Dr Tom Hatton from the CSIRO Land and Water Department warns that the area affected by salinity is likely to increase to 15 million hectares in the coming decades. Much of the land that has been affected is in the most productive agricultural areas (Leigh 2001). Further more, Zeng et al. (2003) reported those in recent years, salinity concerns are increasing in rice (Oryza sativa L.) producing areas of California, where a direct water-seeded system is dominant. Salinity levels of standing water at rice fields in those regions have risen because of irrigation practices such as the use of recirculation water systems and the requirement of water holding after pesticide application during early growth stages. This has resulted in loss of plant stand and reduction of final seed yield in salt-affected rice fields.

The above phenomenon has also occurred in Indonesia, but reliable estimates of the extent of the problem are not available due to inadequate scientific surveys. Along the main rice production area in Indonesia along the north coastal region of Java island (PANTURA), the problem of salinity is increasing, and discussion with farmers from that area indicates that many have moved from lowland rice to salt producing land and fisheries, or abandoned their lands (Sembiring and Gani 2007).

Despite the fact that salinity has been destroying the productive capacity of land for decades, it is only relatively recently that we have recognized the extent of the problem. Unfortunately, the effective efforts to slow down the process on a national scale are very limited. Salinity acts to inhibit plant access to soil water by increasing the osmotic strength of the soil solution. As the soil dries, the soil solution becomes increasingly concentrated, further limiting plant access to soil water. For this reason, it is true that salinity is a major environmental constraint limiting the yield of crop plants in many semi-arid and arid regions, including the drier eastern part of Indonesia.

According to Gregorio et al. (2002), saline soils are characterized by an array of properties that are adverse to rice cultivation. The problem of salinity is compounded by mineral deficiencies (Zn, P) and toxicities (Fe, Al, and organic acids), submergence, deep water and drought. These soil stresses vary in magnitude and interactions over time and place, making long-term adaptability of a cultivar dependent on its
level of tolerance to all the stresses that occur in its growing environment. Thus, in breeding rice for saline environments, multiple stress tolerance traits must be considered. Furthermore, Zeng and Shannon (2000) reported that rice is rated as an especially salt-sensitive crop. The response of rice to salinity varies with growth stage. In the most commonly cultivated rice cultivars, young seedlings were very sensitive to salinity. Yield components related to final grain yield were also severely affected by salinity; panicle length, spikelet number per panicle, and grain yield were significantly reduced. Salinity also delayed the emergence of panicle and flowering and decreased seed set through reduced pollen viability.

The 2004 tsunami caused significant degradation to agricultural lands in the coastal region of NAD. The most affected was lowland rice. The rice crop productivity is constrained by a combination of poor seed quality, use of unsuitable varieties, sub-optimal soil fertility and climate variability. To reduce these constraints in tsunami-affected areas of the east and west coast of NAD, the ACIAR tsunami recovery projects in NAD i.e. SMCN 2005/118 and CP2004/05 followed by LWR/2005/118 was aimed at restoring livelihoods through the re-establishment of annual cropping – especially rice cropping, and to reduce the reliance on food aid in tsunami-affected areas of NAD. Several activities have been completed for this project and some results have been implemented with farmers in NAD. Capacity building through workshops and training, research and variety trials – especially on rice cropping - demonstrating of crop management packages have been completed and evaluated.

Through this article, the information on salinity affected soil and rice crop, especially in NAD after tsunami, is described and the most feasible remedial measure is suggested. Last, but not least, the implications of salinity research for Indonesian rice growing is also discussed.

**TSUNAMI IN NANGGROE ACEH DARUSSALAM**

Tsunami on December 26, 2004 destroyed agricultural land along the western and eastern coast of NAD. The Agriculture Department of Ministry of Agriculture, the Government of Republic of Indonesia has assessed the area affected on food crops by tsunami in east and west coastal districts of Nanggroe Aceh Darussalam (NAD) (Table 1).

At Aceh Besar district 11% of rice crop area was destroyed, especially at Ingin Jaya, Pekan Bada, Dhoknga and Syah Kuala sub-districts. At Pidie district 10.5% of rice crop areas were destroyed, especially at Pidie city and Indra Jaya sub-district. Further more; at Bireuen and Aceh Barat districts 8.1% and 14.7% rice land were devastated by
tsunami. The most affected area was the north-west coast of the province, 50-80% food crop areas were badly damaged; around Calang, Lamno, and the north part of Banda Aceh the rice crop areas were severely destroyed (Gani 2005). The most damaged crop land was rice land, due to location of lowland rice at the lower coastal areas. If direct action is not taken to rehabilitate lowland rice area, NAD will not be self sufficient in rice, as it used to be.

Table 1. Lowland rice damage by tsunami in some districts, NAD 2005.

<table>
<thead>
<tr>
<th>District</th>
<th>Lowland rice area (ha)</th>
<th>Percentage of damage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Damage</td>
</tr>
<tr>
<td>Aceh Selatan</td>
<td>17916</td>
<td>3627</td>
</tr>
<tr>
<td>Aceh Barat Daya</td>
<td>18249</td>
<td>4520</td>
</tr>
<tr>
<td>Aceh Barat</td>
<td>41538</td>
<td>6107</td>
</tr>
<tr>
<td>Aceh Jaya</td>
<td>15529</td>
<td>4159</td>
</tr>
<tr>
<td>Aceh Besar</td>
<td>30915</td>
<td>3574</td>
</tr>
<tr>
<td>Pidie</td>
<td>38302</td>
<td>4023</td>
</tr>
<tr>
<td>Bireuen</td>
<td>20507</td>
<td>1666</td>
</tr>
<tr>
<td>Total</td>
<td>182956</td>
<td>27676</td>
</tr>
<tr>
<td>Total (NAD)</td>
<td>336017</td>
<td>28931</td>
</tr>
</tbody>
</table>

Source: Head of Dinas Pertanian Tanaman Pangan dan Hortikultura Provinsi NAD (personal communication, 2005).

Disasters caused by tsunami were structurally, physically, chemically and biologically in nature, in respect to agricultural productivity. Top soil analysis (January 2005) of some tsunami-affected soils showed that soils had become saline-sodic, with EC of 4.27-15.18 dS m⁻¹ and ESP of 13-72% (Gani 2005). More over, Rahman (2007) reported that the tsunami mud collected from 3 districts indicated a very high salinity ranged from 3.7 to 48.9 dS/m and salt content from 9,000 to 26,000 ppm. Improper handling of this tsunami mud may contaminate the sub soil through tillage and infiltration, leading to an elevated increase of salt concentration in the sub soil. Further leaching of sodium may potentially contaminate the ground water which eventually be utilized by the community for their daily consumption.

From field visit of ACIAR Team on September 2006, it is showed that salinity had decreased considerably. However, it is not only a need to enhance the leaching of both soluble salts and exchangeable sodium and magnesium to reduce their harmful effects, problems on nutrient imbalance after tsunami may be more important (Sembiring and Gani 2007).
Leaching, soil amendments and mulching, and fertilization are believed to be main components of land rehabilitation after tsunami. However, due to structural limitations of irrigation and drainage systems and the very complex problem associated with nutrient ions in tsunami-affected soil, both measures are not easy and required coordination and time. In Aceh Barat rehabilitation of agriculture has been particularly slow. The main limitations are the improvements required to irrigation and drainage systems which also affect the ability to improve soil nutrition (Sembiring and Gani 2007). Because of these limitations, the use of salt tolerant varieties is recommended to sustain rice productivity after tsunami in NAD.

Symptoms of salt injury in the rice plant are stunted growth, reduced tillering, whitening of leaf tips and frequently, chlorotic parts on the leaves, and although rice is classified as a moderately tolerant crop, EC of 6-10 dS m⁻¹, salinity is associated with a 50% decrease in yield (Brinkman and Singh 1982). More over, Dobermann and Fairhurst (2000) noted that rice is relatively more tolerant of salinity at germination, but plants may become affected at transplanting, young seedling and flowering stages. According to Mengel and Kirkby (1979), the detrimental effects of salinity are also often dependent on the stage of plant growth. For many species the seedling stage is very sensitive to salinity. In most cereal crops grain yields are less affected than straw yields. For rice, however, the reverse is true, as this crop is particularly sensitive at the flowering and seed setting stage.

SALINITY RESEARCH IN RESTORING RICE PRODUCTION IN NAD

Soil fertility and other chemical, physical and biological changes related to salinity in tsunami-affected soils have manifested in disappointingly low yields in rice. In NAD province, rice harvested area at 2006 was 318,406 ha (315,324 ha or 99.0% comes from lowland), with production of 1,342,197 ton (1,335,354 ton or 99.5% comes from lowland). These figures were much lower to be compared to their values before tsunami. Table 2 shows that, two years after the tsunami, harvested area and production of lowland as the main system of rice production in NAD are 14% lower than those of 2004, as a consequence of earthquake and tsunami on December 2004.

Due to the facts that saline soils have a complex problems, restoration of annual cropping especially rice cropping in tsunami-affected areas of Aceh Province, Indonesia is not an easy task. To improve the productivity of soil and rice crop, many factors arising after the tsunami must be considered. Research must be conducted to evaluate the real conditions of the tsunami-affected soils, in terms of rice cropping restoration after tsunami. There is a need to develop,
demonstrate and evaluate soil management practices to restore the productivity of rice crop in tsunami-affected production areas, which in turn become a part of management strategies in restoring productivity to pre-tsunami levels, if not enhance it.

Table 2. Rice crops production and harvested area by 2004 and 2006 in NAD

<table>
<thead>
<tr>
<th>Commodity</th>
<th>2004</th>
<th>2006</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Harvested area (ha)</td>
<td>Production (ton)</td>
<td>Harvested area (ha)</td>
<td>Production (ton)</td>
</tr>
<tr>
<td>Lowland Rice</td>
<td>367,537</td>
<td>1,544,528</td>
<td>315,324 (14%)</td>
<td>1,335,354 (14%)</td>
</tr>
<tr>
<td>Upland Rice</td>
<td>3,429</td>
<td>7,547</td>
<td>3,082 (10%)</td>
<td>6.843 (9%)</td>
</tr>
<tr>
<td>Total</td>
<td>370,966</td>
<td>1,552,078</td>
<td>318,406</td>
<td>1,342,197</td>
</tr>
</tbody>
</table>

Values in brackets are percentage reduction from 2004.

Carefully planned field, as well as pot, experiments were implemented to firmly establish the actual causes and identify remedial actions and soil management practices. The trials were widely promoted as demonstration sites in order to increase understanding of the issues and adoption of mitigation strategies. Many scientific approaches and specific technologies have been constructed, tried and evaluated. There is a need to transfer the techniques and knowledge to the farmers around trial sites.

Agricultural research provides the means and capacity for generating new technology to increase agricultural production. Agricultural research systems after the tsunami have a key role to play in agricultural and rural community development in NAD. To cope with problems of rice cropping after tsunami in NAD, through the ACIAR project LWR/2005/118, research systems have been developed. Capacity building through workshops and training, research and variety trials – especially on rice cropping – demonstrating crop management packages have also been conducted and evaluated in some tsunami-affected areas. The DPI-ACIAR from Australia and Indonesian Agency for Agricultural Research and Development managed the project, providing technical inputs to local agronomists, and taking responsibility for data management and communications.

Replicated field experiments were conducted to evaluate technologies (varieties, soil amendments, agronomic management) to improve rice crop production and targeted to address local management issues. Demonstration trials took place in Aceh Besar, Bireuen, Pidie and
Aceh Barat. The field trials were managed and implemented by Dinas Pertanian and Penyuluh Pertanian Lapangan with support from BPTP NAD, ISRI and ICRR. Soil from Tanjung village Aceh Besar and Cot Seulamat village Aceh Barat have been used for pot experiments in Sukamandi. The on-farm participatory research strategy to identify soil and agronomic constraints and evaluate technologies to improve rice crop production was used during field activities. Extension staff and farmers directly engaged with research trials and monitoring activities to ensure there is rapid dissemination of better research results. Rice trials conducted during the project in NAD are follows.

**Aceh Besar district**
- Tanjung village-Lhoknga. Rain fed lowland rice demonstration 2006/07
- Subun village-Lhoknga. Rain fed lowland rice demonstration 2008

**Bireuen district**
- Pineung Siribee village-Samalanga. Irrigated lowland rice demonstration 2006
- Pineung Siribee Village-Samalanga. Irrigated lowland rice demonstration 2007/08

**Pidie district**
- Meuraxa village- Meureudu. Irrigated lowland rice field experiment 2008

**Aceh Barat district, Cot Seulamat village-Samatiga rain fed peaty lowland rice 2007**
- Field experiment
- Technology demonstration
- Variety demonstration

**ICRR Sukamandi – lowland rice pot experiments**
- Using soil from Tanjung village, Aceh Besar, 2007
- Using soil from Cot Seulamat village-Samatiga, Aceh Barat, 2007

**Summary of the results:**
The main findings of the ACIAR project LWR/2005/118 from lowland rice trials are:

- Drainage and irrigation infrastructure needs to be repaired for the optimum technological remediation of saline soil for lowland rice restoration.

- In rain-fed lowland areas, 2 weeks of dry weather started about 45 days after transplanting aggravating the effect of salinity. Stunted growth, reduced tillering, abnormal panicle and spikelet resulted in low grain yield; Lambur, Mendawak, Cilosari, Situbagendit and Ciherang yielded 2.6 to 3.1 t/ha.
The longer the duration of flooding the lower is the level of lowland rice yield and the more complex are the salinity problems. After draining the field and the addition of animal manure, increasing K fertilizer gave an additional grain yield. Leaching, addition of animal manure and K fertilizer could improve soil fertility and rice productivity in irrigated lowland affected by tsunami. The productivity of Ciherang in irrigated lowland ranged from 5.5 to 8.0 t/ha.

Mendawak variety and a hybrid variety (Intani-2) gave higher grain yields than Ciherang in tsunami-affected soil on peat deposits in rain-fed lowland, yielding 5.3, 5.8 and 3.8 t/ha, respectively. Dolomite and boron seemed to be required in this soil to give higher response to NPK fertilization.

Pot experiments using soil affected by tsunami clearly showed that Mendawak was more tolerant than Ciherang. Without P, K, Zn, Cu and Mn addition to the soil from Tanjung grain yields were high enough but N must be added. On the other hand, in peaty soil from Cot Seulamat the most limiting nutrient was K followed by N and P. Further more, this soil does not require additional Ca, Cu or Mg, while B addition will increase the number of panicles.

In terms of soil nutrients and fertilization, different responses were found in different sites based on the severity of tsunami, physical and chemical characteristics of the soil, and irrigation and drainage facilities in each area under study.

IMPLICATIONS OF SALINITY RESEARCH IN ACEH FOR INDOONESIAN RICE GROWING

Rice production in Indonesia continuously faces the challenge of keeping pace with an annual population increase, while the area of fertile lowland available for rice farming is steadily decreasing due to urbanization and industrialization. Total rice production in Indonesia, in 2006, was 54.4 million ton from 11.78 million ha of harvested area and average productivity of 4.62 t/ha. To keep pace with the consumption of 2009, rice production of 61.4 million ton must be targeted. The main effort will be to increase productivity from all of production systems, especially from lowland ecosystem contributing 91% of harvested area and 95% of production in 2006.

Salinity effects on lowland rice at tidal swamp areas have been familiar in reports and for agriculturists. The intrusion of sea water far into the inland has long been reported at some rice production areas. For example, in the PANTURA and South Sulawesi the rice soils had become more saline causing farmers in affected sites changed their
lowland rice to other commodities, or simply abandoned the land. Despite the fact that salinity has been destroying the productive capacity of coastal areas (as well as at the drier eastern part of Indonesia) in Indonesia for decades, it is only relatively recently that we have recognized the extent of the problem and, unfortunately, efforts made on national scale to slow the process is limited (or none?). As a result, personnel responsible to handle salinity problems, especially in rice cropping, are still scarce. It should be much better if salinity problem in Indonesia is handled on national scale. Madamba (1981) have suggested that national agricultural research systems in the developing countries have a key role to play in agricultural and rural development and in advancing the economic status of the developing nations. Moreover, new technologies have better chances for nationwide adaptation on account of ongoing national program for intensifying production (Lantican 1981).

Tsunami in NAD and other rice production areas, on December 2004, awakened agronomists that salinity must be seriously considered in order to revitalize rice production, especially lowland rice; not only in NAD but also in other production areas significantly affected by salinity. Some international organizations have been directly engaged in NAD to restore rice cropping in tsunami-affected areas. It was evident that salinity is a complex problem and needs special and comprehensive efforts, especially for rice crop restoration after tsunami. From field monitoring to tsunami-affected areas, it was also seen that researches are required in revitalization of the affected areas. In addition, there is a need to have experienced staff available to solve problem, to transfer techniques and knowledge on salinity remediation and to evaluate management strategies which at least restore productivity to pre-tsunami levels.

Because research must be shared with the end users, it is extremely important to develop effective strategies for lateral, downward, and even upward communication. In other words, a good research strategy must be coupled with communication and adoption efforts. As has been pointed out by Flores (1981), the primary justification for research is how it can change the lives of people for the better. For this to happen, results of research must reach the people who shall ultimately make use of it. Research is of little use until it is applied for productive purposes.

The ACIAR project, SMCN/2005-118, was a comprehensive and integrated effort in restoring rice cropping in NAD after tsunami, fulfilled justifications mentioned above. The project activities such as field trials and monitoring directly engaged with farmers and involved them in field activities in their local area. The capacity building of extension staff and technical knowledge developed in this project improved the advice and information available to farmers and
empowered local agricultural officials in the BPTP NAD, the Dinas Pertanian and PPL and local farmer groups. Successful cropping of a trial may motivate remaining farmers to return to the land and reduce the area of land currently idle, especially on the west coast. While some recommendations have been made to farmers to increase their rice crop production on tsunami-affected soils, there is considerable work to be done to study more clearly on salinity effects on rice crop after tsunami.

Leaching, soil amendments and mulching, and fertilization are believed to be main components of land rehabilitation after tsunami. However, due to structural limitations of irrigation and drainage systems, both measures are not easy and need a long time, as well as integrated efforts. Because of these, good management of nutrients and adaptation of variety seem to be the main efforts to increasing productivities of tsunami-affected soil in the near future. In Tamil Nadu – India, some rice landraces survived during tsunami, while many others are relatively more tolerance to be planted in tsunami-affected soils. By the way, rice varieties adapted to tidal swamp areas in Indonesia must have some tolerance to soil salinity, because land in these areas (called pasang surut) have salinity problem in varying degrees. Least but not last, IRRI (International Rice Research Institute) has recently distributed seed-lots of salinity tolerance lines to be tested in several countries, including Indonesia. With the above cultivars in hands, the next step is to evaluate them through adaptability testing and demonstration plots in tsunami-affected (hence, saline) soils.

Although there have been much studies of salinity effects on rice, our understanding of the quantitative effects of salinity on rice and critical thresholds of responses is still limited. The determination of salinity-sensitivity parameters, for example, the extents of salinity effects on rice growth and yield components and the interrelationships among yield components under salinity stress, will help to develop better management practices for growing rice under salinity and improve our understanding of the mechanisms of salt tolerance in rice. Further more, the observed differences on the responses at different sites to remedial measures introduced through different trials may be attributed to dissimilarities in soil fertility, salinity, and weather conditions. At the same time, the differences on farmer perceptions to the adoption of remedial technologies, for better rice cropping restoration after tsunami, are closely associated with social-economic conditions of the farmer community. Hence, a location-specific recommendation appears to be necessary to close the gap.

Progress with re-establishment of rice farming is being made in some areas affected by tsunami in NAD. It is proposed that similar activities would be conducted in other locations affected by salinity. Research
and development approach of the project, SMCN/2005-118, is expected to further improve rice productivity in saline affected areas in Indonesia.

Salinity has mainly been studied as an agricultural problem so there is very little information about the effects on other aspects of the ecosystem. The impact of salinisation on loss of biodiversity and ecological damage is likely to be very high as well.

CONCLUSIONS

Salinity poses a threat to further increases in rice productivity in Indonesia. Due to the lack of awareness of this subject for decades in Indonesia, experienced staff to handle the subject are scarce.

The crop land most affected by the December 2004 tsunami was paddy rice, due to location of lowland rice on the low coastal areas. Soil salinity was emerged as a problem and became a main constraint to lowland rice production in NAD, which manifested in lowering yield some years after the tsunami.

The development of management options to ameliorate salinity problems requires analysis of agronomic parameters which affect the interaction between salinity and crop yield. There is considerable work to be done to study more clearly the salinity effects on rice after tsunami or other seawater inundation.

The ACIAR project, SMCN/2005-118, was a comprehensive and integrated effort in restoring rice cropping in NAD after tsunami. The project engaged in rice crop trials to accelerate rice crop restoration after tsunami in NAD, as well as capacity building to empower local agricultural officials.

It is proposed that similar activities would be conducted in other locations affected by salinity. Research and development approach of the project SMCN/2005-118 is expected to further improve rice productivity in saline affected areas in Indonesia.

REFERENCES


PALAWIJA PRODUCTION IN TSUNAMI-AFFECTED SOILS IN THE PROVINCE OF NANGGROE ACEH DARUSSALAM

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Abstract

Research and demonstration activities were carried out in the Province of Nanggroe Aceh Darussalam (NAD) from 2005 to 2008, to improve the production of secondary crops of soybean and peanut on tsunami-affected land. This activity was carried by BPTP NAD in cooperation with ACIAR Australia, NSW-DPI Australia, Balai Penelitian Tanah Bogor, The Pidie District regional government, Aceh Barat, Bireuen and the Regional Government Aceh Besar District. The activities conducted were (1) the addition of organic fertiliser (manure) and inorganic fertiliser (Urea, SP36, KCl) in three varieties of peanuts in Reudup Village, Pidie, 2005/2006. (2) organic fertiliser (manure), gypsum and inorganic fertiliser to local variety peanuts in the Cure Tunong Village, Bireuen, 2006/2007. (3) the addition of organic fertiliser (manure), and inorganic fertiliser to local variety peanuts in the Cure Tunong Village, Bireuen, 2008. (4) the addition of organic fertiliser (manure), and Rhizobium on soybeans, Baro Village, Pidie, 2007. (5) The demonstration of the use of the organic matter (ash) inorganic fertiliser and Rhizobium to soybean in Blang Kubu, Bireuen, 2007/2008. (6) the demonstration of the use of organic and inorganic fertiliser on peanuts, Baro Geunteut, Aceh Besar, 2007/2008. Results of the trials and demonstrations showed that the addition of the organic matter and manure (cow/chicken) could increase yields of peanut and the soybean crops up to 70 percent compared with local practices.

Key words: tsunami, soybean, peanuts, organic matter, manure

INTRODUCTION

The effects of the 2004 tsunami in Nanggroe Aceh Darussalam impacted on agricultural land by increases in soil salinity and a decline in soil fertility. Results of soil analyses showed that organic matter content was very low (0.65%), N very low (0.05%), low potassium 90.13 cmol/kg, and high levels of sodium (3.47 cmol/kg), and ECe(15.5 dS/m.).

The impact of high salinity levels and low organic matter levels on the farming of peanuts and soybean were further exacerbated by the lack of quality seed and the minimal use of organic or inorganic fertilizer in
these crops. Peanut crops failed in Cure Tunong, principally due to the very high percentage of empty pods (>80%). Yields of peanut (0.7 t/ha) and soybean (0.9 T/ha) in many districts were lower than pre-tsunami levels and did not increase in the second planting season.

BPTP NAD began a program of partnership with a number of communities to demonstrate a simple package of technology that could increase yields of peanut and soybean crops and rectify some of the crop and yield problems being encountered. The main focus of this program was to obtain and distribute improved varieties for the local conditions, promote the use of Rhizobium innoculant to increase nodulation, promote the addition of organic matter to tsunami-affected soils and invest in inputs of inorganic fertilizer to increase the profitability of legume crops in NAD.

Through improvement efforts of the land and the introduction of several packages of cultivation technology to the affected land the tsunami natural disaster was hoped for by the condition for the agricultural land could again good, the farmer was motivated again to berusahatani and the maximal production could be achieved.

AIM

Increase the productivity of secondary crops (soybean and peanuts) in tsunami-affected land with the use of effective technology like good drainage, quality seed, organic matter and Rhizobium.

METHODS

Field trials and demonstrations were carried out in paddy and dryland fields affected by the tsunami in the districts of Pidie, Bireuen and Aceh Barat from 2005 to 2008.

   Replications : 3 x Randomized Block Design (RBD)
   Factor 1 : Varieties (V1 = Kancil, V2 = Sima, and V3 = Lokal)
   Factors 2 : Fertilizers
   P1 = manure 20 t/ha + NPK (50-100-50)kg/ha
   P2 = ask 10 t/ha + NPK (50-100-50)kg/ha
   P3 = paten kali 100 kg/ha + NPK (50-100-50)kg/ha
   P4 = NPK (50-100-50)kg/ha

2. The addition of organic fertilizer (manure), gypsum and inorganic fertiliser to local variety peanuts in tsunami-affected dry land, Cure
Replications : 3x Randomized Block Design (RBD)
Treatments :
A = N-P-K (50 kg urea + 100 kg SP36 + 100 kg KCl)/ha
B = A + 500 kg/ha gypsum
C = A + 2 t/ha manure chichen
D = A + 2 t/ha manure cow
E = A + 2 t/ha manure chichen + 2 t/ha manure cow

Replications : 3 x Randomized Block Design (RBD)
Treatments :
A = no fertilizer
B = N-P-K (50 kg urea + 100 kg SP36 + 100 kg KCl)/ha
C = B + 1 t/ha manure cow
D = B + 2 t/ha manure cow
E = B + 4 t/ha manure cow


Replications : 3x Split plot Design
Treatments :
Factors 1: Varieties (V1 = Anjasmorow, V2 = Burangrang, V3 = Ijen, V4 = Kaba, dan V5 = Lokal)
Factors 2 : fertilizers (T1 = no fertilizer, T2 = manure 2 t/ha + nodulin, T3 = manure 2 t/ha + Mikroflora, Biophos + nodulin)


RESULTS
1. The peanut trial in Reudup Village 2005/06 yielded 1.6 t/ha with the variety Kancil and the addition of manure 20 t/ha + 50 kg/ha urea +100 kg/ha SP36 + 100 kg/ha KCl.
2. The Cure Tunong Village peanut trial in 2006/07 yielded only 0.7 t/ha with the addition of manure 4 t/ha. The low yield was caused by the high percentage of empty pods (42 %). Even so, these this
yield was 60% higher compared to results of local farmer practice (no fertilizer).

3. The second Cure Tunong Village peanut trial in 2008 yielded 1.92 t/ha with treatment E (manure 4 t/ha + NPK (50 kg urea + 100 kg SP36 + 100 kg KCl) /ha.

4. A Demonstration of the use of organic and inorganic fertiliser on peanuts in Baro Geunteut Village (2007/08) led to yields of 1.97 t/ha with the addition of 2 t/ha manure, 25 kg/ha urea, 75 kg/ha SP36, 50 kg/ha KCl, and 300 kg/ha straw ash at planting.

5. The addition of organic fertiliser and *Rhizobium* to soybean in Baro Village (2007) led to yields up to 3.2 t/ha using the Anjasmoro variety and the addition of 2 t/ha of manure and 300 kg/ha rice ash at planting.

6. The demonstration of the use of the organic matter, ash, inorganic fertiliser and *Rhizobium* on soybean (Anjasmoro) in Blang Kubu Village (2007/08) led to yields up to 3.1 t/ha in the treatment with 300 kg/ha ash and inorganic fertilizer (50 kg/ha urea, 100 kg/ha SP36, 100 kg/ha KCl).

**CONCLUSION**

Improving the production of palawija crops (peanuts and the soybean) on tsunami-affected land requires:

- the addition of organic matter and fertilizer
- good quality seed
- good drainage
- good timing for planting the crop (especially soybean) to avoid heavy rainfall months
- Integrated pest management and weed control

The demonstration of successful crops with much improved yields has motivated farmers in these communities and surrounding areas to consider legume rotations in rice paddies and to increase dryland plantings.

**REFERENCES**


