8. Field crops

The main field crops in Aceh are rice, soybeans and peanuts. A variety of vegetable crops are also grown, including red onion, chilli, tomatoes, snakebean/longbean, amaranth (bayam) , maize, cassava, rockmelon, eggplant, spinach, lettuce, sawi, kangkung (*Ipomea aquatica*), and cucumber. Vegetables suitable for waterlogged areas include kangkung and genger/yellow velvet leaf (*Limnocharis flava*). Crop priorities differ for backyard and commercial growers.

Many areas inundated by the tsunami experienced crop production problems due to disturbed soils, sediment, salinity and loss of organic matter and trace elements.

The first rice crops often failed or achieved very low production, but the second crops were better, due possibly to the leaching effect of the rice paddy water. As salinity levels declined, vegetative growth improved but there were often problems with fruit, grain and nut production, indicating nutrient deficiencies, possibly caused by tsunami removing organic matter from the soil. Lack of organic matter proved to be a major issue for crop production, particularly in the sandier soils.

Crops grown in coastal soils such as peanuts were more affected by seawater inundation than crops grown on better soils further inland such as soybeans. Some vegetable crops were affected by the quality of groundwater used to water the crops.

Interestingly, crops grew well in peaty sediments, particularly soybeans, due to the high nutrient levels. Some coastal rice crops yielded very well with 12 months of the tsunami (Bradbury et. al. 2005) most likely due to a beneficial effect from tsunami-deposited peat sediments. The effects from these sediments are short-lived with subsequent crops not yielding as highly without some form of fertiliser. Two years after the tsunami, most soil fertility problems in tsunami-affected areas were due to nutrient deficiencies and imbalances related to the loss of organic matter and the effects of salts and sediments.

The variable crop performances highlighted the importance of monitoring growth, yields and nutrient levels to identify trends and develop site histories. Where there is potential to establish new production systems such as different crops/rotations, develop trials to demonstrate these. For instance, the different soil treatments required for rice (compaction) and palawija/non-rice crops (loose soil) suggested trials using permanent beds for palawija crops rather than alternate puddling/cultivation of one site, to the detriment of soil health.

Where possible incorporate agronomic advice and management within a farming system approach that considers soil fertility and health, and integrated pest management as part of crop production.

Site selection

Cropping on highly saline areas is a waste of resources so it is important to grow crops where tsunami impacts are minimal and soil fertility relatively unaffected. The Aceh experience showed that salinity levels were related to the permeability of the soils and the length of time the seawater stayed on the soil. Crop failures also occurred in low lying areas near tidal creeks due to inundation with marine water during high tide events.

Sandier soils close to the beach dune systems appeared to be the most saline after the tsunami. Peanut crops on the dunes showed patchy growth or leaf yellowing, the patchiness associated with salt that accumulated on the soil surface due to evaporation of salty shallow groundwater. The yellowing appeared to be a related nutritional or possibly a disease problem. There may be a need for phosphorus on salinity-affected sandy soils to help plants fill pods or grain.

Raised crop beds (right) are useful in saline soils because the beds can be irrigated to leach salt before crops are planted. Raised beds are also useful in areas prone to waterlogging.

Avoiding saline areas is relatively easy using EM38 surveys to identify saline soils. If an EM38 is not available, farmer knowledge and experience of tsunami flooding levels and timing, soil and plant indicators of salinity, and soil tests can all help with salinity assessment.

To restore cropping quickly it is useful to know the types of farming systems at the site before the tsunami such as crop types, animal input, fertilisers used, yields etc. This information, in association with soil assessment and soil/leaf tissue analysis, helps identify agronomic issues specifically caused by the tsunami (eg crop failures, poor growth, low yields, empty pods and husks, change in weeds, waterlogging, nutrition).

Aceh's experience highlighted the need for good records about district cropping practices, seasons and seed sources. This information could be collated and held by agricultural organisations at local, provincial and national levels, and even international (FAO), to enable aid organisations to provide locally appropriate agronomic assistance after seawater inundation.

Use of salt-tolerant varieties

Aceh's high rainfall meant that salinity was not a long term problem in most areas, so there was not a great need for salt-tolerant varieties. However, it can be useful to have access to seed or planting material of tolerant varieties, particularly in the early months after the tsunami.

Salt tolerance levels of different crops

http://www.fao.org/DOCREP/005/Y4263E/y4263e0e.htm

Salinity problems did occur in rain-fed rice fields, so salt-tolerant rice varieties may have a specific niche in rain-fed systems. While no varieties are truly salt-tolerant, there are varieties in Indonesia that appear salt-tolerant - Mendawak, Sunggal and Banyuasin.

Plant nutrition

Salt tolerant rice varieties

Indian Agricultural Research Institute

http://www.iari.res.in/tsunami/salt.html

International Rice Research Institute

http://www.knowledgebank.irri.org/tsunamiAndRice/Do_Rice_Varieties_Vary_in_Tolerance_to_Salt_.htm

Agronomic trials conducted in Aceh after the tsunami found a range of symptoms of nutritional disorders, particularly lack of grain filling in both rice and peanuts. Possible reasons for the nutrient problems included loss of organic matter and trace elements, high inputs of urea in relation to potassium, and lack of phosphorus and calcium on salinity-affected sandy soils. These problems meant that pre-tsunami fertiliser recommendations were often irrelevant, even wrong, so it is important to test tsunami-affected soils for at least the major nutrients before preparing the soil, fertilising or planting. Testing the soil will also ensure that the correct amount of fertiliser is applied; over-fertilising is a waste of money because nutrients not used by the plants leach out of the crop root zone.

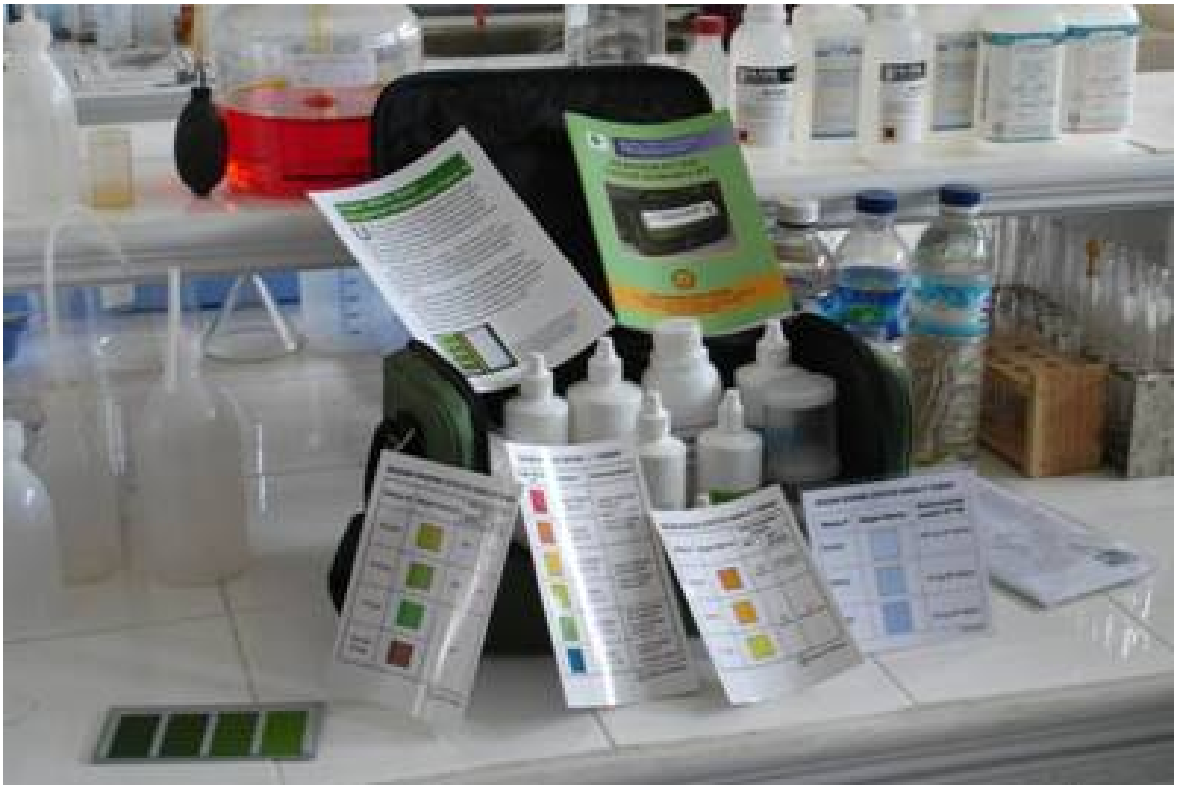

Figure 12: Contents of the paddy soil test kit produced by ISRI. Kits are also available for other crops like vegetables and sugar cane.

Peaty soils and sediments were high in organic matter and nutrients, but nutrients in these sediments dwindled after 2-3 crops because nutrients taken up in crops were not replaced. So these sediments also needed testing for nutrient levels and possible amendments to neutralise their natural acidity.

Inland peat soils offered cropping opportunities for farmers who lost land in the tsunami, but only if they were managed carefully with plenty of amendments to ameliorate the high acidity.

It is important to keep records of fertilisers used and fertiliser recommendations provided to farmers so that advisors and farmers can link fertiliser applications with crop production.

Case study: Empty peanut pods

At Bireuen many peanut plants had empty pods in a crop harvested in February 2006. Farmers in the area reported that this was the first time these problems had been encountered. The peanuts were normally grown in deep sandy soil (sand dunes) without fertilisers, and cropped twice a year with weed fallows in between. The plants had good vegetative growth and appeared to have enough nodules, but the root systems were very shallow. Weeds were well established in the crop and in bare areas. EM38 showed low salinity, so possible nutrient causes included lack of calcium, essential for kernel development and absorbed directly from the soil through pod wall. High soil magnesium can also reduce kernel quality and led empty pods.

A trial investigating effects of fertiliser, gypsum, chicken and cow manures found that the best pod development was the treatment with combined chicken and cow manures indicting a need for organic matter in the soil. Organic matter helps conserve soil moisture and improve the ability of peanut plants to absorb nutrients. Overall, nodulation was poor and plants showed magnesium, potassium and iron deficiency. Other case studies may be viewed at: http://www.dpi.nsw.gov.au/research/projects/06P302

Leaf tests

Where crop growth is poor, it can be useful to sample leaves before harvest for analysis to determine nutrient status (deficiency and toxicity). Because nutrients and fertilisers leach readily from sandy soils, many farmers apply liquid fertiliser in a foliar spray in combination with pesticide sprays. However, care is needed in selection of liquid fertiliser to ensure the product has been tested and is reliable. Leaf colour charts (right) provide a simple measure of the fertiliser needs of a rice crop.

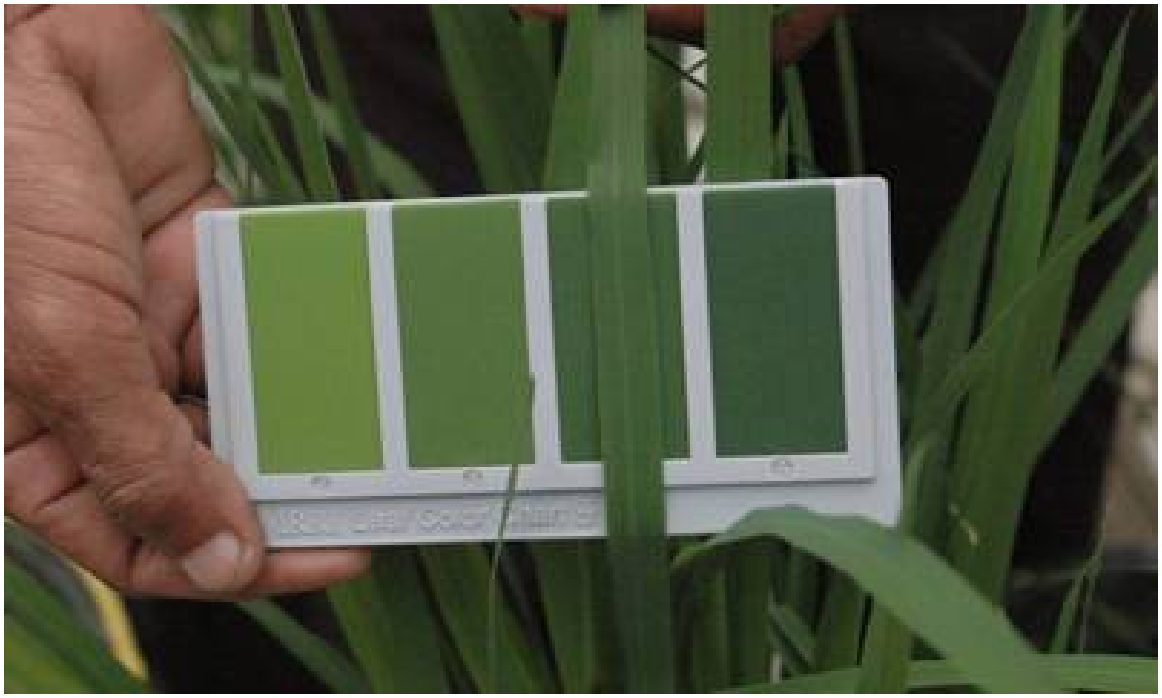

Figure 13: Leaf colour charts help determine how much fertiliser to add to a rice crop

Rhizobium inoculation

Seeds of legumes such as peanuts and soybeans need to be inoculated with rhizobium bacteria before planting. Rhizobia are organisms that attach to legume roots and form nodules that enable the plant to obtain nitrogen from the air. In Aceh it is considered best practice to inoculate every crop to ensure good nodulation in the crop establishment phase because survival of rhizobium in soil from one season to next is uncertain, and at best uneven. Where peanut inoculum is not available, a common practice is to take 1kg of soil from a 70 day old peanut crop and grind it, pass it through a 2mm sieve, and mix it with 10kg of moistened seed. The seed must be planted that day.

Fertilisers

Where possible, fertiliser recommendations need to include organic amendments such as manure or compost. Lack of organic matter in soils was identified as an important constraint to production in the tsunami affected soils in Aceh. The tsunami's scouring action removed organic matter, leading to a drop in soil fertility.

Figure 14: Compost is ideal for improving organic matter levels

Organic amendments can substitute 25-100% of chemical fertilisers, depending on the kind, amount and content of the material. Manure, composts, crop residues and mulches increase soil nutrient levels and generally improve soil health and long term soil fertility. As well, they encourage biological life, and improve soil structure and soil moisture holding capacity. Farming systems that incorporate crop rotations and stubble management also increase soil organic matter.

Where organic matter is in limited supply, compost or rotted manure can be incorporated in the planting row. This will provide nutrients close to the young plants, and encourage leaching of any salt in the soil. A corn trial at BPTP's Banda Aceh grounds found that when manure was incorporated beneath the corn row, near-surface salinity was significantly lower.

Source: August 2005 report

Demonstration trials may be useful to compare crop production from fermented fertilisers, chemical fertilisers, and no fertilisers, or a 50-50 mix of chemical and fermented products.

Figure 15: Liquid fertiliser from fermented organic products (left) and compost making (right)

Livestock and Manure

In Aceh's coastal areas, few grazing animals or poultry survived the tsunami, leading to a dearth of manure, an important agricultural input in Aceh's sandy coastal soils. It is important to reintroduce poultry, goats and cattle as quickly as possible because their manure adds nutrients to the soil, builds organic matter levels, and contributes to compost. One buffalo can produce approximately 2 tonnes of manure a year.

After the tsunami manure was in limited supply due to livestock losses, and even when freely available cost money to collect, so alternative sources of organic matter (green manure, legume crops in rotation with chilli) may need to be considered. The Aceh experience was that farmers would incorporate manures only if they could see a result and even then only for cash crops.

It is financially difficult for many farmers to acquire livestock so this could be a useful aid project once there is food for animals available. Reintroduction of poultry where all birds have been killed is particularly useful; the birds' manure is an important nutrient source and organic soil amendment, and the birds also provide eggs and meat.

Grazing is a good use of land that is too waterlogged for cropping or does not have a reliable irrigation source, but was not an option for many Aceh farmers because the farming blocks are only 1ha or less and used for rice which provides food and income.

A salt-tolerant grass (Diplacne fusca) became more prevalent after the tsunami. While the mature grass is not palatable to cattle, the grass is grown widely in Pakistan as a forage crop eaten when young. Aceh farmers confirmed that cattle will eat the young shoots.

Compost

Making compost after a tsunami provides organic matter for soil, creates a useful product from organic debris, and offers productive activity for farmers. Aceh farmer groups made a range of composted fertilisers. One group used rice husks, peanut pods and cow/chicken manure. Another made bokashi fertiliser from cow manure, rice ash, wood ash, rice stubble and micro-organisms; another group made liquid fertiliser from buffalo manure, lime, and home-made fish emulsion.

Composting in the tropics

http://www.gardenorganic.org.uk/pdfs/international_programme/Compost102.pdf

Creating compost on farm

http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/166476/compost-on-farm.pdf

Plant-based mulch

A mulch of dried organic matter such as coconut leaves will lower the soil temperature and hold moisture in the soil, both of which will make the soil more liveable for soil organisms. Mulch also protects the soil from drying out and hardening, particularly useful for compacted rice paddy soils used to grow palawija crops during dry seasons. The difficulty in Aceh was finding enough suitable organic material to use for mulch, because the local custom is to burn dead leaves to provide ash used for fertiliser when planting. One option is to grow a green manure crop to act as mulch between crops, but for many farmers this will tie up productive land for too long. Another option is to grow stock feed or a cash crop that can double as a green manure crop. Caution needs to be used in growing green manure/stock feed crops that could become weed pests. It is important not to use peanut crop residues on soil to be used for peanuts, because of the risk of infecting the new crop with leaf pathogens. Peanut residues are better collected and composted before use.

Alley cropping with legume shrubs

http://www.fao.org/ag/agp/AGPC/doc/Publicat/Gutt-shel/x5556e0g.htm

Seed supply and quality

Obtaining good quality seed was a major problem after the tsunami in Aceh. Demand for seed was so high the main seed producers could not supply enough good quality seed, and not all farmers used certified seed, so crop establishment was unreliable. If seed storage facilities are available, train farmers to select plants for mother seed and produce seed crops. Training is also needed in seed quality assurance, storage and distribution.

Seed banks

The shortage of seed after the tsunami revealed the need to develop and maintain local seed breeding through local farmers' groups. In Aceh seed banks have been constructed in rural areas to store locally bred seed.

Provide seed of preferred varieties for the local market

Through access to local records or farmer interviews, ensure that agricultural aid is agronomic ally appropriate for the area, soil type and season, and local markets and tastes. Access to familiar varieties is important in the initial stages of recovery. After the tsunami farmers many farmers given seed by aid groups later found the plants were the wrong varieties for the local market, so sales were low, wasting the farmers' time and resources, and giving them low returns.

Plant according to the local seasons

It is important to ensure that seeds are planted in the correct season to ensure reliable production.

Pests and weeds

Trap barrier systems for mice

http://www.aciar.gov.au/system/files/sites/aciar/files/node/736/Partners_0610_p08-09.pdf

After the tsunami rats and pigs were a problem because there were fewer people to control shrub land where the animals sheltered. Pest controls such as chemical controls and trap barrier systems for mice and fumigants need coordination between farmers to make a difference. Good quality fencing wire that does not corrode in salt air is also useful and may be a suitable project for NGOs. In Meulaboh, one farmer used pineapple plants as an effective barrier to pigs.

The main pest and disease problems for vegetables include whitefly, phytophthora and anthracnose. A women's group in Meulaboh controlled pests and disease in their chilli crops with a mixture of garlic, chilli, tobacco leaves and other ingredients.

Weeds

Many farmers commented on the changes in weed species after the tsunami, possibly reflecting increased salinity, changed nutrient status and lack of organic matter. It is useful to identify the new species as collectively they may provide important information about soil nutrient status. In one area peanuts were not weeded once they flowered for fear of disturbing the roots, but the weeds competed with the crop for nutrients and moisture, reducing crop yields. Raised beds may make weed control easier because people can easily move between plant rows.

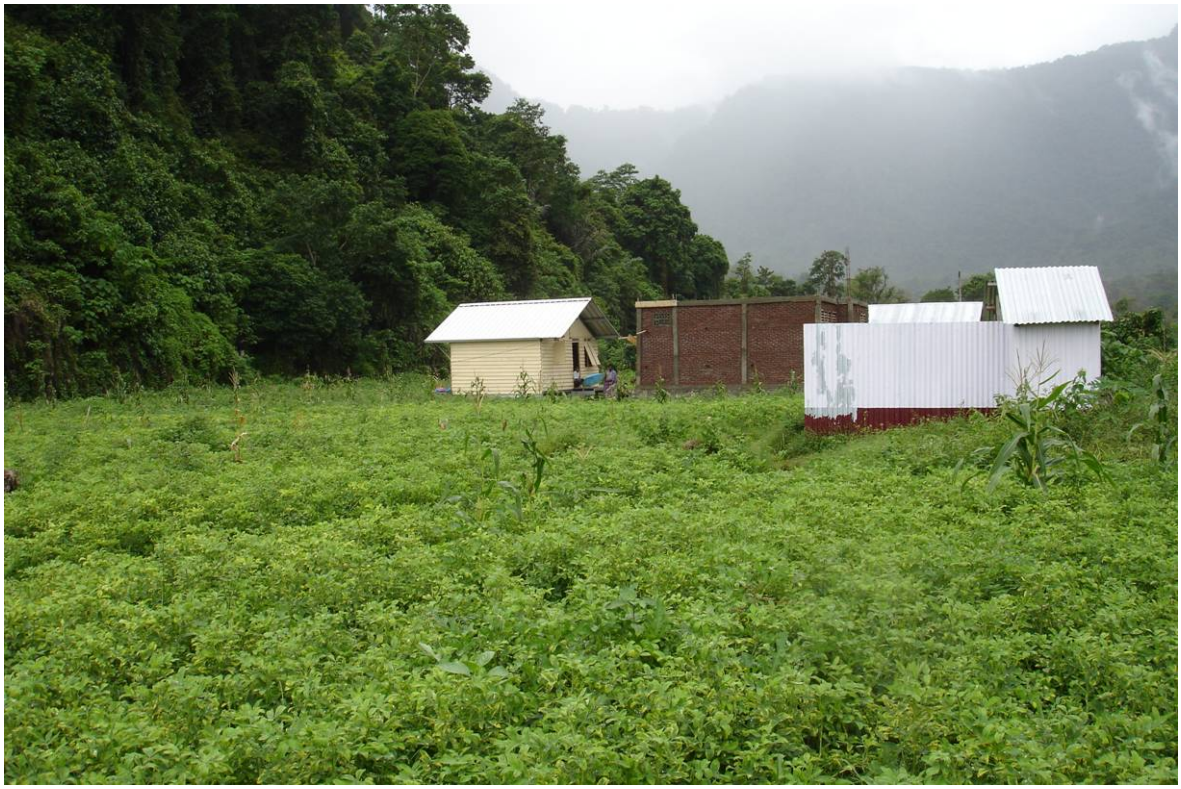

Figure 16: Poor weed control significantly reduced yields in this peanut crop