Climate change is an emerging issue that poses a defining challenge for all on the planet. As farmers’ livelihoods are closely tied to environments, and poorer farmers tend to live and work in marginal areas not supported by the appropriate infrastructures, they will be highly vulnerable to any changes in climate. The most favourable scenario of Intergovernmental Panel on Climate Change (2007) predicts a temperature rise of 2°C by the end of this century. Up to the year 2050 this could mean a temperature increase of about 1°C. Cruz et al. (2007) calculate that the mean annual temperature increase in the Philippines in the last 30 years was only 0.14°C. A one degree increase over the next 40 years would mean temperatures will rise seven times faster than in the previous 30 years. This simple calculation illustrates the future risks and challenges associated with climate change. The above scenario is the most optimistic one given by the IPCC. It assumes that greenhouse gas emissions grow only slowly up to the middle of the century and then decline due to a diversity of mitigating measures.

Sea level rise, salt water intrusion, and an increase in the frequency and intensity of extreme weather events are expected. In addition, the International Rice Research Institute estimates a 10% yield
decline for every one degree centigrade rise in temperature (Ho 2005). Clearly the challenge is immense.

In this chapter, we have included a preliminary discussion of climate change. This is an emerging issue of great concern to the farmers in the network. They are presented in three sections. Firstly, we draw on some literature to discuss the issue of mitigation. Can the work of sustainable agriculture reduce the impacts of agriculture on the climate? Next we draw on discussions with farmers to highlight some of the changes they have observed already taking place. Finally, we discuss the adaptation strategies in place and the ways these can be strengthened by the network.

The results presented here are exploratory. However, we find strong indications that a sustainable farmer-led approach gives better climate change outcomes both in terms of mitigation and for its adaptation potential. In particular, we find the farmer-led sustainable agriculture approach documented in this study to be resilient, productive and adaptive with robust social and ecological mechanisms that help farmers respond effectively to emerging challenges.

**Figure 8.1: Key findings**

Full organic farmers have:

- Better climate change outcomes
  - Increased diversity, enhanced crop tolerance, better soil fertility, an active breeding program and strong social mechanisms combine to make MASIPAG farmers more able to respond to climate stresses.
  - The elimination of pesticide use, good soil and water management, and an emphasis on local markets and on-farm inputs reduces the climate impact of sustainable agriculture.

**Mitigation**

Agriculture contributes to climate change as well as being impacted upon by it. Currently, it is estimated that agriculture makes up 12% of total emissions worldwide (Niggli et al 2007) although this figure does not include the production and
transportation of agricultural chemicals. This section will take an initial look at the potential for sustainable agriculture to mitigate climate change largely by drawing on existing literature. The discussions around climate change and agriculture have been extensive and results are still emerging. The information currently available, however, shows strong potential for sustainable agriculture to help mitigate climate change (see, for example, Niggli et al 2007).

High input agriculture requires large amounts of fuel. A study by Pimentel et al (1995) estimates that one hectare of corn raised by high input agriculture requires 1,000 litres of oil. The organic farmers in this study, by contrast, use no fertilisers or pesticides and do not employ mechanised, high input methods. A reduction in fossil fuels burned for transportation, both for importing inputs such as pesticides and fertilisers and for the sale of goods, is also important. In contrast to an agricultural system that moves products around the world - approximately 66 calories of fuel is required to fly one calorie of carrot from South Africa to the UK, for example (Hines et al 2002) - the approach promoted by MASIPAG emphasises local production and consumption, short supply chains and food sovereignty.

In addition to eliminating the use of fossil fuels for the transportation of fertilisers, the elimination of chemical fertiliser also reduces soil emissions of nitrous oxides, one of the major causes of direct emissions from agriculture (Smith et al. 2007). Irrigated rice fields emit large amounts of nitrous oxide. This gas contributes 300 times more to global warming than equal amounts of carbon dioxide. The level of high soluble nitrogen in soils can be influenced strongly by organic and chemical fertiliser application. The conversion of fertiliser nitrogen into nitrous oxide is called denitrification. Several authors (see for example, Burdick 1993, Schumacher 1996) postulate that these losses augment with a higher nitrogen balance in the soil. Thus, it can be assumed that substantial amounts of nitrous oxide emissions are released through the application of chemical fertiliser. Mengel (1984) points out that denitrification losses are higher than expected and these losses are particularly high in flooded tropical rice soils. Also a
more recent study by Petersen et al. (2006) found lower emissions for organic farming compared to conventional farming in five European countries.

Another major contribution to climate change is the production of chemical nitrogen fertilisers. World consumption is totaled at 90.9 million tons for 2005 (IFA, 2007) and this requires vast amounts of fossil fuels for its production. To give another example, a 100-hectare stockless arable farm in the UK, consumes on average 17,000 litres of fossil fuel annually through fertiliser inputs (Cormack, 2000).

The good management of soil can lead to a better rate of carbon sequestration in organic agriculture. Recent studies that look at overall impacts of organic agriculture that incorporate attention to carbon sequestration, show that its potential to reduce climatic impacts is high. Küstermann et al. (2007) found a decrease of 80% in global warming impacts at the Scheyern experimental farm while Robertson et al (2000) found a 64% decrease in Michigan, USA. The use of animal manure as fertiliser, better soil fertility that stops soil erosion and increases organic matter in the soil, good water management and appropriate composting techniques all have the potential to increase the level of carbon sequestered in the soil (Reganold et al. 1987). The re-use of biomass in a closed loop system rather than burning it as may be done in conventional farming is another advantage for this system.

As resource poor farmers growing mostly for local markets in a largely non-mechanised context, all farmers involved in the study, including conventional farmers, contribute less emissions than a large-scale highly mechanised, export oriented agriculture. The farmers practicing farmer-led sustainable agriculture, however, through eliminating chemical fertiliser and pesticide, working to improve soil fertility, and focusing on local level production, are making a particularly significant contribution to reducing the climatic impacts of agriculture.

Studies of organic agriculture in temperate contexts have shown some concern about lower yields in organic systems. This would
mean the organic system would create more greenhouse gases per unit output. The yield results gained in this study mean that this negative effect is not experienced.

**Figure 8.2a: Risk to projected rainfall and risk.**  
(Source: Manila Observatory 2008)
As Elpidio Paglumotan describes, this is an important aspect of their work:

MASIPAG is a real alternative to global warming because it's a contribution to the environment. It is a big help to our children and the next generation that is also an element of food security so we can sustain for the next generations.
Climate change threats

There are many ways that climate change can negatively affect small-scale farmers. The farmers in the network already report a range of effects including increasing droughts (frequency and intensity, irregularity of rainfall), typhoons (strength, duration and frequency), strong winds (frequency and intensity), flooding (increase in frequency and intensity of flash floods, lake flooding) and salt water intrusion. Figure 8.3 documents the perceived magnitude and frequency of climate calamities by province as reported by the respondents. The table looks at climate-related weather changes identified by eight different working groups made up of a total of 26 farmer leaders, NGO support staff and scientists. This took place over two sessions. In the first session, the major problems were listed. The magnitude of damage and the changing

Figure 8.3: Perceived magnitude and frequency of calamities by province

<table>
<thead>
<tr>
<th></th>
<th>Nueva Viscaya</th>
<th>Pangasinan Luzon</th>
<th>Capiz Visayas</th>
<th>Davao Oriental Mindanao</th>
<th>Zamboanga del Sur Mindanao</th>
<th>Cotabato del Norte Mindanao</th>
<th>Zamboanga del Norte Mindanao</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1(B1) T1</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Flooding</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>M2(B2) T2</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Long rainy season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M3(B3) T3</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Typhoon</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landslide</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M4(B4) T4</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Flash flood</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M5(B5) T5</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Long drought</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M6(B6) T6</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Sudden change of weather condition</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

Explanations: M1 = Magnitude of calamities; B = Frequency of calamities before (period) 1988-1998; T = Frequency of calamities today

<table>
<thead>
<tr>
<th>Codes</th>
<th>Frequency</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - no effect</td>
<td>0 - every 15 years</td>
<td>a) Typhoon belt</td>
</tr>
<tr>
<td>1 - up to 10% yield decrease</td>
<td>1 - every 10 years</td>
<td>b) Now it is heavier than before</td>
</tr>
<tr>
<td>2 - 11-25% yield decrease</td>
<td>2 - every 7 years</td>
<td>c) Due to Mt. Pinatubo eruption</td>
</tr>
<tr>
<td>3 - 26-40% yield decrease</td>
<td>3 - every 3 years</td>
<td>d) Before it floods every November - February, now it floods quarterly</td>
</tr>
<tr>
<td>4 - 41-100% yield decrease</td>
<td>4 - every 2 years or more often</td>
<td>e) Before it came frequently but with regular schedule (June - September), now it does not come as it was expected or sometimes it comes every month</td>
</tr>
</tbody>
</table>
frequency of the events were then rated by 10 leaders from people’s organisations in the MASIPAG network.

As one farmer, Eddie Panes, describes:

There are a lot of changes - unlike before. In the early 80s the climate was still normal. Every year we had two seasons – dry and wet - but now I think it’s unpredictable. That’s why if you’re a MASIPAG farmer we need to research the climate. Before, when we say dry, it was dry for many months. Then during the wet season, it’s raining... That’s why some of the farmers get failure when they are farming.

Flooding and an unusually long rainy season were among the most frequent problems mentioned by farmers. Four to five of the seven provinces were affected. Flooding created the highest levels of damage illustrated by the high ratings of 3-4 indicating a 25-100% yield decrease as a result of flood events. The frequency of events was also shown to increase over time. In the Visayas and Mindanao these events were still rather rare (1-2) occurring once in 7-10 years. In northern Luzon, farmers face this problem annually. The damage levels for a prolonged rainy season are a little lower and cause at most a 25% yield loss. This variation in the lengths of rainfall, however, showed the fastest increase in frequency as occurrences increased sharply in all provinces. In three instances the frequency increased from occurring once in 7 years to biannually or annually.

Typhoons are major causes of flooding. These storms can also cause major wind damage. Their effect is mainly felt in Luzon and the Visayas. Damage was rated up to 25%. The main problem, however, is frequency. More than 20 typhoons per annum cross the Philippines with about 8 to 9 landfalls each year (IPCC 2007). Farmers in the north complain that they have had to abandon the typhoon season completely for rice cultivation. The damage simply is too frequent and too high.

Long drought was mentioned by more than half the provinces. The magnitude of yield losses was similar to excessive rain with losses of up to 25%. Another aberration of climate was named “sudden change of weather”. The farmers reported sudden quick rises in temperature of rather short duration. This was something
farmers have not experienced before and it was associated with considerable crop damage (level 3).

Coping strategies and adaptation

In the face of climate change, resilience and adaptiveness of agricultural systems will become increasingly important. Climate change adaptation is defined by Ulsrud et al. (2008) as adjustments to reduce vulnerability and enhance resilience in response to observed or expected changes in climate and associated extreme weather events. Adaptation can be considered a dynamic social process that involves adjustments in practices and policies within

Farmer Lucio Gurango plants a drought-resistant variety ahead of the regular planting season, hoping to determine new cropping schedules.
a context where not only the climate is changing, but where societal transformations are also taking place. Structural and systemic factors, such as local, national and international economic policies and power relations, influence the capacity of individuals and local communities to respond. Individual and cultural characteristics such as beliefs, values and worldviews also influence adaptation processes. MASIPAG farmers have both the technological and the social infrastructure necessary to help facilitate climate change adaptation. The advocacy of the group will also work to push for changes at other scales.

The evaluation team discussed coping strategies with farmers during the field visits at the local level and in working groups at the corn and national workshops in Mindanao. The discussions show that the current MASIPAG recommendations are very suitable to mitigate adverse climatic effects. Climatic variability has always been an important issue for MASIPAG and therefore no completely new strategies are needed, but rather a more careful and more comprehensive adoption of the existing extension messages is required.

An important concept in farmer-led sustainable agriculture is to create more diversity in farming systems. Different species of crops and trees provide different kinds of foods at different times and provide multifunctional benefits: fodder, green manure, firewood, windbreaks, medicines, erosion control, wildlife habitat and so forth. The breeding programs on rice and corn also apply the diversity concept and enable farmers to grow a large number of different varieties better adapted to climatic and location-specific variability. Integrating livestock into the farming system is another strategy of diversification.

As Ka Pecs, explains:

We have so many varieties. For strong winds just keep on planting those shorter plants with bigger stalks and erect leaves, those are fitted for strong winds, for typhoon belts. For flooding never use the dwarf varieties, you go on to the medium, tall varieties with strong stalks. The advantage of MASIPAG is that it has a diverse source of seeds to choose from, traditional or MASIPAG or farmer bred lines. There are so many available to fit your problems.
Soil fertility enhancements and good farm planning are also important as they help maintain productivity in the face of drought or other extreme weather conditions. The following are more detailed adaptation steps formulated by the farmers in response to two key climate related problems.

**Typhoons and flooding.** Most damage is done in the period close to rice harvest. Thus, farmers use a risk minimisation strategy by planting a high number of different varieties. As each variety has a different harvest time, the risk of a full crop failure is minimised. Staggered planting dates and intercropping can help to further reduce risk. Community nurseries and planting of additional trees can help against the strong winds of typhoons. Upland farms can further diversify into livestock as fodder is more abundant and livestock are less sensitive to climatic changes. On a regional and national level, MASIPAG can help to establish biodiversity areas, enhance the capacity of the back-up farms to produce and store seed to supply calamity affected people’s organisations with emergency seeds and planting materials.

**Drought.** Diversification of crops is a good strategy for drought. Perennial crop such as bananas and many root crops are more drought resistant than rice or corn. Plant breeding work can identify more drought resistant varieties. Agroforestry trees mobilise water from deeper soil layers and help to create a moister microclimate. Organic farming aims at increasing soil humus content. Humus has a very high water holding capacity and thus plants can support water stress for a longer period. Building terraces, or water retention systems, can improve water availability for crops. Irrigation systems can mitigate the effects of drought. A shift from crops with high water consumption to crops with lower water consumption can help to save water.

A set of coping strategies in relation to the following less frequent and more erratic weather hazards is compiled in the following table.

In addition to technical approaches, the creation of people’s organisations and provincial coordinating bodies along with the participatory structure of the organisation can be seen as social innovations that help farmers to adapt to the multiple stresses of
FOOD SECURITY AND FARMER EMPOWERMENT

These elements generate synergistic effects that contribute towards a greater resilience of the MASIPAG farming system. Greater empowerment and the emphasis on farmer knowledge within the network will see farmers better placed to work on appropriate adaptive measures.

The social aspects of the organisation in supporting climate change adaptation are underscored by Eddie Panes who describes:

There is openness and sharing within the group. We get more active group participation, they can participate more actively. We share
whatever we learn at the meeting. We don’t know what climate change will bring, what really will be our situation and it changes all the time. So we just share whatever technologies we have, like in knowing which varieties are more adaptive to our place, the technologies that are best for wind, rain drought and for all those situations.

The farmer-led approach documented in the study has a positive role to play in both mitigating climate change and in responding to it. The diverse, productive and resilient systems promoted by the network will maximise the adaptive capacity of farmers and farming communities. While the systems discussed do represent a positive measure, they need to be seen in a broader context of change. Mitigation measures are urgently needed by the sectors and countries who contribute most to climate change. Further, small-scale farmers, regardless of how knowledgeable, resilient and empowered they may be, cannot be expected to respond continuously to disasters. Supportive measures such as seed stores, solidarity funds, early warning systems and other appropriate infrastructure must thus be developed. Strong advocacy is needed to achieve mitigation measures at an international scale and to encourage the development of appropriate support mechanisms for those affected.