Glyphosate Residues in Genetically-Modified Corn Fields in Maayon, Capiz

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MASIPAG is a network of farmers’ groups, scientists and non-government organizations in the Philippines seeking to improve farmers’ quality of life through their control over genetic resources, agriculture technology and associated knowledge.

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<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>iv</td>
<td>Acknowledgments</td>
</tr>
<tr>
<td>1</td>
<td>Introduction</td>
</tr>
<tr>
<td>3</td>
<td>Review of Related Literature</td>
</tr>
<tr>
<td>6</td>
<td>Methodology</td>
</tr>
<tr>
<td>9</td>
<td>Results and Discussion</td>
</tr>
<tr>
<td>12</td>
<td>Conclusion and Recommendations</td>
</tr>
<tr>
<td>13</td>
<td>The Call for a Safe, Sustainable, and People-Centered Agriculture</td>
</tr>
<tr>
<td>14</td>
<td>References</td>
</tr>
</tbody>
</table>
Acknowledgments

This paper is dedicated to the thousands of small farmers and their families who fell victim to the dangers of glyphosate and are now fighting for their right to health, to information, and for social justice.

This research was supported by Action Solidarité Tiers Monde (ASTM) and Sarah Wright of the University of Newcastle, together with MISEREOR and Swedish Society for Nature Conservation (SSNC). MASIPAG claims sole responsibility for the content, and it does not necessarily reflect those of its supporters.

This study was headed by MASIPAG scientist member Dr. Chito Medina and the research team with the community members of Brgy Guinbialan. The team includes lead writer Eloisa delos Reyes and MASIPAG Visayas staff, Kervin Bonganciso and Analyn Diaz.

This project was managed by the MASIPAG Information-Communications and Advocacy Unit and the MASIPAG Visayas Regional Office.
Introduction

Glyphosate is the world’s most widely used herbicide in human history. It has affected agricultural soils, surface and underground water, fresh and processed food, and many products that are commonly used. Its use in tandem with herbicide-tolerant GM crops, such as Roundup Ready Corn (RR Corn) by Monsanto, increased 15-folds since herbicide resistant crops were introduced in 1996. According to a study by MASIPAG in 2012, farmers spray about four liters of glyphosate per hectare twice every cropping season. This amounts to a total usage of almost 5.3 million liters of the herbicide in the Philippines per season of GM corn farming in 2011 alone. More than 10 years of commercialization and propagation of GM corn in the Philippines and the associated use of glyphosate has led to many issues and concerns particularly in its socio-economic, environmental and health impact.

In 2012, MASIPAG led a study to determine the socio-economic impacts of GM corn among the Filipino farmers in 12 corn growing communities. Results showed that Filipino farmers suffered from the high cost of production (with more than 40% of the total cost spent on the GM corn seeds and the required chemical inputs such as glyphosate) while the yields are inconsistent and unreliable. In fact, research conducted in Isabela province showed that GM (Bt corn and RR corn) and non-GM corn had no statistical difference in production output (Afidchao, 2014). Because of the high production inputs, farmers get into a debt trap that often leads to bankruptcy and even loss of land and other meager resources. The situation is aggravated among farmers who rely on unscrupulous financers and traders due to high interest on loans.

Effects of GM corn farming on the environment and on the health of farmers and other members of the communities in Maayon, Capiz were documented initially by MASIPAG in 2017. Farmers in the village observed an increase in serious illnesses since the first introduction of GM corn and glyphosate use. Around 16 people have reportedly contracted cancer, with at least five people succumbing to the disease. This confirms most of the observations, including the alarming increase of people getting seriously ill in
the communities where GM corn and glyphosate are widely used.

In 2015, the International Agency for the Research on Cancer (IARC) of the World Health Organization (WHO) classified glyphosate as “probably carcinogenic to humans” (Category 2A). Despite this report, not much study has been done on its long term impact on Filipino health and the Philippine environment, specifically to farmers who are exposed daily to the said herbicide. To this day, glyphosate remains as one of the most popular herbicide and is widely used and promoted in the Philippines. As such, MASIPAG, along with several organizations, has embarked on documenting impacts of glyphosate use among GM corn farming communities.

Pesticide residue analysis is usually done in the laboratory using High-Performance Liquid Chromatography (HPLC) or Gas Chromatography-Mass Spectrometry (GC-MS) (for volatile compounds). These are quite precise quantitative analysis but they are generally expensive. A rapid strip test technology to detect glyphosate residues is currently available. The test is an “immunochromatographic test” for qualitative screening of glyphosate in water and food samples. This simple test can be conducted by anyone wishing to determine the level of glyphosate in their immediate environment, including the farmers and the concerned community members. Being qualitative, the rapid strip test reveals absence, present in low level, or present in high levels of glyphosate residues.

The use of the simple dipstick strip test was also deliberate as an approach to involve the community in the study. The so-called Citizen Science Research also resonates at some level with the farmer-led development approach that MASIPAG is espousing, which gives emphasis on the central involvement of the farmers and their communities in any endeavor.

This study was conducted in Brgy. Guinbialan, a small village in Maayon in the province of Capiz from May 24 to August 23, 2018. It aims to detect the presence of glyphosate in different environmental media with the intent to get a snapshot of the persistence of the said herbicide in the environment, the food produced and the inhabitants. In particular, the objectives of the study are:

1. Determine the glyphosate presence in soil, water, corn;
2. Test human urine for glyphosate presence, and;
3. Engage and mobilize the community for data collection, result validation and preliminary analysis thru citizen science research.

The intention is to call the attention of the concerned government agencies to come up with a systematic and sustained monitoring of the dynamics and persistence of glyphosate residues, and address the associated effects and impacts of glyphosate.
Review of Related Literature

Glyphosate [N-(phosphonomethyl) glycine] has been introduced commercially in 1974 and has since become the most widely-used and heavily-applied herbicide in the world.

It is estimated that about 8.6 billion kilograms of glyphosate-based herbicide had been sprayed worldwide from 1974 to 2018. In 2012, glyphosate is used in more than 160 countries, with more than 1.4 billion pounds applied per year not only for agricultural production but also for weed management in private (lawns, gardens) and public (parks, streets) spaces.

Glyphosate kills weeds by blocking proteins essential to plant growth and is always combined with other chemical ingredients; uses chemicals such as ‘surfactants’ to enable the entry of glyphosate into plant cells. One of the most commonly-used glyphosate is the Roundup brand by Monsanto. In the mid-1990s, when the genetically modified crops were introduced, glyphosate use increased 15 folds. According to Szekacs et al. (2012), “the subsequent development and approval of genetically engineered (GE), herbicide-tolerant (HT) crops dramatically changed how farmers could apply it.” Since 1996, the promotion and use of herbicide tolerant GM crops have significantly increased, particularly cotton, corn and soybeans, making it possible for farmers to apply glyphosate for months after crops started growing.

In the Philippines, glyphosate is widely-used among major crops such as rice, corn and plantation crops such as sugarcane, palm oil, banana, pineapples, coffee, rubber and also cash crops such as vegetables. The Philippines Fertilizers and Pesticides Authority (FPA) lists more than 70 glyphosate products, most of which are Monsanto (now with Bayer) brands.

Meanwhile, among the most common glyphosate used for other crops include Phoenix, Rapid Fire, Ricegard, Karet, Supercut, Tekburn, Grassout, Gambit, Glysinate, Sharpshooter, Pyanchor, Machismo, Topline, Formosa, Firestorm, Kervance, Select, Gallant, Burado, Eraser and many others. Recently, Glyphosate has also been known to be used for weeding out public spaces such as parks, schools and residential areas.

Effects of Glyphosate

In 2015, IARC classified the weed-killer as “probably carcinogenic to humans.” This pronouncement came at the heels of various studies whose results point to the negative effects of Glyphosate. Szekacs et al. (2012) cites Charles Benbrooks’ article noting “other recent studies have found connections between glyphosate exposure and a number of other serious health effects, including liver and kidney damage and non-Hodgkin’s lymphoma, among others.”

Glyphosate poses a serious threat to health. At the farmers’ level, glyphosate can be ingested through food or the contaminated water source. Farmers are at risk from the direct contact with leaks from the chemical sprayer strapped on their backs, or the wind direction can blow the glyphosate towards the residential areas of the community. According to the Biomedical Research International, the commercial Roundup herbicide is 125 times more toxic than the pure glyphosate because of the adjuvants present in the herbicide formulation.

There is a debate on what is the safe level for glyphosate. Antoniou et al. 2012 reported that regulators in Germany used industry-sponsored toxicological studies and came up with 60 mg/kg body wt/day as the Lowest Observed Adverse Effect Level (LOAEL).

From the LOAEL, the No Observed Adverse Effect Level (NOAEL) is calculated at 31 mg/kg body wt/day. The Acceptable Daily Intake (ADI) for glyphosate is calculated from the NOAEL value using the usual 100-fold safety factor, and the
German regulators proposed 0.3 mg/kg body wt/day.

In a review of the divergence of regulatory decisions from scientific evidence, Antoniou et al. (2012) cited an independent study done by Suresh et al. in 1993, indicates that the LOAEL for glyphosate should be 20 mg/kg body wt/day, which is three times lower than the officially accepted LOAEL by Germany regulators. Thus, the NOAEL should be 10 mg/kg body wt/day, and applying the customary 100-fold safety factor, the ADI should be 0.1 mg/kg body wt/day.

Complicating the situation is that Roundup and glyphosate had been reported to be endocrine disruptors and behave on a non-linear relationship. As such, toxic effects may occur at very low doses, even if there are no effects observed at lower doses. Axelrad et al. 2003 reported that Roundup had toxic effects as low as 10 ppb (=0.01 microgram/L).

Among the recorded health problems caused by glyphosate are as follows:

1. **Autism and other multiple chronic diseases.** Glyphosate inhibits natural cellular processes that might cause diseases such as autism, allergies, Alzheimer’s disease, gastrointestinal disorders, obesity, diabetes, heart diseases, depression, infertility and others.

2. **Endocrine System Disruption.** Glyphosate destroys the organ systems of the body creating hormones that are essential for growth, respiration, temperature regulation of the body, sleep and others. Even the minimum allowable level of concentration of glyphosate in drinking water can also be harmful.

3. **Cancer.** WHO’s International Agency for Research on Cancer declared glyphosate as Category 2A carcinogenic that could potentially cause cancer among humans. There are evidences pointing to glyphosate as a cause of non-Hodgkin’s lymphoma, a cancer of the lymphatic system.

However, in 2018, Bayer (who now owns Monsanto after the historic merging in 2017) has been sued by victims of glyphosate. In August 2018, the San Francisco Superior Court jurors ruled in favor of Dewayne Johnson, a 42-year-old school groundskeeper suffering from non-Hodgkin’s lymphoma; in March and May, Bayer lost again to Edwin Hardeman (also from San Francisco) and Alva and Alberta Pilloid from California who all suffered from non-Hodgkin’s lymphoma.

All these people have in common are the long-term use and exposure to Monsanto’s glyphosate Roundup. More than 45,000 similar lawsuits have been filed in court against Bayer.

Friends of the Earth likewise reports about the effects of glyphosate on the environment. Various studies have been conducted to look into the impacts of glyphosate on biodiversity, soil wildlife in agricultural areas and in water.
GM corn farming in Guinbialan

Before the introduction of genetically modified (GM) corn and its accompanying chemical inputs, farmers in Guinbialan are subsistence farmers, with some having already converted to organic and sustainable farming. Like most of the villages in the municipality of Maayon, farming is the major source of livelihood. Female household members are also actively involved in the farming activities, particularly as farm workers.

The village of Guinbialan sources its water from the Manayuba and Guinbialan Rivers. Spring water and deep wells also abound in the community, whose water are used for drinking (for humans and animals alike), bathing, and washing. The encroachment of glyphosate-sprayed GM corn farms, most of which located just within 100-150 meters away from these water sources greatly increases the risk of contamination of these water sources.

The introduction and distribution of GM corn in the community has been pervasive and systemic: local agricultural traders and financiers only sold GM corn seeds and only provided production support for those buying and planting them. With the early successes enjoyed by the farmers in terms of yields and income, they were enticed to carry on with planting Bt corn first, followed by the Roundup Ready (RR) corn. Whereas the Bt corn was supposedly tolerant to the corn borer pest, the RR corn is designed to withstand the use of herbicides such as glyphosate.

The most important come-on strategy for RR corn is its zero-tillage feature. Proponents and developers of the RR seed technology promised that with the use of RR corn, farmers will not need to manually remove the weeds, or plow the land which can be laborious and back-breaking for the farmers. Farmers only need to spray glyphosate to remove the weeds, and even makes land-preparation easier. The zero-tillage feature also allowed the farmers to open up terrain and lands that are not normally considered for cultivation: steep hills and mountainsides have been stripped off their vegetation and planted with RR corn in a bid to expand the GM corn area planted by a farmer or his/her family. Apparently, local financiers provide additional incentives to farmers depending on the size of their GM corn cultivation. Aside from production loans, financiers also offer farmers and their families loans for non-agricultural uses, which they often avail to augment their meager income. However, these financial loans are only available to those planting GM corn, which further tightens the noose around the farmers.

Farmers in Guinbialan have been using RR corn for more than 10 years, and they were among the early adopters of the technology. Initial documentation on the effects of the use of GM corn and glyphosate indicates that there are indeed alarming health and environmental effects. There has been no post-release monitoring conducted by the Department of Agriculture or other relevant agencies to date, to sufficiently investigate the impacts of GM corn farming.

Meanwhile, NGO-led studies have already documented the negative socio-economic impacts of GM corn, including the crippling indebtedness and cycle of hunger and poverty that the GM corn production has caused the farmers in different corn-growing areas in the Philippines.
Methodology

A. Sampling and Testing

Prior to the glyphosate residue testing, community mapping (see Figure 1) was conducted in September 2017 to locate the important areas that can be subjected to further environmental study. On May 2018, the sites were revisited and through a plenary workshop conducted with 10 community representatives (including barangay officials, barangay health workers and PO Leaders) the sampling sites were finalized.

Water and soil sampling was done in three batches to span the whole cropping cycle of GM corn farming, from land preparation to near harvest. The pre-planting sampling was done on May 24-25, 2018; post-planting was done on June 18-19, 2018; and before harvest was done on Aug 22-23, 2018. Glyphosate residue tests on corn kernels and urine samples were done only on the first batch of sampling.

- For the soil samples, GM corn fields were identified as sampling areas. Soil samples were collected in a column of soil six to eight inches deep, then put into plastic bags, labeled, then brought for analysis. The soil samples were air-dried overnight, pulverized in mortar and pestle, then subjected to residue testing. There were three samples each for the pre-planting, post-planting and before harvest. Each soil sample was made up of composite samples. During the first sampling (pre-planting), additional three soil samples were collected where glyphosate had just been sprayed during the previous 2-10 days.

- Water samples were put in plastic bags, labeled then brought for analysis the same day. For the first sampling, a total of six water samples were tested, three samples were taken from the river system while three samples were from spring water which serves as source of the community’s drinking water. For the post-planting and before harvest, four water samples were taken at a time from the river system only. All the water samples are near the GM corn farms, with an estimation of around 4 meters as the nearest and 100 meters being the farthest.

- For the corn kernels, 25 corn seeds were collected to constitute a sample, pulverized, then analyzed for residues. Three samples of newly harvested corn kernels, and another three samples of dried corn kernels were tested.

- Glyphosate residues were also tested in human urine samples during the May 24-25, 2018 sampling. Three farmers volunteered and signed the free and prior informed consent (FPIC) before obtaining their urine samples. All three farmers sprayed glyphosate on their respective farms 3-5 days prior to the research. Also, it is important to highlight that these farmers are not using proper protection against the chemical when spraying.

During the course of the sampling process the community representatives were involved from collecting the samples to the actual sampling.
B. Dipstick Strip Test

The Abraxis Glyphosate Strip Test is a rapid immunochromatographic strip test that is used to detect glyphosate in water and food samples. According to its manufacturer, Abraxis, the strip test is used in qualitative screening of glyphosate with a detection range of 2.5 parts per billion (ppb) up to 100 ppb.

The testing is done with the membrane strip that recognizes specific antibodies for glyphosate. Depending on the presence (or absence) of glyphosate in the sample, test lines are visible when the antibodies react with the glyphosate membrane on the strip.

Results are then interpreted with the following guide:

<table>
<thead>
<tr>
<th>Control Line</th>
<th>Test Line</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>No control line present</td>
<td>No test line present</td>
<td>Invalid result</td>
</tr>
<tr>
<td>Control line present</td>
<td>Very faint or no test line present</td>
<td>&gt;100 μg/mL (ppb)</td>
</tr>
<tr>
<td>Control line present</td>
<td>Moderate intensity test line present</td>
<td>Between 2.5 and 100 μg/mL (ppb)</td>
</tr>
</tbody>
</table>

C. Citizen Science Research

According to Dickinson et al. (2010), “citizen science invites the public to participate in both scientific thinking and data collection.” Particularly in the field of ecological studies, volunteers across geographical areas are able to collect and share data, influencing the scope and coverage of ecological research.

Citizen science research banks on the active participation of volunteers (citizens) “who are able to access learning materials and protocols, gather data, and enter them online into centralized, relational databases,” where the results can be viewed and shared.

This was further emphasized by Conrad and Hilchey (2010) wherein “the focus of recent citizen science is not the traditional “scientists using citizens as data collectors,” but rather, “citizens as scientists” (Lakshminarayanan 2007).

Dipstick kit used in the research.
The nature of citizen science implies that in many cases, the work being undertaken is not documented in traditional journal articles, although there certainly are exceptions. They also refer to citizen science as community-based monitoring (CBM). In Europe, CBM or citizen science contributes to the monitoring efforts of the government in biodiversity conservation, since most of the volunteers are amateur naturalists.

The emphasis on participation and recognition of the local and inherent knowledge among the people fits right in the MASIPAG farmer-led approach and farmer-empowerment.

Since its formation in the 1980s, MASIPAG has been guided by the mission to help in the improvement and development of farmers’ knowledge and skills so that they themselves will be capable to develop solutions and innovations not only in their agricultural production, but also in their organizations and communities.

MASIPAG programs such as the Farmer-Developed and Adapted Technologies (FDAT) focus on developing the scientific capacity among farmers in crafting solutions and farming innovations. Systematic and programmatic education and training are regularly conducted to build their analytical and technical skills.

As such, active participation of farmers and local village officials is an integral part of the study as described in the methodology above.

- The community participated in obtaining samples for testing and conducted the actual testing using the dipstick kit under the close supervision of the lead research scientist. They were also keen to identify the results based from the parameters set by the testing kit with the guidance of a scientist.

- The farmers and community members provided immediate feedback helping in the validation of the results of the tests.

D. Limitation of the Study

Due to limited budget, the study only covered one cropping season in one community. There is a need for year-long study in the community and in other RR corn growing areas.

Likewise, the study is only a qualitative determination of glyphosate residues. There is a need for a quantitative analysis using HPLC/GC-MS equipment. Bigger budgetary requirements are needed to undertake it.
Results and Discussion

**Glyphosate residue in soil**

Glyphosate residues were detected in all soil samples at any sampling time: before planting and spraying, after planting and spraying, and before harvest (Table 1). It is interesting to note that the soil samples before planting/before spraying (May 24-25, 2018) with detectable glyphosate residues were already four to five months (120 to 150 days) since the last herbicide spraying.

The data indicates long residual activity in the soil. Pesticides degrade mainly through microbial decomposition, photodegradation or chemical decomposition with water reaction. However, degradation can be delayed if they bind or are adsorbed to soil particles. Studies have shown that glyphosate binds (Chelation) strongly with calcium, iron, magnesium, manganese, nickel, zinc, etc. and makes it more environmentally stable while rendering the said minerals unavailable to the plants. Furthermore, glyphosate degrades into Aminomethylphosphonic acid (AMPA) which is as toxic as glyphosate. Studies have shown that AMPA persist longer in the soil compared to glyphosate. The level of AMPA was not determined in this study.

**Glyphosate contamination of water**

Water samples collected from river systems across the study sites contained detectable levels of glyphosate residues (Table 2). Spring water, serving as source of drinking water in Guinbialan, collected before corn planting and before spraying, were also contaminated with glyphosate residues.

Glyphosate and the river system is complex and problematic because the farmers wash their sprayers and soiled clothes after spraying in the rivers. Glyphosate residues in water systems could also be sustained due to runoff after heavy rainfall that wash out the herbicide from the corn fields into the river system. Leaching and seepage in low lying areas could also carry glyphosate residues into the rivers. The heavy rainfall before the Aug 22-23, 2018 sampling might have washed down glyphosate residues from the cornfields resulting to the higher level of detectable glyphosate during that sampling period. Yang et al. (2015) found that 4 to 5 percent of applied glyphosate is transported through runoff in a simulated 60 minute rain simulation at 1mm per minute. Water erosion is an important pathway for glyphosate and AMPA towards bodies of water (Todorovic et al., 2014).

<table>
<thead>
<tr>
<th>Soil Sample/Farm</th>
<th>Glyphosate Residue (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm FB</td>
<td>10-100</td>
</tr>
<tr>
<td>Farm NV</td>
<td>10-100</td>
</tr>
<tr>
<td>Farm RI</td>
<td>10-100</td>
</tr>
<tr>
<td>Farm CV</td>
<td>2.5-10</td>
</tr>
<tr>
<td>Farm LB</td>
<td>10-100</td>
</tr>
<tr>
<td>Farm RI2</td>
<td>10-100</td>
</tr>
</tbody>
</table>
The glyphosate residues in the river system pose some direct health risks to the inhabitants in the study area because it is the main water source for bathing, washing clothes and other everyday activities in the community.

Human activities were observed to be most frequent in the convergence of the Manayuba and Guinbialan Dako rivers because of more water volume and its proximity to the residential areas. But it is even a bigger concern in the spring waters being contaminated with glyphosate because the water is used for drinking.

In Sri Lanka, Jayasumana et al. (2015) reported an epidemic of Chronic Kidney Disease of unknown etiology (CKDu) in a rice farming community. The illness was attributed to drinking water from wells contaminated with glyphosate.

Glyphosate was detected both in newly harvested corn and dried corn grains (Table 3). This means that glyphosate is not fully degraded in the corn grains, even after several days of sun drying. This implies that RR corn used in formulated animal feeds are also contaminated with glyphosate.

GM corn is being used primarily for animal feeds which may prove detrimental to animal health. Most feeding studies on laboratory test animals are usually conducted over a period of 45 to 90 days and suggest that glyphosate is safe. And most of these studies are directly or indirectly supported by the industry. However, the short feeding duration accounts only for acute toxicity of the chemical.

Independent scientists also suggest determination of chronic effects of pesticides. This would mean a feeding duration for the entire life span of test animals as well as the effects on its offsprings. For example, Seralini et al. (2014) reported that mice fed with RR corn, with its inherent glyphosate residues, throughout the duration of their life developed tumors.

Studies on the effect of glyphosate on livestock fed with RR corn and its glyphosate residues are still not undertaken. Likewise, since there is no segregation of GMO and non-GMO in the country, it is highly likely that the GM corn is also being used for corn-based food for humans, thereby exposing the Filipino population to glyphosate.

### Table 2. Glyphosate residues in water samples from RR corn fields in Guinbialan, Maayon, Capiz.

<table>
<thead>
<tr>
<th>Water Sample</th>
<th>Glyphosate Residue (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manayuba river</td>
<td>2.5</td>
</tr>
<tr>
<td>Guinbalan Dako river</td>
<td>2.5</td>
</tr>
<tr>
<td>G Proper/Lalay</td>
<td>2.5</td>
</tr>
<tr>
<td>Converge M/G Dako</td>
<td>2.5</td>
</tr>
<tr>
<td>Spring Suba*</td>
<td>2.5</td>
</tr>
<tr>
<td>Spring Manayuba*</td>
<td>2.5</td>
</tr>
<tr>
<td>Spring Guinbialan*</td>
<td>2.5</td>
</tr>
</tbody>
</table>

*drinking water

### Table 3. Glyphosate residues in Round-up Ready corn grain samples from Guinbialan, Maayon, Capiz.

<table>
<thead>
<tr>
<th>Corn Grains Sample</th>
<th>Newly Harvested Corn Grains (May 24-25, 2018)</th>
<th>Dried Corn Grains (May 24-25, 2018)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>2.5-10</td>
<td></td>
</tr>
<tr>
<td>S2</td>
<td>2.5-10</td>
<td></td>
</tr>
<tr>
<td>S3</td>
<td>2.5-10</td>
<td></td>
</tr>
<tr>
<td>S4</td>
<td></td>
<td>2.5</td>
</tr>
<tr>
<td>S5</td>
<td></td>
<td>Spoiled sample</td>
</tr>
<tr>
<td>S6</td>
<td></td>
<td>2.5</td>
</tr>
</tbody>
</table>
Glyphosate in farmers’ urine

Glyphosate was also detected in farmers’ urine (Table 4). It is possible that they have inhaled the herbicide and absorbed through dermal contact during spraying. When asked, farmers claim that they do not wear any protective covering or equipment during spraying aside from their usual work clothes. They do wash themselves immediately at the nearest water source, but this may not be effective if the poison was inhaled or has already penetrated the skin.

These results are of concern because the farmers are being poisoned without even knowing it. These chronic exposure to the herbicide may lead ultimately to illness. Experiments on test animals of mice and rats showed that glyphosate caused kidney and liver damage as well as gastric disease (Williams et al., 2000; Samsel and Seneff, 2013). Exposure to glyphosate also had been implicated in the rise of autism among children (Samsel and Seneff, 2013).

The IARC assessment found sufficient evidence that glyphosate can cause cancer and evidence on its genotoxicity (ability to damage DNA) was strong. Exposure to glyphosate was also reported to cause increased cases of childhood leukemia, Parkinson’s disease and non-Hodgkin’s lymphoma (Guyton et al., 2015).

Table 4. Glyphosate residues in urine of RR corn farmers from Guinbialan, Maayon, Capiz (May 25, 2018).

<table>
<thead>
<tr>
<th>Urine Sample</th>
<th>Glyphosate Residue (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1 (4 days after spraying)</td>
<td>2.5-10</td>
</tr>
<tr>
<td>Sample 2 (5 days after spraying)</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Sample 3 (3 days after spraying)</td>
<td>2.5-10</td>
</tr>
</tbody>
</table>

Dispersal, dissipation and persistence of glyphosate in the environment

Glyphosate is generally persistent which is not easily biodegradable and has limited volatility. When sprayed, the herbicide is partitioned into different environmental media (Figure 2). If spraying is done before planting, about 10 to 25 percent of the glyphosate land on the weeds, the rest would be deposited in the soil. Some amounts are temporarily suspended in the air, and may be inhaled by the farmer spraying the chemical. Depending on the wind speed, it may drift to adjacent areas (farm or residential areas) but ultimately settle into the soil.

In the soil, glyphosate has high binding (chelation) affinity with calcium, iron, magnesium, manganese, nickel, zinc, etc. making these mineral micronutrients unavailable to plants. Glyphosate may be adsorbed to soil particles, and it can last from 4 to 180 days (Borggaard and Gimsing 2008). With rainfall, glyphosate can be washed away (leached) in runoff, or flow laterally in the soil through seepage. Glyphosate can remain in water with 50 percent still intact in a period of 28 days (Samsel Seneff, 2013).

Glyphosate can be converted into its main metabolite, aminomethylphosphonic acid (AMPA), which had been reported to be as toxic as glyphosate. In bodies of water, AMPA is even more persistent with a half life of 76 to 240 days (Vereecken, 2005; Torretta et al. 2018). It is the glyphosate residue and its metabolite AMPA in water that brings risk because water is utilized by people for washing, bathing and for drinking. With two cropping seasons of RR corn, and with the
Conclusion and Recommendations

This study confirmed presence of glyphosate in soil and water before spraying/planting, after spraying/planting and before harvest. Residues in corn grains were also detected. Farmers spraying the herbicide were also found to be contaminated as evidenced by glyphosate residues from their urine samples.

The fact that glyphosate is widely used in the country, replications of this simple study in other GM corn-growing and glyphosate-using communities is recommended to further establish the extent of glyphosate presence in the environment. The use of Gas Chromatography-Mass Spectrometry (GC-MS) or other quantitative testing methods is also recommended to further establish the studies.

More importantly, the confirmation of the presence of the herbicide in soil, water, urine and corn kernels exposes the community to possible health problems and should be of serious concern and warrants immediate action. We therefore recommend and urge the local government and the relevant government line agencies, particularly the Dept. of Agriculture (DA), Dept. of Environment and Natural Resources (DENR) and the Dept of Health on the following calls:

1. Conduct the necessary post-release monitoring of GM corn and conduct systemic glyphosate residue testing on food and glyphosate-treated products through the Department of Agriculture-Bureau of Plant Industry (DA-BPI).

2. Conduct further studies on the impacts of glyphosate in the environment through the Department of Environment and Natural Resources (DENR). It must also ban RR corn cultivation in areas with slopes greater than 18 percent as provided by law. It must also rehabilitate affected upland ecosystem due to massive clearing for RR corn planting as facilitated with the use of glyphosate.

3. Conduct systematic, long term and independent studies on health problems among glyphosate-using farming communities through the Department of Health. The department is also urged to immediately respond to the reported health problems among GM corn farming communities.

4. Conversion of small scale farmers to alternative agricultural systems should be supported by the local government unit and the Dept. of Agriculture by providing production support (technical and financial), by non-GM corn seeds and promotion of diversified farming.

5. Liability and redress mechanisms should be enacted by Local and national legislators to exact responsibility and
accountability from the herbicide producers, including just compensation mechanisms for the glyphosate-affected farmers and communities.

6. Ban the use of glyphosate and other highly hazardous pesticides by the Fertilizer and Pesticide Authority (FPA). Globally, there is a widespread banning and rejection of glyphosate in countries such as Thailand, Vietnam, Germany, Canada, France, and New Zealand among others from which the Philippines can emulate.

7. Ban the use of GM corn and other glyphosate-resistant crops.

The Call for a Safe, Sustainable, and People-Centered Agriculture

The study is an affirmation of the people’s concern over glyphosate contamination in the environment, water and food systems. Mitigating measures need to be put in place the soonest possible time.

The growing yet unchecked expansion of GM corn in forest and hilly areas, the increasing use of glyphosate in plantations and even within residential areas coupled with lax regulation on highly hazardous pesticides and GM crops gravely increases the threats to the people’s health and environmental impacts.

The presence of glyphosate in the farmers’ urine is alarming and should serve as a wakeup call to everyone, especially for the government to find means to encourage farmers to stop using glyphosate and GM corn and revert to sustainable and safe means to achieve local food security and better livelihoods for small farmers.

Moreso, the case of GM corn farmers in Guinbialan is but a microcosm of the larger picture depicting how poverty further entrenches the corporation and local elites control over farmers and agriculture.

With the current chemical and capital-intensive agriculture, this has made agriculture and expensive yet highly vulnerable means of making a living.

Still farmers bite the bullet to be able to support their family, whether it might cause further health problems, debts or even cost their land. This is the case of the more than 400,000 GM corn farmers across the country, with many more farmers who have been made subservient to corporate agenda to agriculture.

Indeed, it is a complicated situation, but not something that is impossible to be liberated from.

The people’s call for a safe, sustainable and people-centered agriculture should therefore be strengthened. MASIPAG’s diversified and integrated farming system (DIFS) is one of the many ways to rid of the farmers from the lock-ins created by GM corn farming and glyphosate use.

Likewise, farmers are encouraged to form organizations which they can rely to address challenges in agriculture thru ‘bayanihan’, sharing of resources such as seeds and technologies, collective cultivation among others.

Farmers should also call for the respect for their rights on seeds, land, water and information and knowledge to further contribute in ensuring food security and increasing local economies and livelihoods.

Through sustainable agriculture and agroecology, resource-poor farmers can break off the dependency from GM corn and glyphosate and regain control over farming and food systems.
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MASIPAG is a network of farmers’ groups, scientists and non-government organizations in the Philippines seeking to improve farmers’ quality of life through their control over genetic resources, agricultural technology and associated knowledge.

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