# Pesticides and Women's Reproductive Health



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## **PESTICIDES AND WOMEN'S REPRODUCTIVE HEALTH**

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## **EXECUTIVE SUMMARY**

account for а significant omen percentage of the agricultural workforce, particular in Asia where the global average of 37 % rises to 62.59 % in India and 72.5 % in Palestine. Women are involved in every aspect of agricultural work including those that give rise to pesticide exposures spraying or other ways of applying pesticides, loading and mixing pesticides for others to use, washing clothing used by themselves or others during spraying, being in fields that are being sprayed or have recently been sprayed – picking, harvesting, weeding, etc. Occupational exposures add to the other exposures a woman is subject to, particularly household where pyrethroid insecticides maybe used and all sorts of pesticides might be stored in the kitchen. Then there are the residues in food and drinking water that add further to the burden.

As a result, women are widely exposed to pesticides, and this together with their innate susceptibly, especially to endocrine disrupting pesticides, and their often lesser access to training in application techniques, makes them particularly vulnerable to the effects of pesticides. Exposure to pesticides can have negative impacts on every aspect of women's reproductive system affecting their own health, their chances of delivering a healthy baby, and the chances of that baby growing up to be a healthy, intelligent, well-functioning adult. Women's primary health can be impacted from subtle hormonal changes that influence menstrual cycles, mood and pain levels, to lifeending breast, uterine, cervical and ovarian cancers. Their reproductive health can be impacted by their ability to get pregnant, stay pregnant and deliver a healthy full-term baby. The child's health can be affected in every way imaginable: from respiratory and immune functions to childhood cancers to birth defects impaired neurodevelopment including to cognitive and motor functions, autism spectrum disorder, attention deficit/hyperactivity disorder, intelligence and intellectual development, behaviour, socialisation, to breast cancers later in life for daughters and male sexual capacity for sons.

Those exposures prenatally or during pregnancy can have profound influences on the growing foetus and infant as the pesticides pass across the placenta from maternal blood to cord blood to foetus, and through breast milk to the growing child.

And yet, because there has long been a belief that 'men do the spraying' and therefore men are the ones mainly exposed to pesticides, there has been far more research on the effects of pesticides on reproductive outcomes for men than for women such as impacts on fertility. Added to this, what research has been carried out on the impacts of pesticides on women's reproductive health have generally been carried out in USA and Europe, and often in relationship to household exposure to insecticides or food residues. And much of the research has been, and continues to be, on now-obsolete organochlorine insecticides. Therefore, there is a shortage on studies on the impacts of occupational exposure to currentuse pesticides on women's reproductive health. The exception is Thailand where a number of studies have been carried out on exactly this. So this review has had to draw on information from other areas and other types of exposures (mainly household pyrethroid exposures for example from a number of studies in China).

All classes of pesticides are implicated: organochlorine insecticides, organophosphate insecticides, carbamates, synthetic pyrethroid insecticides, neonicotinoidinsecticides, herbicides including the ever-present glyphosate, fungicides, fumigants – and particularly anything with endocrine disrupting properties. No pesticides can be exonerated at this point because of the inadequate research, and the innate difficulty in proving an adverse effect was caused by a particular pesticide in epidemiological studies. We know some of the pesticides that are a problem, but we don't know which ones are not.

Therefore, women should not be exposed to any pesticides. The cost to themselves, their families, their communities and the country are too high. The costs are physical, emotional, psychological and financial. Women cannot work when they are ill, when they are in severe pain, or when they have to look after severely ill or disabled children. Women cannot work when they are seeking medical help for, or dying from, breast cancer. Women have a significant role to play in farming, but that should be in agroecological

farming using non-toxic methods of natural pest and ecosystem management, which benefit the women, their children and families, their community, their environment and the country as a whole.

Exposure to pesticides can have negative impacts on every aspect of women's reproductive system affecting their own health, ...



# **1. INTRODUCTION**

Agriculture Organization of the United Nations (FAO) in 2020, women account for about 37 % of the agricultural workforce globally, with that figure rising to 48 % in low income countries,<sup>1</sup> 62.9 % in India,<sup>2</sup> and 72.5 % in Palestine.<sup>3</sup> Those figures, however, likely under represent women's contribution to the agricultural workforce because their work is often unpaid and unrecognised by official statistics.

This significant presence of women in agriculture, combined with their innate greater sensitivity to pesticides makes women particularly vulnerable to the harmful effects of pesticides used in farming, with their reproductive health being especially at risk.<sup>4</sup> The USA's Centers for Disease Control and Prevention (CDC) has highlighted links between certain pesticides and various health issues in humans, such as hormonal imbalances, reduced fertility, miscarriages, birth defects, and developmental disabilities in children.

But, because of the innate difficulty in identifying which pesticides cause the problems, it is equally difficult getting national and international action to prevent the damage. As the ground-breaking United Nations Environment Programme Report stated:

It is also generally considered that while epidemiological studies may point to an association between pesticide exposure and a health outcome, it is very difficult to prove that a pesticide has caused an adverse health effect based on epidemiological studies alone.<sup>5</sup>

Whilst there is very little in the way of comprehensive assessments of the impact of pesticides on women's reproductive health, one such study concluded that "occupational and non-occupational exposure from pesticides seems to be grossly underestimated for women due to the perception that their work is not hazardous for their health and are not at risk of exposure."<sup>6</sup> Then too women often do not receive even the basic training in how to reduce risk from pesticides when applying them.<sup>7</sup>

That said, there are numerous studies that show exposure to pesticides in general wreak havoc on the pregnant women and the unborn/newborn, and indeed even later in life for the offspring of maternal exposure. And there are an increasing number of studies showing an association between certain pesticides and classes of pesticides and particular adverse effects on women's reproductive health.

However, most studies on the chronic effects of occupational exposure to pesticides (83 %) have been carried out in high and upper-middle income countries, with very few (1.1%) from low-income countries.<sup>8</sup>

# 2. METHODOLOGY

n initial search of the UNEP report on pesticides<sup>9</sup> and the USA's Centre for Disease Control and Prevention's (CDC) National Institute of Occupational Safety and Health (NIOSH)<sup>10</sup> was undertaken to identify areas of impact of pesticides on women's reproductive health. This was followed by a PUBMED search for "pesticide AND reproduction AND women", which resulted in 1,624 hits. Of these, 99 were considered relevant. The focus was primarily on current use pesticides in occupational settings in Asia, but as these studies are limited in number other relevant exposures were also considered – such as indicative studies on household exposure to pesticide likely to be used in occupational settings (pyrethroids) - as well as exposures in other regions, where necessary. Many of the studies involving obsolete organochlorines like aldrin, dieldrin, endrin, chlordecone, chlordane, heptachlor, BHC, etc have been omitted (but not DDT and endosulfan which are still used in some countries). Animal and human cell studies were included only where necessary to identify pesticides that are likely to be contributing to a particular reproductive health problem. The large number of studies relating to insecticide-treated bednets, the medical use of pesticides (warfarin) and the small number of studies relating to intentional ingestion were omitted.

Additional research was carried out using PubMed, to find associations between pesticides and particular health impacts.

# 3. HOW WOMEN AND THEIR CHILDREN ARE EXPOSED TO PESTICIDES

#### 3.1 Exposure of Women

The main exposure routes for pesticides are dermal (skin contact and absorption), inhalation and accidental ingestion. These exposures can occur whilst spraying, mixing and loading sprayers for themselves or others to spray, working in recently sprayed fields including picking flowers or cotton and weeding, and even harvesting sprayed produce when preharvest intervals are not observed, a problem that is very frequent in some Asian countries – a recent study in Bangladesh found that 93.3 % of summer vegetable growers did not consider the pre-harvest interval.<sup>11</sup>

Women are 50 % of the total workforce in the tea plantations of southern India and 68 % of them reported working in the plantations for up to six months of their pregnancies. Air samplers found that they were exposed to chlorpyrifos methyl, carbendazim, thiamethoxam, ethion and thiophanate methyl.<sup>12</sup>

Women are also exposed to pesticides when washing clothing used during mixing, loading, spraying and harvesting in recently sprayed fields, when pesticides are stored in the home especially the kitchen, through spray drift and volatilisation, contaminated dust in the house and yard, and use of household insecticides.

And eating pesticide-contaminated food and drinking contaminated water. Although food residues are not relevant to occupational exposure, they do add to the burden of pesticides resulting from the latter, and they can be substantial in some cases. For example, in Pakistan, high levels of pesticide residues in food, especially in Punjab and Sind – where 30–70 % of tested food exceed the MRLs compared with EU and USA where MRL exceedance is less than 5 % – have been associated with a number of health risks including reproductive problems and cancer, particularly in vulnerable groups like pregnant women and children.<sup>13</sup>

Exposure to pesticides at any stage can be a problem for women, but exposure during pregnancy and breast-feeding are especially critical because of the impact on the unborn/ developing child as well as the woman at a physically and emotionally vulnerable time in her life.

## 3.2 Exposure of Children

Children may be exposed as an unborn foetus from the transfer of pesticide residues across the placenta to the foetus, or via breastmilk in their infancy.

#### Foetal Exposure

Foetal exposure occurs when chemicals to which the mother is exposed cross from the maternal blood system into the placenta, across the placental barrier, into the cord blood and then into the foetus.

Pesticides have been shown to reach placental tissue and cross into cord blood in numerous studies. In Kyrgyzstan, elevated levels of organochlorine pesticides in placental tissue were associated with pre-eclampsia, low birth weight, congenital malformations, infections, stillbirths, preterm delivery, and frequency of hospitalizations after delivery (infections).<sup>14</sup>

Other types of pesticides have also been found in cord blood, particularly chlorpyrifos which is associated with decreased birth weight and length and reduced sensory function and neurodevelopment of the child, and a host of other problems.<sup>15</sup> A study has detected glyphosate in cord blood among farm workers in Thailand.<sup>16</sup> The fungicide azoxystrobin has been detected in urine from pregnant women and their children in the US and has been shown in animal studies to cross the placenta and enter the developing brain of the offspring. Azoxystrobin is associated with autism, brain aging and neurodegeneration.<sup>17</sup>

A study of pregnant farm workers in northern Thailand found that prenatal exposure to organophosphates was disrupting placental gene networks which could lead to changes in placental function that affect the developing foetus.<sup>18</sup> Another study in Thailand found glyphosate and paraquat in the cord blood of pregnant women involved in farming.<sup>19</sup> A third study of pregnant farm women in Thailand found that the post-partum placentas of those exposed to the pyrethroids cypermethrin, cyfluthrin and permethrin (as measured in maternal urine) had differentially expressed genes related to cell proliferation, differentiation and the immune system and the authors concluded that there were significant implications for foetal development.<sup>20</sup> And yet another study in Thailand measured paraquat in the meconium of neonates whose mothers came from an agricultural area.<sup>21</sup>

In China, a number of organochlorine pesticides were detected in cord blood, including DDT and methoxychlor, and HCH derived from lindane use.<sup>22</sup> Endosulfan and DDT have been found in cord blood in northern India, with an indicative transfer rate of 60-70% from mother to newborns which may lead to adverse neurodevelopment effects on the child.<sup>23</sup>

Pyrethroid metabolites were measured in the urine of pregnant women and their children at birth in urban Brazil,<sup>24</sup> whilst in Argentina, chlorpyrifos, chlorothalonil and trifluralin were measured in the placentas of pregnant women, in addition to banned organochlorines.<sup>25</sup>

In laboratory studies diuron was found to cross human placental cells and could be metabolised in the placental cells to a toxic metabolite.<sup>26</sup>

In a study of the blood of pregnant women and their foetuses in China, neonicotinoid insecticides – imidacloprid, acetamiprid, clothianidin, thiacloprid, thiamethoxam – and their metabolites, were found to pass through the placenta and could be measured in foetal serum.<sup>27</sup> And a separate study found that the greater the level of neonics in maternal blood, the greater the risk of defects in the septum of the heart in the offspring.<sup>28</sup>

#### Breast Milk

Pesticide residues in breast milk are a risk factor for both the newborn child, and the mother in terms of breast cancer; and in Taiwan an association was found between the level of chlordane in breast milk and infertility.<sup>29</sup> Numerous pesticides (at least 42) have been found in breast milk across the world: organochlorines, organophosphates, carbamates, pyrethroids, and herbicides such as atrazine and dactal.<sup>30</sup> In China, the fungicide chlorothalonil was found in breast milk recently.<sup>31</sup> Neonicotinoids have also been found in breast milk, in particular acetamiprid, thiamethoxam and clothianidin, also in China.<sup>32</sup> All of these are transferred to the breastfeeding infant at a time when all their organ systems are developing and they are especially susceptible to the impacts of chemicals.

A study by Lucknow's Queen Mary Hospital found that over 100 infant deaths during a 10month period, in the Maharajganj district of northern India, were linked to pesticide residues in breastmilk.<sup>33</sup>

# 4. HOW PESTICIDES CAN AFFECT WOMEN'S REPRODUCTIVE AND OCCUPATIONAL HEALTH

esticides can affect women's health in numerous ways – through impacts on their reproductive organs and hormones, impacts during pregnancy, and impacts on the health and development of their children – and via multiple exposure routes. When women continue to work with or around pesticides up until the late stages of pregnancy, their unborn child becomes particularly vulnerable to adverse impacts, and if that child then returns to the fields with its mother while she works it will be even more impacted. If the child is too ill to be taken to work, the mother may herself be unable to work and will suffer severe economic impacts. Social impacts too if the child exposed in utero is born with disfiguring and/or debilitating birth defects.

## 4.1 Mechanisms

There are a number of mechanisms involved in the toxicity of pesticides to pregnant women and infants. In terms of breast cancer alone, pesticides are implicated as mammary carcinogens, as tumour promoters, by affecting mammary gland development, by compromising the immune system, by interfering with communications between cells, and by other mechanisms – for example intrauterine growth retardation has been shown to increase susceptibility to breast cancer later in life.<sup>34</sup>

#### **Endocrine Disruption**

Endocrine disruption is the key mechanism for the impact of many pesticides (and other chemicals) on women's' reproductive health. Endocrine disrupting pesticides are associated with subfertility and infertility, aberrations in the reproductive cycle, polycystic ovarian syndrome, endometriosis, uterine fibroids; and breast, uterine, cervical and ovarian cancers.<sup>35</sup> The development of the reproductive tract is profoundly influenced by steroid hormones, so the developmental period is one of particular vulnerability to endocrine disrupting pesticides. For example, endocrine disruptors DDT is associated with implantation failure and reduced fertility, and methoxychlor is toxic to ovarian follicles.<sup>36</sup>

#### Carcinogenesis

Carcinogenesis is the process where normal cells are transformed into cancer cells through abnormal cell division. The process is characterised by changes at the cellular, genetic and epigenetic levels. Broadly it involves the stages of:

- cancer initiation which may occur via a number of mechanisms including mutations of a tumour suppressor gene, chromosomal damage, DNA damage, covalent bonding with elements of the cell (particularly nuclear elements), disruption of the mitochondrial membrane potential, and formation of free radicals that cause oxidative stress and DNA damage leading to cancer
- tumour promotion promoting the growth of cancer cells and hormonally sensitive tumours
   this is the primary effect of oestrogen in breast cancer, and oestrogenic pesticides.

There are a large number of pesticides known to be carcinogens and/or tumour promoters, including organochlorines, organophosphates, pyrethroids, fumigants and herbicides such as paraquat, 2,4-D and fungicides such as mancozeb.<sup>37</sup>

#### **Oxidative Stress**

Oxidative stress is a condition that can occur when there are too many unstable molecules called free radicals in the body and not enough antioxidants to get rid of them. This can lead to cell and tissue damage, and long-term oxidative stress may play a role in the development of chronic inflammation, cancer, and other diseases. Many pesticides are known to cause oxidative stress, including organochlorines such as endosulfan, organophosphates such as chlorpyrifos, pyrethroids such as cyhalothrin, herbicides such as 2,4-D and paraquat, fungicides such as mancozeb.<sup>38</sup> The results of a study of pregnant women in China, measuring pesticides and metabolites in their urine and impacts on a number of biomarkers indicated that "gestational exposure to organophosphates, pyrethroids, neonicotinoids, their transformation products, and their mixture may increase oxidative damage to lipids, RNA, and DNA during pregnancy."39

### 4.2 Effects on Women

The reproductive capacity of females is determined by many different factors, including regular reproductive cycles, fluctuation in hormones, and number of viable and healthy oocytes.<sup>40</sup>

There are a number of conditions affecting women's reproductive capacity that may be caused or progressed by pesticides, including time to puberty, time to pregnancy, time to menopause, gestational diabetes, preeclampsia, miscarriages and still births, and a raft of hormonal changes including those that lead to primary ovarian insufficiency also known as premature ovarian failure, which occurs when a women's ovaries stop working before she is 40 years of age.

However, there are also effects separate to reproductive capacity that affect women's reproductive system. Reduction in cycle length, dysregulation of the hypothalamic-pituitaryovarian axis (the system of hormones that controls female reproduction) and the decline in the number of ovarian follicles occurs in all women and leads to reproductive aging or menopause. But irregular cycles, early menopause and premature primary ovarian insufficiency (POI)<sup>41</sup> can negatively affect the health of women – as can a number of conditions of the reproductive system including endometriosis, polycystic ovaries, uterine fibroids; and breast, uterine, cervical and ovarian cancers. Early menopause not only decreases the possibility of pregnancy, it also has negative impacts on heart health, bone health and cognitive function.<sup>42</sup>

The effects of exposure to pesticides can have far reaching effects on women, their reproductive systems and function and their children. The metabolites of chlorpyrifos, measured in Thai rural women's urine during in the first trimester of pregnancy was significantly associated with changes in 691 unique metabolic features including tryptophan metabolism, fatty acid oxidation and peroxisome metabolism, cytochromes P450 metabolism, glutathione metabolism, and vitamin B3 metabolism. These changes were all related to oxidative stress, cellular damage and repair, and systemic inflammation, which could ultimately contribute to health outcomes for the woman, and neurodevelopmental deficits in the child.<sup>43</sup>

#### Hormonal Changes

The main hormones involved in women's reproductive health are oestradiol, progesterone, follicle stimulating hormone (FSH) luteinizing hormone (LH), anti- Müllerian hormone (AMH), and thyroid hormones. All of these can be affected by exposure to pesticides.

Most information on changes in reproductive hormones relates to women's fertility, but the health of women is also affected by these changes - for example low AMH can cause missed periods and irregular bleeding, and all the anxiety that goes with those situations. High levels of FSH can bring on premature menopause, and fat accumulation. High levels of LH can cause mood swings, weight gain or loss, fatigue, etc. Too much oestradiol can cause acne, loss of libido, osteoporosis, depression, breast and uterine cancer, whereas too little can cause early menopause, depression, heart diseases, memory problems and osteoporosis.44 Progesterone has impacts on sleep and mood, menstrual cycle, skin health, libido, bone health and the immune system.

Pesticide-induced changes in hormones have been detected in farm women in Ranga Reddy District, Telangana, India, with significantly lower levels FSH, as well as alterations in LH, and a significant correlation between chlorpyrifos levels and oestradiol. In addition to chlorpyrifos, diazinon, malathion, and monocrotophos were detected in the blood of the women. These same pesticides, plus phosalone, were also detected in their children, aged 9–15 years.<sup>45</sup>

In a recent hair analysis of Chinese women aged 25-45, alterations in sex hormone levels, particularly 17β-oestradiol, among women of reproductive age was associated with longterm exposure to even background levels of a number of pesticides - lindane, propoxur, permethrin, fipronil, mecoprop, prochloraz, and carbendazim.46 This may have resulted from ingestion of residues in food and/or ambient levels in the environment, so imagine how much worse that exposure would be in occupational settings especially if no or inadequate PPE is used as is so frequent in Asia. Another study in China found that pyrethroid metabolites in the women's urine was associated with decreased oestradiol and FSH.47

Also in China, the metabolites of pyrethroid insecticides were shown to increase the risk of primary ovarian insufficiency with higher levels of FSH and LH and lower levels of anti-Müllerian hormone (AMH) which is an important hormone for ovarian function and fertility.<sup>48</sup> Reduced levels of AMH were also found in rural women (median age 24) in South Africa who were engaged in indoor residual pyrethroid spraying.<sup>49</sup> In a US study, lower levels of AMH were found in women who had had prenatal farm exposure to pesticides via maternal residence or work on a farm.<sup>50</sup> In Poland, lower levels of AMH and higher levels of FSH were found in women with increased levels of pyrethroid metabolites.<sup>51</sup>

Pesticides that are oestrogen receptor agonists such as simazine, atrazine, endosulfan have oestrogenic and/or antiandrogenic effects and are associated with abnormally high levels of AMH.<sup>52</sup>

A decrease in AMH, decreased follicle count and increased FSH has been found in women in Poland with 3-phenoxybenzoic acid (3-PBA), a pyrethroid metabolite, in their urine.<sup>53</sup> Thyroid hormones are essential for human growth, development, metabolism, cardio-vascular homeostasis, and the immune system – and the levels of, and balance between, the various thyroid hormones are critically important to women. The European Union has screened 287 pesticides for their effect on the thyroid and its hormones and found that 101 can affect them, according to Peng et al (2024).<sup>54</sup> Difenoconazole, 2,4-D, metolachlor and tebuconazole, at background levels (as measured by hair analysis) have been associated with alterations of the thyroid hormone levels in women of reproductive age in China.<sup>55</sup>

#### Menstrual Cycle

Women who used pesticides including atrazine, lindane and maneb, experienced longer menstrual cycles and missed periods in a study of North American women, and if they used hormonally-active pesticides there was a 60–100 % increased odds of long cycles, missed periods and intermenstrual bleeding, all of which can affect women in their day-to-day functioning.<sup>56</sup> Longer cycles of periods and missed periods have been related to exposure to carbamates and herbicides among pesticide applicators and spouses in USA.<sup>57</sup>

Another US study found that women who were exposed to pesticides occupationally experienced a median increased time to menopause of three months, and if the pesticides were EDCs then an increased time of five months.<sup>58</sup>

Increased body burdens of pesticides are associated with early onset menopause. Pesticide exposure in girls hired as farmworkers is associated with irregular menstrual cycles. DDT and pyrethroids are associated with primary ovarian insufficiency (POI) in women.<sup>59</sup>

#### Endometriosis

Endometriosis is a disease in which tissue similar to the endometrial lining of the uterus grows outside the uterus, leading to inflammation, scarring, severe pain in the pelvis and during intercourse, fatigue, depression, anxiety and a decreased chance of getting pregnant.<sup>60</sup> It also leads to reduced ovarian reserve, poor oocyte quality, impaired embryo implantation and reduced live birth rate. It causes excessive oestrogen production and progesterone resistance i.e., a reduction in the normal response of tissues to progesterone.<sup>61</sup>

Whilst its cause(s) are unknown, there is evidence that pesticides may be implicated in some cases. Endometriosis has been associated with exposure to diazinon, chlorpyrifos and chlorpyrifosmethyl in a study of reproductive-age women in the US.<sup>62</sup> Permethrin is also known to increase endometriosis.<sup>63</sup> A systematic review of the association between organochlorine insecticides and endometriosis found a small, but statistically significant association between exposure to these pesticides and endometriosis.<sup>64</sup>

#### Polycystic Ovary Syndrome (PCOS)

PCOS is a chronic hormonal condition that affects women of reproductive age. It is an endocrine disorder and hence susceptible to the influence of endocrine disrupting chemicals. It usually starts during adolescence. Symptoms fluctuate over time but it can cause hormonal imbalances, irregular periods, excess androgen levels and cysts in the ovaries. Irregular periods, usually with a lack of ovulation can make it difficult to become pregnant. Some women diagnosed with PCOS present with peripheral insulin resistance, impaired glucose tolerance, and increased risk for the development of type 2 diabetes and metabolic syndrome. It is linked with infertility and those that do conceive have a higher risk of pregnancy complications, including gestational diabetes, hypertension, preeclampsia, preterm birth, and perinatal mortality.65

The cause(s) of PCOS are largely unknown but there is evidence that pesticide use can cause or contribute to it, for example in the United Arab Emirates.<sup>66</sup> In China, PCOS has been linked to elevated levels of DDT and its metabolites in blood.<sup>67</sup> Sharma et al (2021) identified two pathways by which pesticides are implicated in PCOS, the first being via endocrine disruption and in particular mimicking oestrogen, and the other is by the generation of free radicals resulting in oxidative stress which in turn alters the AhR (aryl hydrocarbon receptor) pathway, which leads to impaired oestrogen receptor signalling and reduced follicle growth and oocyte number. Both pathways lead to an increased ratio of LH to FSH, and 'follicle arrest'.68

Pesticides that are oestrogen receptor agonists, such as simazine, atrazine, endosulfan, have oestrogenic and/or antiandrogenic effects and are associated with PCOS.<sup>69</sup> So too are DDT, vinclozolin and permethrin.<sup>70</sup>

#### **Uterine Fibroids**

Uterine fibroids (leiomyomas) are hormonesensitive benign tumours that form in the myometrial layer of the uterus. They are common, with about 80% of women below 50 years of age having them, often without realising it. However, up to 30 % of women with fibroids experience serious symptoms such as heavy and prolonged bleeding, chronic pelvic pain, urinary incontinence, as well as reduced implantation rate, spontaneous abortion, infertility, preterm labour, placental abruption, and postpartum haemorrhage. They are the reason for up to 50% of hysterectomies. DDT, endosulfan and fenvalerate are all associated with uterine fibroids.<sup>71</sup>

#### **Reproductive Cancers**

Breast cancer is one of the most common cancers in the world and the second leading cause of cancer deaths among women.<sup>72</sup> At least 100 pesticides are known to increase the risk of breast cancer. These include organochlorines, organophosphates, carbamates, pyrethroids, fungicides, triazine and other herbicides including 2,4-D, alachlor and glyphosate, fumigants, and inert ingredients of formulated pesticides products such as nonylphenol.<sup>73, 74</sup>

A positive association was found between uterine (endometrial) cancer and occupational exposure to pesticides in Spain, including exposure individually to insecticides, fungicides and herbicides.<sup>75</sup>

It seems that very little research has been carried out on any association between cervical cancer and pesticides. There is a study from Mexico indicating a possible association with organochlorine pesticides in blood.<sup>76</sup> A spatial analysis of cancers in Guadeloupe, French West Indies, reported that living in rural areas was a risk factor for cervical (as well as breast) cancer.<sup>77</sup> An older review of cancer among migrant and seasonal farmworkers in the US found elevated levels of cervical cancer.<sup>78</sup>

Ovarian cancer is much rarer and with few established risk factors. There is very little information relating to pesticides and ovarian cancers other than that endocrine disruptors are a probable cause. Prevalence of ovarian cancer were increased in areas of high pesticide use in Southern Spain.<sup>79</sup>

## 4.3 Effects on Pregnancy

Some pesticides can reduce fertility, delay time to conception, affect implantation and placental development, cause gestational diabetes, pre-eclampsia, gestational hypertension, and spontaneous abortion or miscarriage.

Hormone levels during pregnancy are of vital significance to both the ongoing health of the mother and the health and well-being of the developing foetus. Thyroid hormone balance is particular crucial as even minor changes may have significant consequences for the foetus - and that balance can be affected by a number of pesticides including DDT.<sup>80</sup> Mancozeb and pyrimethanil may inhibit the secretion of free-thyroxine (FT4) (causing hypothyroidism), whilst chlorpyrifos and pyrethroids may cause hyperthyroidism in pregnant women.<sup>81</sup> In China, background levels of the metabolites of organophosphate insecticides were associated with alterations of the balance of thyroid hormones, in particular (FT4) and thyroidstimulating hormone,<sup>82</sup> and pyrethroids with FT3 (free triiodothyronine) in pregnant women.<sup>83</sup>

#### Infertility, Subfertility

This is far less literature available on pesticides and infertility in women than there is for men,<sup>84,85</sup> but what is available shows adverse impacts from pesticide exposure.

A number of factors influence fertility in women including increased time to get pregnant, early onset menopause or premature ovarian failure (defined as the cessation of menstrual cycles before the age 40 characterized by very low blood levels of anti-Müllerian hormone (AMH). Women are born with a finite number of oocytes (egg cells), so exposure to any pesticides that may damage oocytes will reduce fertility. High exposure to pesticides has been linked to poor quality and reduced quantity of oocytes in women receiving treatment for infertility in France.<sup>86</sup> Premature ovarian failure has been linked to exposure to pyrethroids, and DDT to ovarian aging and early menopause.<sup>87</sup> The presence of DDT or simazine have been linked to failure of a follicle to develop.

There is evidence that occupational use of pesticides by women adversely affects fertility, leading to increased time to pregnancy.<sup>88</sup> But while there is information relating to DDT<sup>89</sup> and other mostly obsolete organochlorines, there is limited information on current use pesticides. However, in a study in China, women who were planning a pregnancy were followed for a year to observe their time to pregnancy: it was found that those with higher levels of organophosphate or pyrethroid metabolites in their urine, had significantly longer times to pregnancy.<sup>90</sup>

Longer menstrual cycles and missed periods have been related to exposure to carbamates and herbicides among pesticide applicators and spouses in USA.<sup>91</sup>

However, organophosphates are becoming recognised as a cause of female infertility, with an analysis of data collected over four years for the USA's National Health and Nutrition Examination Survey (NHANES) yielding a link between female infertility and the metabolites of organophosphate insecticides, and particularly the metabolite dimethylphosphate (DMP).<sup>92</sup> Malathion is one of the organophosphates particularly linked with increased risk of infertility in the NHANES survey.<sup>93</sup>

#### **Gestational Diabetes**

Gestational diabetes mellitus (GDM) is the development of high blood sugar levels during pregnancy, which go away once the child is born. It happens when a hormone produced by the placenta prevents the body from using insulin effectively. GDM can cause complications during pregnancy including preeclampsia, premature birth, increased size of the baby, etc. There are a number of factors that increase the risk of GDM, including being overweight, age, race, family history of diabetes, etc. And being exposed to pesticides: in the US, women who reported mixing or applying pesticides to crops, or cleaning spray equipment, were at increased risk of GDM, particularly with ever-use of four herbicides (2,4,5-T; 2,4,5-TP; atrazine; or butylate) and three insecticides (diazinon, phorate, or carbofuran).<sup>94</sup> Neonicotinoids (imidacloprid, thiamethoxam, clothianidin) were associated with gestational diabetes in China.<sup>95</sup>

#### Preeclampsia

Preeclampsia is a serious medical condition that can occur about midway through pregnancy. Women with preeclampsia experience high blood pressure, protein in their urine, swelling, headaches and blurred vision; but they may also be symptomless. Exposure to the herbicide propoxur applied near homes in rural France is associated with preeclampsia.<sup>96</sup> Prenatal exposure to DDT, as measured in blood is associated with gestational hypertension, and this exposure may have its origins early in the woman's development.<sup>97</sup> Occupational exposure to organophosphate insecticides in Sicily (Italy) was associated with a 12 % increase in incidence of gestational hypertension.<sup>98</sup>

#### Shortened Gestation / Pre-term Births

Shortened gestation is a risk factor associated with poor health outcomes in children; and exposure to pesticides during pregnancy is associated with shortened gestation/pre-term birth, according to a review of information abstracted from the US's Centre for Disease Control. Fungicides, insecticides, fumigants, herbicides and other pesticides were all implicated.<sup>99</sup>

In India, residues of HCH and DDT in the placenta were associated with pre-term deliveries in urban women.<sup>100</sup>

In China, exposure to the neonicotinoid insecticide imidaclothiz was associated with pre-term births,<sup>101</sup> and in two studies in the US exposure to glyphosate during pregnancy had the same effect.<sup>102, 103</sup>

#### Miscarriage/Spontaneous Abortion

Miscarriages matter: that's the title of a recent study published in the Lancet, which looks at physical, psychological and economic costs of miscarriage. The physical costs include bleeding and infection, and the physiological consequences include increased risk of anxiety, depression, posttraumatic-stress disorder and suicide. Repeated miscarriages are also a risk marker for longerterm health problems such as cardiovascular disease and venous thromboembolism. Miscarriages are also a marker for future obstetric complications including preterm births, foetal growth restriction, placental abruption, and still births. The economic costs of miscarriage are both personal and societal.<sup>104</sup> And miscarriage rates appear to be higher in rural women with pesticide exposure than in urban women.<sup>105</sup>

A recent comprehensive systematic literature involving 1,525 peer-reviewed published studies found a 41 % increased risk of miscarriage among pregnant women exposed to pesticides.<sup>106</sup> Organochlorines, including endosulfan, are implicated.<sup>107</sup>

## 4.4 Effects on Their Children

An important part of the effects of pesticides on women's reproductive health is the impact the pesticides she has been exposed to have on the child she gives birth to. The child is exposed to the pesticides *in utero* via placental transfer of residues from the mother to the child via the cord blood, or via residues in breastmilk transferred to the newborn. These residues can affect birth outcomes such as birth weight and height and head circumference, birth defects, childhood cancers, cognitive function, learning disabilities, developmental disorders, ADHD and autism, immune function and respiratory function.

#### **Birth Outcomes**

Data from the large National Free Preconception Health Examination Project (NFPHEP) in China found that maternal exposure to pesticides before pregnancy was a risk factor for stillbirth, heightened sensitivity to smells during pregnancy, and low birth weight. Exposure during pregnancy was a risk factor for miscarriage.<sup>108</sup>

Exposure to pesticides in general during pregnancy is associated with impaired foetal growth,<sup>109</sup> but there is also information on the impacts of particular pesticides on particular outcomes.

Exposure to organochlorines has long been recognised as having an effect on the outcomes of pregnancy. For example, in a recent study in China, DDT and HCH in the placenta were associated with a reduction in birth weight, height and head circumference;<sup>110</sup> and in rural Cambodia, where the poorest populations had the highest exposure and less favourable outcomes, DDT reduced gestational age and birth length but increased birth weight.<sup>111</sup>

However, other pesticides are also implicated: organophosphates with decreased head circumference and reduced birthweight;<sup>112</sup> pyrethroids with reduced birth weight;<sup>113</sup> chlorpyrifos with decreased birth weight and length;<sup>114</sup> the neonicotinoids imidacloprid and acetamiprid with decreased head circumference;<sup>115</sup> atrazine with foetal growth restriction and small head circumference;116 carbofuran with increased head size in males;<sup>117</sup> and chlorpyrifos with birth weight and length.118

Sometimes there are gender differences in the effects of pesticides on birth outcomes: chlorpyrifos in the urine of urban pregnant women was associated with a decrease in head circumference of boys but not girls.<sup>119</sup>

Stillbirth is another birth outcome associated with pesticide exposure: a large study in Arizona linked living within 500m of any pyrethroid, organophosphate or carbamate pesticide application during a 90-day preconception window, or the first trimester, with stillbirths. The study particularly implicated cyfluthrin, zetamalathion, carbaryl, cypermethrin, and propamocarb hydrochloride exposure during the preconception period and fenpropathrin, permethrin, OPS, acephate and formetanate exposure during the first trimester.<sup>120</sup>

Neonatal deaths, too, are associated with pesticide exposure: hospital and communitybased case control studies in central Sudan reveal a significant and consistent two-fold elevated risk in perinatal mortality associated with pesticide exposure, with the risk increasing to three-fold amongst women employed in agriculture.<sup>121</sup>

#### **Birth Defects**

Neural tube defects are some of the most common and most disabling of all foetal congenital defects, and there is evidence that the risk of these is associated with pesticide exposures. A study in China found an association between residues in umbilical cord tissue of organochlorine pesticides – including endosulfan and DDT – and neural tube defects.<sup>122</sup> But this is just one of many studies linking birth defects to preconception or first trimester exposure to organochlorines such as endosulfan; the herbicides 2,4-D, MCPA, atrazine, trifluralin, dicamba, cyanazine, glufosinate; organophosphates; and other pesticides.<sup>123</sup>

Maternal occupational exposure to pesticides (in greenhouses in Denmark) was associated with cryptorchidism in three-month-old sons.<sup>124</sup> The presence of the herbicides isoproturon and MCPA in the meconium of newborns has been linked to hypospadias in France.<sup>125</sup>

Male sexual development appears to be especially at risk from maternal exposure to pesticides, preconception or during pregnancy. Prenatal exposure to pesticides has long term effects on reproductive function in boys. In Denmark, it has been found that boys whose mothers were exposed to pesticides have smaller genitals that those whose mothers were not exposed, and the greater the exposure the greater the effect in terms of smaller testes and shorter penile length. Eight out of 59 of the prenatally exposed boys also had genital malformations.<sup>126</sup>

#### **Developmental Disorders**

Organophosphates have long been known to have adverse impacts on child neurodevelopment. Impacts of foetal exposure organophosphates include abnormal to primitive reflexes in newborns; mental and motor delays in preschoolers; and decreases in working and visual memory, processing speed, verbal comprehension, perceptual reasoning, and IQ among elementary school-age children - as well as elevated risks of attention-deficit/ hyperactivity disorder (ADHD) and autism spectrum disorder (ASD).<sup>127</sup> For example, maternal urinary levels of organophosphate metabolites were associated with reduced motor and cognitive skills at the age of five weeks.<sup>128</sup> In China, prenatal exposure to organophosphates is associated with a significant reduction in the score for the Neonatal Behavioural Neurological Assessment.<sup>129</sup> In Thailand, maternal urinary organophosphate metabolites were linked to impaired neurodevelopment at seven months.130 In China again, prenatal exposure to chlorpyrifos and atrazine are associated with deficits in communication at 12 months of age.<sup>131</sup>

However, evidence is increasing that pyrethroids also interfere with neurodevelopment: a recent review found "sufficient evidence" of an association between prenatal pyrethroid exposure and adverse neurodevelopment.<sup>132</sup> FoetalexposuretopyrethroidsinChinanegatively affected neural and mental development of infants.<sup>133</sup> Exposure to pyrethroid insecticides during the first trimester of pregnancy can lead to an increased risk of neurodevelopmental delays: in particular reduced motor development and reduced adaptive behaviour in two-year olds.<sup>134</sup>

In the US, prenatal exposure to pyrethroids was associated with depression, problems with emotional expression and control, behavioural regulation, ability to control impulses, and ability to direct attention in children.<sup>135</sup>

Increased prenatal exposure to pyrethroid insecticides among women in Brittany, France, was associated with abnormal or borderline social behaviour among their offspring at the age of six, together with internalizing difficulties (e.g., anxiety, depression, obsessive-compulsive disorder)andexternalizingdifficulties(inattention, aggression, hyperactivity, rule-breaking).<sup>136</sup>

Foetal exposure to propoxur was associated with poor motor development in children at age two.<sup>137</sup> Prenatal exposure to 2,4-D was associated with lower language skills at one year of age, chlorpyrifos with lower cognitive and motor scores in boys but not girls, and pyrimethanil with lower language ability in girls but not boys.<sup>138</sup>

Maternal exposure to a number of pesticides – profenofos, lambda-cyhalothrin, chlorothalonil, imidacloprid, cypermethrin, metalaxyl, mancozeb, chlorpyrifos – among farmworkers, in Tanzania, was associated with neurodevelopmental delays in their children aged from 0–6.<sup>139</sup>

Many of the studies do not involve occupational exposure to pesticides, but one that does, linked use of pesticides in greenhouses to impaired neuropsychological function in girls at school age, in particular language and motor speed functions.<sup>140</sup>

#### Autism Spectrum Disorder (ASD)

A recent systematic review found that prenatal exposure to pesticides increases the risk of ASD in

children, and in particular organophosphates.<sup>141</sup> Although the women involved were exposed to pesticides in their residence, occupational exposure is likely to have a similar, or worse effect. A second meta-analysis also concluded that maternal pesticide exposure was positively related to ASD, and also to ADHD, in particular organophosphates and pyrethroids with ASD, and organochlorines with ADHD.<sup>142</sup>

Risk of ASD was associated with prenatal and infant exposure to glyphosate, chlorpyrifos, diazinon, malathion, avermectin and permethrin, methyl bromide and myclobutanil, in California.<sup>143</sup>

#### ADHD

Organophosphates are also strongly linked to ADHD. For example, in USA, OP metabolites in the urine of pregnant women are consistently associated with behaviours related to ADHD.<sup>144</sup> In Mexico, ADHD in boys and increased attention problems in girls were associated with metabolites of chlorpyrifos and chlorpyrifosmethyl in the urine of their mothers when they were pregnant.<sup>145</sup> In Taiwan, a positive-doseresponse relationship was found between organophosphate metabolites in urine and ADHD in school-age children.<sup>146</sup>

#### **Childhood Cancers**

According to a review by Fucic et al (2017),<sup>147</sup> "The pathways leading to childhood and juvenile cancers, such as leukemias, neuroblastoma/ brain tumours, hepatoblastoma, and Willm's tumor involve prenatally-induced genomic, epigenomic and/or non-genomic effects caused by xenobiotics." These are the most common childhood cancers. And: "All prenatally-induced cancers originate from a blocked or altered differentiation of target foetal cells." This cancer risk comes from exposure to mutagenic and nonmutagenic carcinogens and endocrine disruptors: chemicals including pesticides. UNEP reported a positive association between maternal exposure to pesticides in general, herbicides or insecticides and childhood leukemia.148

Studies have shown that use of pesticides during pregnancy was associated with acute lymphoblastic leukaemia, acute myelocytic leukemia and neuroblastoma in infants and children. Pesticides implicated include chlorpyrifos, malathion, methomyl and paraquat.<sup>149</sup> A wide range of organochlorines, organophosphates, pyrethroids and herbicides have been linked to childhood cancers.<sup>150</sup>

But it doesn't stop at childhood: there is evidence that maternal exposure to pesticides is linked to some cancers in their offspring later in life. A recent analysis of breast cancer in women in Denmark revealed that there is an increased risk if their mother had been employed in horticulture and hence likely to have been exposed to pesticides. Preconception exposure was associated with ER positive tumours and perinatal exposure with ER negative tumours.<sup>151</sup> Another study showed that maternal DDT exposure "predicted daughter's breast cancer".<sup>152</sup>

#### **Respiratory Function**

Put simply: "chronic exposure to pesticides in foetuses is associated with chronic respiratory symptoms and disease". That was the finding of a review carried out in Spain, which found asthma, bronchitis and persistent cough in children linked to maternal exposures to pesticides during pregnancy.<sup>153</sup> Mancozeb is one pesticide exposure to which exposure during the first half of pregnancy is associated with respiratory problems in the first year of life.<sup>154</sup>

# 5. Pesticides Implicated

t has now become obvious that a wide range of pesticides are implicated in a wide range of adverse effects on women's reproductive health, including on pregnancy and the outcomes of pregnancy.

Organochlorines have been widely studied for their implications on reproductive health – mainly in men, but also to a lesser degree in women. This is in part because of their early wide-spread use and their persistence in the environment, in the food chain, and in our bodies. Residues of insecticides like DDT, dieldrin, chlordane, HCH, HCB, heptachlor, endosulfan, lindane, methoxychlor are widely found in blood, breast milk, placental tissue, amniotic fluid, cord blood, and the meconium and blood of newborn infants.<sup>155</sup>

Less well studied are our current use pesticides, partly in the initial belief that only persistent organic pollutants could linger long enough in our bodies to cause a problem. However, in recent years that situation has started to be remedied and now there many more studies on, for example, the impact of organophosphates, pyrethroid and neonicotinoid insecticides on the female reproductive system. Organophosphates are now known to impair the fertility of women and cause a high risk to reproductive potential, causing fluctuations in the levels of sex hormones, delayed menstrual cycle, endometriosis, ovarian dysfunction and diseases, alteration in ovary weight, changes in follicle growth, altered oocyte feasibility, premature delivery, abnormalities in child growth and development. The use of OPs decreased fertility in farm women in Ontario, Canada.156

The OPs chlorpyrifos, diazinon, malathion, and parathion are all linked to lower birth weight and shorter gestational age among women with agricultural or residential exposure, and also to neurodevelopmental or childhood behaviour problems. Among the carbamates, carbaryl is linked to neurodevelopmental or childhood behaviour problems and propoxur to childhood leukaemia. The pyrethroids: deltamethrin is linked with neurodevelopmental problems and permethrin to leukemia. Neonicotinoids: damage to DNA and RNA during pregnancy, gestational diabetes and other effects including neurodevelopmental impacts on children. Fungicides such as vinclozolin and thiram are linked with infertility, and breast cancer.<sup>157</sup>

Tables 1 summarise the information on pesticides provided in this report. However, it should not be regarded as comprehensive, as the examples provided are indicative only. They are examples, not a full list of all the pesticides involved, as this is not a systematic review or metanalysis. So, this table should be regarded as a minimum. In many studies or reviews simply the class of the pesticide is mentioned not the specific pesticide, therefore the lack of a particular pesticide in the right columndoes not mean a lack of involvement. For example, pyrethroids and menstrual cycles: the whole class is a problem. This situation comes about because, with pyrethroids and organophosphates, it is largely their metabolites, which are common to a number of pesticides of that class, that are found. Finally, it should be remembered that 100 pesticides are linked with causing breast cancer and 101 pesticides have been determined by the European Union to affect the thyroid hormones that underlie the total health of mother and infant. Many of them are not in these tables.

... it should be remembered that 100 pesticides are linked with causing breast cancer and 101 pesticides have been determined by the European Union to affect the thyroid hormones that underlie the total health of mother and infant.

## Table 1: Female reproductive system – examples of impacts and pesticides

Condition	Class of pesticides	Pesticides
	OPs	chlorpyrifos
	OCs	endosulfan, lindane
	pyrethroid	permethrin
Hormonal changes	triazine herbicides	atrazine, simazine
	other	2,4-D, carbendazim, difenoconazole, fipronil, mecoprop, metolachlor, prochloraz, propoxur, tebuconazole
	OCs	
Menstrual cycle and	pyrethroids	
menopause	carbamates	
	herbicides	
	ОС	chlordane
endometriosis	OPs	chlorpyrifos, chlorpyrifos-methyl, diazinon
	OCs	DDT, endosulfan
	pyrethroids	permethrin
Polycystic ovary syndrome	triazine herbicides	atrazine, simazine
	other	vinclozolin
	OCs	DDT, endosulfan
Uterine fibroids	pyrethroids	fenvalerate
	OCs, OPs, carbamates, pyrethroids, fumigants	
Breast cancer	fungicides	mancozeb
	herbicides	2,4-D, alachlor, glyphosate, paraquat
Effects on pregnancy		
Damage to DNA and RNA during pregnancy	OPs, pyrethroids, neonicotinoids	
	OPs	chlorpyrifos and 100 other pesticides
Changes to thyroid	pyrethroids	
normones	other	mancozeb, pyrimethanil
	OCs	DDT, methoxychlor
	OPs	malathion
	carbamates	
Infertility/sub-fertility	pyrethroids	
	triazines	simazine
	other herbicides	
	OPs	diazinon, phorate
	carbamates	carbofuran
Gestational diabetes	neonicotinoids	imidacloprid, thiamethoxam, clothianidin
	herbicides	2,4,5-TP, atrazine, butylate
Preeclampsia	OCs	DDT
Pre-term births	All classes of pesticides	DDT, glyphosate, imidaclothiz

#### Table 2: Birth outcomes – examples of impacts and pesticides

Outcome	Class of pesticide	Pesticide
	OCs	DDT
	OPs	acephate, chlorpyrifos, malathion, propoxur
	carbamates	carbaryl, carbofuran
Reduced birth weight/length	pyrethroids	cyfluthrin, fenpropathrin, permethrin, zeta- cypermethrin
	neonicotinoids	Acetamiprid, imidacloprid
	other	atrazine, formetanate, propamocarb hydrochloride
	OCs	DDT, endosulfan
Birth defects	OPs	
	others	2,4-D, atrazine, cyanazine, dicamba, glufosinate, isoproturon, MCPA, trifluralin
	OCs	DDT, endosulfan
	OPs	chlorpyrifos, diazinon, malathion, profenofos,
	carbamate	propoxur
Neurodevelopmental (inc. ASD and ADHD)	pyrethroids	cypermethrin, cyfluthrin, lambda-cyhalothrin, permethrin
	neonicotinoids	imidacloprid
	other	2,4-D, avermectin, azoxystrobin, chlorothalonil, glyphosate, mancozeb, methyl bromide, metalaxyl, myclobutanil, pyrimethanil
	OCs	
	OPs	chlorpyrifos, malathion
Childhood cancers	pyrethroids	
	herbicides	paraquat
	other	

It has now become obvious that a wide range of pesticides are implicated in a wide range of adverse effects on women's reproductive health, including on pregnancy and the outcomes of pregnancy.

# **6. Summary and Recommendations**

xposure to pesticides can have negative Limpacts on every aspect of women's reproductive system affecting their own health, their chances of delivering a healthy baby, and the chances of that baby growing up to be a healthy, intelligent, well-functioning adult. Women's primary health can be impacted from everything to subtle hormonal changes that influence menstrual cycles, mood and pain levels, to life-ending breast, uterine, cervical and ovarian cancers. Their reproductive health can be impacted by their ability to get pregnant, stay pregnant and deliver a healthy full-term baby. The child's health can be affected in every way imaginable: from respiratory and immune functions to childhood cancers to birth defects to impaired neurodevelopment including cognitive and motor functions, ASD, ADHD, IQ, intellectual development, behaviour, socialisation, to breast cancers later in life and male sexual capacity.

Occupational exposure to pesticides comes about through use of pesticides, loading and mixing pesticides for others to use, washing clothing used when spraying, being in fields that are being sprayed or have recently been sprayed – picking, harvesting, weeding, etc. Occupational exposures add to the other exposures a woman is subject to, particularly household where pyrethroid insecticides maybe used and all sorts of pesticides might be stored in the kitchen, and also residues in food and drinking water.

Those exposures prenatally or during pregnancy can have profound influences on the growing foetus and infant as the pesticides pass across the placenta from maternal blood to cord blood to foetus, and through breast milk to the growing child.

classes of pesticides are All implicated: organochlorine insecticides, organophosphate insecticides, carbamates, synthetic pyrethroid neonicotinoid insecticides, insecticides, herbicides including the ever-present glyphosate, fungicides, fumigants – and particularly anything with endocrine disrupting properties. No pesticides can be exonerated at this point, because the amount of research on the impact of women's reproductive health is much less than for men's reproductive health and is entirely inadequate. We know some of the pesticides that are a problem, but we don't know which ones are not.

Women should not be exposed to pesticides. The cost to themselves, their families, their communities and the country are too high. The costs are physical, emotional, psychological and financial. Women should be engaged in agroecological farming using non-toxic methods of natural pest and ecosystem management.

Women should be engaged in agroecological farming using non-toxic methods of natural pest and ecosystem management. References:

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Women should not be exposed to pesticides. The cost to themselves, their families, their communities and the country are too high. **PAN Asia Pacific (PANAP)** is one of the five regional centres of Pesticide Action Network (PAN). PANAP works for the elimination of harm caused by pesticides on human health and the environment. PANAP also promotes agroecology, helps strengthen people's movements in their assertion of rights to land and livelihood, and advances food sovereignty and gender justice.

As a network, PANAP is currently comprised of more than 100 partner organisations from the Asia-Pacific region and has links with about 400 other regional and global civil society and grassroots organisations.

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