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Agrochemicals and human well-being: A review in context of Indian agriculture

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Abstract
Modern chemicals, in form of fertilizers and pesticides, have undoubtedly increased the food production worldwide. Over use of chemical application and its effect on environment and human health could not be neglected any further. Residual effect of agrochemicals could be seen in both the terrestrial life and marine life. Future food demand must be achieved with better quality food, along with use of less toxic chemicals. Alternate practices like introduction of GMOs, precision agriculture and IPM must be put into practice, to lessen the load of chemical use. This review evinces the health hazards caused due to misuse and over use of agrochemicals and also talks about the contributing factors, of which poor education and extension system plays pivotal role. Improving the literacy among the farmers, strengthening the extension, training and involvement of media could provide scope for reducing vulnerability of farmers to health related issues caused by prolong exposure to the toxic chemicals.

Keywords: Agrochemicals, pesticides, health and well-being, environment health, food production

Introduction
About 1.8 billion people worldwide are engaged in agriculture and most of them use pesticides to protect their crops. Agrochemicals have become a non-separable part of agriculture systems due to better outcome in crop yields, which is very important to meet the food demand of the growing population (Alexandratos and Bruinsma, 2012) [8]. Pesticides are also used for public health purposes, while many others use pesticides for lawn and garden applications in and around their homes (Kiely *et al*., 2004) [32] and agrochemicals have enabled to duplicate the food production during the last century (Carvalho, 2017) [13].

Agriculture is mainstay of India's GDP and most of the rural population is engaged in agriculture related activities. Being a developing nation India is already facing many traditional issues like malnutrition, sanitation, insufficient medical care etc. Industrial advancement, economic growth and globalization have also made contribution to the never-ending list of the occupational health issues. Use of chemicals (*viz.* insecticides, fungicides, herbicides or fertilizers) has become a significant part of Indian agriculture, as farm productivity has been found to be directly proportional to chemical (phosphate fertilizer, Roser *et al*., 2017) [41] application. Agrochemical use is prominent in areas with better irrigation facilities, like the states of Karnataka, Andhra Pradesh, Maharashtra and Punjab, accounts for 38% of total pesticide use in the country (Agnihotri, 2000 and Shetty, 2004) [2, 43]. This supports the facts, as stated by (Devi, 2007) [18].

Arguments stating misuse and overuse of agrochemicals in agriculture & associated sectors not only negatively impacting soil health, but also are reasons for health problems and environmental pollution worldwide (Soares *et al*., 2003; Mancini *et al*., 2005; Remor *et al*., 2009) [45, 33, 38]. India alone, account for one-third of all pesticide poisoning cases in the world (Devi, 2007) [18]. Females agricultural practitioners face adverse effect of being exposed to agrochemicals (pesticides mainly), either directly or indirectly (*via* their male relatives). Moreover, female oriented jobs *like* mixing concentrated chemicals or refilling the sprayers is equally hazardous as its application. In a similar study done by Chitra *et al*., 2013 [15] in South India, it was observed that about 68% of farmers are directly exposed to pesticides while its application and more than 75% farmers use highly hazardous chemicals for farm use. Further, 88% of farmers involved in chemical application don't use any precaution. Furthermore, as Reported by TechSci Research 2018 [47], reported that global pesticides market is expected to

cross business of $ 90 billion by 2023. As recommended by FAO that Class* Ia and Ib pesticides should not be used in developing countries, further suggested that class II pesticides should also be avoided. Sadly the use of these "powerful" pesticides is still prevalent in India. To add to this vicious cycle, mega-companies do the branding by promoting the idea that "Potent Pesticides- Prevent crop Loss" (Grace *et al.*, 2007) [28].

*FAO Classification: Ia (extremely hazardous), Ib (Highly hazardous) and II (Moderately hazardous) pesticides

Organochlorines (*like* DDT, heptachlor, endosulfan) are very potent insecticides, and are structurally similar to steroid hormones (Tebourbi *et al.*, 2011). Similarly, Organophosphate (like malathion, parathion and DDVP) and carbamates (like carbofuron and aldicarb, to name a few) act as AchE inhibitors cause interruption of impulse transmission at synaptic level. Likewise, insecticides such as imidacloprid are neurotoxic and antagonist to nicotinic acetylcholine receptors (nAChRs) (Tomizawa and Casida, 2005) [48]. Fact of the matter is that, action of these toxic chemicals is not restricted to target pest only, but bring into play the side-effect to non-target organisms also. Most noticeable and reported impact is that of DDT, traces of which are still present throughout the food chain. Herbicides also reported to exerts its effect on excretory and nervous system of mammals (Casida 2009; Singh *et al.*, 2016) [14, 44]. Therefore, we should learn the lessons from our past mistakes and promote awareness regarding the judicial use of agrochemicals.

This review literature attempts to address farmer's knowledge regarding agrochemicals, its proper application and harmful effects caused to the farmer, his family members and environment as a whole. Further, light has also been thrown on importance of education and extension services in creating the awareness, mainly towards health issues due to exposure to pesticides and other chemicals.

Pesticides and Health Hazard

Contamination of food and environment with toxic chemicals is almost unaffordable (Carvalho, 2017) [13] and as reported by Alavanja in 2009 [7] that, each year about 25 million agricultural workers throughout the world become prey of unintentional pesticide poisonings. As per recommendations of EFSA 2016 [21], caution has to be exercised on application of chemicals to reduce further exposure of human population from environmental contamination. In continuation of that, reports tell that each year there are almost 355,000 people die of unintentional poisonings because of unrestrained use of toxic chemicals (WHO 2012; Alavanja and Bonner, 2012) [51, 6] or improper handling and unsafe spraying, that undeniably cause high risk of health hazards (Bag 2000, Gupta 2004) [11, 29]. Credence on pesticide usage by untrained farmers has posed a high health risk to themselves, co-workers, children and non-target organisms in the environment (Akbar *et al*., 2010) [5]. Non target organisms like bees, marine lives, birds and small mammals also suffered annihilation directly or due to legacy left behind by application of toxic chemicals (Paoli *et al.*, 2015; WHO 2017) [35, 50].

Literature tells that pesticide exposure lead to various health issues, ranges from acute poisoning, skin disorders, endocrine disruption , foetal deformities, miscarriages, reproductive problems, lowering the sperm count of applicants, cardiopulmonary & neurological impairments and various cancers (Arora 2007, George and Shukla 2011; Mrema *et al.*, 2013; Araújo *et al.*, 2016; WHO 2017) [10, 27, 34, 9, 50]. Common reported symptoms may include itching, eye-irritation, vision problems, vomiting and dehydration. Harley, 2008 [30] reported that women with significant exposure to pesticides took longer to get pregnant.

Factors Responsible

Schreinemachers *et al.*, 2015 [42] documented that many farmers in South Asian countries (including India) were using banned and toxic pesticides in their farms (rated by WHO), unaware of their consequences in long run. Similarly, Rijal *et al.*, 2018 [40] in a report concluded that information regarding pesticides' type and characteristics is very low among the farmers. Inappropriate handling and over-dose in application of such toxic chemicals is principal factor behind the health issues. Though a number of socio-economic factors contribute to this, but education and extension plays a vital role in this. In a broad sense, it could be discussed under following sub-heads:

1. **Literacy, Knowledge & Information:** Illiteracy and ignorance regarding the evils of toxic chemicals is prevalent among the farmer workers, especially women folks. Despite the fact that most of the crucial information regarding the characteristics of the chemical in question is displayed on the packaging, but inability to read the warning labels (either due to language barrier, too long instructions or illiteracy) about its use and dosage, farmers are unable to put the knowledge into practice (Rengum 2006, Waichman *et al.*, 2007 and Abdullah *et al.*, 2019) [39, 49, 1]. Furthermore, illiterate farmers are easily deceived by the pesticide dealers easily deceive illiterate farmers by selling expired products to them, on reasonable rate (Ahmad, 2000) [3].
2. **Training & Extension Services:** The primary information source for the farmers is their fellow men and extension advisors (Farooq *et al.*, 2007) [23]. Related literature is hardly read by a farmer. Furthermore, source of popularity for a particular chemical in a rural community is seller/dealer. As reported by FAO, 2008 [25], chemical pesticides are less extensive and effective in short run, moreover, supply agents get subsidy by public agencies to accelerate the crop production of the area. Mass media like TV and radio talks are infrequent source of information for the farmers (Abdullah *et al.*, 2019) [1] mostly because, related programmes are not broadcasted at prime time. Training programmes about the precautions required and the hazardous effects overuse of pesticides are also limited. Extension workers are often limited to progress and resourceful farmers only, because generating profit is primary motto Davidson *et al*., 2001 [17]. Plianbangchang *et al*., 2009 [36] reported that only 19% of the farmers obtained the training in handling of agrochemicals.
3. **Safety Equipment and Health care:** Faulty handling and application of agrochemicals lead to wastage of chemicals (Eddleston *et al*., 2002) [19] and health related risk factors become prominent among the applicants either due to over dosage or lack of proper clothing and safety measures (Raksanam *et al*., 2012) [37]. In a cross sectional survey in Vellore (TN, India) done by Francis *et al.*, 2013 [26], it was found that about 75% of farm women are unaware of the fact that agrochemicals care harmful and could pass through skin, and need safe disposal. Although in 6% of the spray sessions the workers' neurotoxic effects were extremely serious, none sought

medical care. Low-income marginal farmers were more often subjected to severe poisoning than were landlords (Mancini *et al.,* 2005) [33]. Also reported by Ajayi and Akinnifesi, 2007 [4], that upon asking about precautions, that most of the respondents said they cover their body with protective clothing. The use of masks and glasses was almost non-existent, but they usually use cloths to cover their faces instead of using a mask. Use of gloves and boots were also limited. The main reasons for not using protective clothing was the high cost of inputs, the non-availability of these materials, and that their discomfort due to hot weather. Feenstra *et al*., 2000 [24] reported that about 60% farmers are aware of health hazards due to pesticides but are not willing to take safety measures, which make them susceptible for pesticide poisoning. Furthermore, only few farmers' use personal protections like shoes, masks, and gloves (31%, 14% and 9% respectively) while chemical application (Khan *et al.,* 2010) [31].

Recommendations: What could be done?

1. First and foremost is need of education and literacy among the farmers, which will develop them personally, socially as well as economically. Trainings and workshops must be conducted, especially in rural and backward areas, regarding proper usage and application of pesticides, its dosage and safety measures to be taken. Alternate methods like Integrated Pest Management must be encouraged among the farmers through mass media and extension workers (Damalas and Koutroubas, 2017 and Abdullah *et al.*, 2019) [16, 1].
2. Emerging field of science and technology must be integrated in traditional agriculture like GMOs, precision agriculture and pest resistant Hybrid lines and cultivars (Carvalho FP, 2017) [13].
3. Conducting environmental awareness programmes and redefining the existing government policies for sellers and manufacturers of the agrochemicals. Likewise, structured and strict policies must be implemented for the buyers of the chemicals to regulate pesticide applications, including dosage and best periods of application.
4. Continuous education and training programmes of extension functionaries (for skill up-gradation), who have direct link among the farmers and therefore, act as a tool for disseminating advances in agricultural science among the farm people.
5. Special workshops to improve and strengthen information exchange about the pesticide issues between farmers by use of print and electronic media, to reduce the health and environmental risks associated with the overuse and misuse of agrochemicals. (Abdullah *et al.*, 2019) [1].

Conclusion

Irrespective of progress achieved in improving the knowledge regarding toxicity and environmental impact of chemicals, control of risks is far from being grasped and controlled (EUROSTAT 2012; EEA 2013) [22, 20]. From the literature available, it could be concluded that progressive and literate farmers must be encouraged to use safety measures while pesticide application, so that they also disseminate the same among their fellow men. As pointed out by Binetti *et al.*, 2008 [12], that experimentation on risk and hazards could not follow the trends of chemical production, because it would be time taking process to assess the results. Although with time, many hazardous chemicals have been replaced by biodegradable and environment safe chemicals but contamination by legacy residues still affects the food and water (Carvalho, 2017) [13]. Promotion of IPM and modification of Hybrid lines against disease & pest by modern research in biotechnology and genetics could lessen the use of agrochemicals upto some extent. Furthermore, worldwide agreement on scientific agriculture practices, like introduction of GMOs into cultivation, precision agriculture, organic farming and launch of new policies and general agreements among the counties, regarding environment safety can also ensure favourable results in safer food production by reducing the amount of chemical (and water usage).

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