

Chapter 7

Concluding Remarks and Policy Recommendations

Abstract Burning of farm waste causes severe pollution of land and water on local as well as regional scale. The off-field impacts are related to human health due to general air quality degradation resulting in aggravation of respiratory (like cough, asthma, bronchitis), eye and skin diseases. This study finds that total annual welfare loss in terms of health damages due to air pollution caused by the burning of paddy straw in rural Punjab amounts to Rs. 76 million. These estimates could be much higher if expenses on averting activities, productivity loss due to illness, monetary value of discomfort and utility could also be considered. To avoid burning of rice (and wheat) stubble, management of agricultural waste for alternate uses is being practiced and promoted. Various departments and institutions are promoting alternative uses of straw instead of burning, e.g., rice residue as fodder, crop residue in bio thermal power plants and mushroom cultivation, rice residue used as bedding material for cattle, production of bio-oil, paper production, bio-gas and in-situ. Other uses include incorporation of paddy straw in soil, energy technologies and its use in thermal combustion for generation of electricity.

Keywords Stubble burning · Alternate uses of rice stubble · Existing legislation on air pollution

7.1 Introduction

Agriculture sector is the prime mover of economic growth in Punjab. It has been governed by factors of production such as land, capital, energy, nutrients, water and other agricultural inputs. With only 1.5 % of geographical area of the country, Punjab has produced about 20 % of wheat, 10 % of rice and cotton each, of the aggregate produce of these crops in the country. The State is the chief granary of India contributing 22.1 % of rice and 38.7 % of wheat to the Central pool in 2011–2012. Further, over 95 % of the foodgrains moved inter-state to feed deficit areas through the Public Distribution System are the stocks procured from this State. It is characterized as the backbone of the Public Distribution System and a strong base for the food security of the country.

Given tremendous achievements in the past, however serious concerns are now emerging about the future prospects of Punjab's agricultural sector. The greatest concern is about the over exploitation of ground water resources of the state. Further, in the past two to three decades, intensive agricultural practices have put a tremendous pressure on the soils and resulted in steady decline in its fertility (nutrient availability) both with respect to macro and micronutrients. Both rice and wheat have high nutritional requirements and the double cropping of this system has been heavily depleting the nutrient contents of soil. One of the recognized threats to the rice-wheat cropping system sustainability is the loss of soil organic matter as a result of rice-wheat residue burning in the fields.

Though various studies in the literature have addressed this issue of burning of the crop stubble but none have brought to the forefront the adverse implications of this unwarranted practice on human and animal health. The present study proceeds first by bringing to the forefront the amount of pollution being caused by rice residue burning. Thereafter the harmful effects of the pollution being generated by rice stubble burning on human and animal health are studied. Based on the information obtained, the study analyzes Punjab Government's existing policies to address the air pollution caused by rice stubble burning. Based on the findings of the Punjab Government policies to address the pollution caused by crop stubble burning, the study aims at providing policy suggestions to stamp out the practice.

7.2 Summary of the Findings

There is a misconception that industrial sector is the only contributor of pollution whereas agriculture also contributes to pollution in various ways. Crop residue burning is one among the many sources of air pollution. Due to technological advancements in the agricultural sector, waste concentration goes beyond certain limits thereby distorting the balance. Burning of farm waste causes severe pollution of land and water on local as well as regional scale. It is estimated that burning of paddy straw results in nutrient losses viz., 3.85 million tonnes of organic carbon, 59,000 t of nitrogen, 20,000 t of phosphorus and 34,000 t of potassium. This also adversely affects the nutrient budget in the soil. Straw carbon, nitrogen and sulphur are completely burnt and lost to the atmosphere in the process of burning. It results in the emission of smoke which if added to the gases present in the air like methane, nitrogen oxide and ammonia, can cause severe atmospheric pollution. These gaseous emissions can result in health risk, aggravating asthma, chronic bronchitis and decreased lung function. Burning of crop residue also contributes indirectly to the increased ozone pollution. It has adverse consequences on the quality of soil. When the crop residue is burnt the existing minerals present in the soil get destroyed which adversely hampers the cultivation of the next crop. Open field burning of crop stubble results in the emission of many harmful gases in the atmosphere, like Carbon Monoxide, N_2O , NO_2 , SO_2 , CH_4 along with particulate matter and hydro carbons.

However, appropriate assessments have not been undertaken to demonstrate the relevant impact of agriculturally based pollution to broad scale air pollution; that enforcement of the residue burning ban would lead to net public benefits; that adoption of the Happy Seeder is the most efficient means of utilizing/coping with the rice residue loads without resorting to burning; that the provision of government assistance is necessary or warranted to achieve efficient levels of Happy Seeder adoption; This study addresses these questions.

Crop residue burning is one among the many sources of air pollution. The on-field impact of burning includes removal of a large portion of the organic material, denying the soil an opportunity to enhance its organic matter and incorporate important chemicals such as nitrogen and phosphorus, as well as, loss of useful micro flora and fauna. The off-field impacts are related to human health due to general air quality degradation resulting in aggravation of respiratory (like cough, asthma, bronchitis), eye and skin diseases. Fine particles also can aggravate chronic heart and lung diseases and have been linked to premature deaths in people already suffering from these diseases. The black soot generated during burning also results in poor visibility which could lead to increased road side incidences of accident. It is thus essential to mitigate impacts due to the burning of agricultural waste in the open fields and its consequent effects on soil, ambient air and living organisms.

Several evaluations have been carried out to assess the impact of air pollution from agricultural residual burning. Air pollution contributes to the respiratory diseases like eye irritation, bronchitis, emphysema, asthma etc., which not only increase individuals' diseases mitigation expense but also affect their productivity at work. Most of the studies valuing health impacts of air pollution remain confined to urban areas as air pollution is considered mainly the problem of urban areas in developing countries. Though health consequences from burning of agricultural residue are not fully understood, relative short exposure may be more of a nuisance rather than a real health hazard. Many of the components of agricultural smoke cause health problem under certain conditions. There are many studies in developed countries that estimate the value of adverse health effects of air pollution. Similar evidences are available from India and other developing countries. These studies used either household health production model or damage function or cost of illness approaches to estimate the monetary value of health damage caused due to ambient air pollution. Note that these studies are restricted to measure the monetary value of reducing urban air pollution to the safe level since air pollution has been considered mainly the problem of urban areas.

These studies used either household health production model or damage function or cost of illness approaches to estimate the monetary value of health damage caused due to ambient air pollution. Note that these studies are restricted to measure the monetary value of reducing urban air pollution to the safe level since air pollution has been considered mainly the problem of urban areas. The present study used data of 625 individuals collected from a household level survey conducted in three villages, namely Dhanouri, Ajnoda Kalan and Simro of Patiala district of Punjab for 150 households. To get the estimates of monetary values of

human health impact of pollution two equations were estimated: one with mitigation expenditure and the other with workdays lost as dependent variables. Tobit and Poisson models were used for estimating mitigation expenditure and workdays lost equations, respectively.

On an average, total amount of stubble generated for paddy and wheat per acre was around 23 and 19 quintals, respectively. Out of this in the case of paddy, more than 85 % was burnt in the open field and less than 10 % was incorporated, while rest of 5 % was used for other purposes. In the case of wheat, 77 % of the total amount was used as fodder for animals while 9 % was incorporated and around 11 % was burnt. Although farmers were convinced that burning was not harming the level of crop yield but they pointed out that burning of field added extra cost to the production because of top soil getting affected by the burning. The farmers who burnt the field (fully or partly) to clear the wheat stubble used 169 kg of urea in the next crop of paddy while those who incorporated or adopted other means used 145 and 148 kg of urea, respectively. Similarly, those farmers who burnt paddy field, used added amount of Di-Amonia Phosphate (DAP) to recapture the nutritive lost in the fire in comparison to those who incorporated or removed stubble manually. Higher expenses were not only in terms of higher fertilizer but also in terms of higher irrigation requirement by those who burnt their field to clear the stubble.

Household survey showed that paddy stubble burning leads to air pollution and several other problems. Irritation in eyes and congestion in the chest were the two major problems faced by the majority of the household members. Respiratory allergy, asthma and bronchial problems were the other smoke related diseases which affected household members in the selected villages. Almost 50 % of the selected households indicated that their health related problems get aggravated during or shortly after harvest when crop stubble burning is in full swing during the months of October, November and December. In the peak season, affected families had to consult doctor or use some home medicine to get relief from irritation/itching in eyes, breathing problem and similar other smoke related problems. On an average, the affected members suffered at least half a month from such problems and had to spend Rs. 300–500 per household on medicine. In addition there were few examples where a family member had to be hospitalized for three to four days and additional expenditure was incurred. On an average, households spent around more than a thousand Rupees on the non-chronic respiratory diseases like coughing, difficulty in breathing, irregular heartbeat, itching in eyes decreased lung function etc., during the year 2008–2009. However, out of this total expenditure, around 40–50 % was spent during the months of October and November during the time of crop stubble burning. There was an additional cost in terms of household members remaining absent from work due to illness.

The study finds that total annual welfare loss in terms of health damages due to air pollution caused by the burning of paddy straw in rural Punjab amounts to Rs. 76 million. These estimates could be much higher if expenses on averting activities, productivity loss due to illness, monetary value of discomfort and utility could also be considered. There is additional monetary cost of burning to the farmers in terms of additional fertilizer, pesticides and irrigation. One also needs to add the losses of soil nutrient, vegetation, bio-diversity and accidents caused because of low visibility.

To avoid burning of rice (and wheat) stubble, management of agricultural waste for alternate uses is being practiced and promoted. Agricultural waste includes paddy and wheat straw, cotton sticks, bagasse and animal waste. Keeping in view the increasing problems associated with crop stubble burning several initiatives for its proper management have been taken up. Various departments and institutions are promoting alternative uses of straw instead of burning. These include use of rice residue as fodder, crop residue in Bio thermal power plants and mushroom cultivation, rice residue used as bedding material for cattle, production of bio-oil, paper production, bio-gas and in-situ. Other uses include incorporation of paddy straw in soil, energy technologies and thermal combustion.

The problem of pollution caused by rice and wheat crop stubble burning has not received much attention by the policymakers and the various pollution authorities till recently. This could be partially due to the fact that the rice burning (the major source agri waste burning pollution) takes place only during selected months of October, November and December. The pollution is restricted only during these months. However even during these months there is considerable loss to human health and environment degradation. It is believed that Punjab Government regularly publishes the adverse impacts of crop stubble burning in local newspapers. Punjab Government, its various Departments and other institutions like Punjab Agricultural University, Punjab Farmers Commission etc., are all making efforts to devise some alternate economic uses of rice stubble. These include the stubble treated with urea as a fodder for animals, its use in biothermal energy production, paper manufacturing, mushroom cultivation, bedding for animals, etc. Punjab government is also providing subsidy to the farmers to promote the use of equipments which help in checking the burning of crop residues, like rotavators, happy seeders, zero-till-drills and straw reapers. In the local dailies of Punjab one comes across articles requesting farmers to stop burning the stubble or creating awareness among them about its ill effects. An example, the District Magistrate Amritsar banned the burning of crop stubble (the Tribune dated 19th May 2009). However the practice still continues in the rural belt of Amritsar district, including Attari, Ajnala and Majitha. Thus the problem of agri waste burning still remains unresolved. While on the one hand, there is an urgent need to revitalize the research in agriculture and related activities, on the other hand, to tackle the problem of soil degradation and water depletion, a dedicated programme for promoting resource conservation technologies, such as zero tillage, deep ploughing, raised bed planting, laser land leveling etc., should be undertaken. Heavy investments are required to be made for rejuvenation of these resources. The Rashtriya Krishi Vikas Yojana (RKVY) is a welcome initiative in that direction. There is a requirement for an eco-friendly technology that will be beneficial to the farmer community and the State by providing them a tool for improving soil health and environment for sustainable agriculture.

India is a legislation rich country with reference to pollution. The Ministry of Forest and Environment is a vital agency in the administrative setup of the Union Government. The Ministry is entrusted with the task of planning, coordinating, overseeing and implementing various forestry and environment programmes. In order to promote the development of clean technology, development of tools and

techniques for pollution prevention and to formulate sustainable development strategies, the Ministry granted an aid in 1994 for the development and promotion of clean technologies. Eleven major laws exist to control pollution in India and many forums for their implementation in various ways. Among the existing legislation on air pollution in India includes: Air Prevention and Control of Pollution Act, 1981; The Environment Protection Act, 1986; The National Environment Tribunal Act, 1995; The National Environment Appellate Authority Act, 1997; and Biological Diversity Act, 2002. Under these different Acts, provisions are made to protect the environment from all kinds of pollution related to industrial and agricultural activities. The Punjab Pollution Control Board (PPCB) is entrusted with the functions of planning a comprehensive program for the prevention, control and abatement of pollution in Punjab. PPCB has to support and encourage developments in the field of pollution control. PPCB has taken various measures to limit the amount of industrial pollution in the state but not much has been done to address agricultural pollution. The Central Pollution Control Board (CPCB) is the 'Central Board' for the prevention, control and abatement of air and water pollution in India. CPCB has initiated a nationwide programme of ambient air quality monitoring called NAMP.

The division of environment assists the State Department of Environment, Government of Punjab in technical matters pertaining to environment, identification of major areas of ecological concern, defining the State Government policies and plans on various environmental issues, coordinating and monitoring schemes related to environment, creating environmental awareness and promoting environmental education, training and research.

Moreover Punjab State Council for Science and Technology was also recognized as one of the institutes for imparting training on pollution control, waste management, clean technologies, environment policies, health monitoring and assessment and solid waste management conducted by the Central Pollution Control Board under the Human resource development programme. The Punjab Energy Development Agency was established in the year 1991, for the promotion and development of non-conventional and renewable energy programs or projects in the state of Punjab. Thus, as far as the institutional setup is concerned, there is enough constitutional provisions made under the law of the land to control and abet pollution related to agricultural waste burning. However, what is requisite to meet with this evil practice is strong will power among the governance and viable economic alternatives available to the farmers to keep the stubble burning practice at a bay.

7.3 Policy Recommendations and Research Needs

- The burning problem is rampant in Punjab, Haryana and Uttar Pradesh and data about air pollution in rural areas is too scarce as most of the pollution monitoring stations are setup in urban areas. Therefore, it is necessary to have a proper idea of real amount of air pollution generated by the burning of crop residuals. It is also necessary to have exact measurement of RSPM, black carbon (soot) in

the ambient air, measurement of meteorological parameters like wind velocity, temperature profile and humidity etc., in the rural areas to initiate policy actions to avoid the same.

- Imposing ban on burning legally may not succeed unless farmers are properly educated and made aware about its adverse implications for human and animal health and its undesirable impact on soil, biodiversity etc. To educate farmers, extension activities like Documentary on environment and climate change may be made. In the documentary emphasis should be put on how burning adversely impact the climate change and educate the farmers about the economics of not burning the agricultural residues.
- Alternatives to burning agricultural residue like collection and transportation of agricultural residues, gasification as a fuel for the boilers, converting into briquettes and designing of suitable harvester should be promoted.
- Free electricity should not be promoted as the same policy has led to installation of high powered tube wells that are responsible for over draw water from deep inside the earth.
- In-situ management in the field, composting by chemical means and straw mulching by mechanical means should be promoted. The machines like the use of disc plough, disc harrow, rotavator, zero tillage and happy seeder can help in mulching the crop stubble.
- Wastes/residue should be collected from the fields and should be disposed off or used for making useful products like making compost, organic manure to improve soil fertility, and gasification for use as a fuel or for power generation; night soil to produce biogas and manure.
- The stem may be cut from the root level itself. The same would require a suitable thresher cum harvester that should be developed using indigenous techniques. Use high power tractor for deep cutting. For small farmers it can be followed on cooperative basis.
- Make the small farmers to understand that making chaff out of the agricultural residues is to their advantage.

Open Access This chapter is distributed under the terms of the Creative Commons Attribution Noncommercial License, which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author(s) and source are credited.