Meeting Report

Crop Residue Management in South Asia: Advancing Subregional Cooperation for Sustainable, Climate-smart and Integrated Management of Crop Residues

15 September 2022
13:00 – 15:00 (Indian Standard Time)

v

Hybrid mode
Venue: ESCAP Subregional Office for South and South-West Asia (SSWA)
New Delhi, India

Contents

1. Introduction

The burning of crop residue is one of the key reasons for creating severe air pollution in certain countries of South Asia. It affects people's health, contributes to climate change with the emission of greenhouse gases and affects agricultural production and food security by deteriorating soil health. Crop straw yield has kept growing and maintained a high level with increases in agriculture production in South Asia. The lack of suitable agricultural technology and machinery to sustainably utilize the straw or promote its recycled usage has led to their burning and caused a high level of air pollution, including through transboundary sources, in Bangladesh, India, Nepal and Pakistan.

ESCAP's Subregional Office for South and South-West Asia (ESCAP-SSWA) and the Centre for Sustainable Agricultural Mechanization (ESCAP-CSAM) in collaboration with its network of institutions, carried out national studies for Bangladesh, India, Nepal and Pakistan to better understand the status of crop residue management in these countries, identify gaps and opportunities, collect good practices/technologies of straw management (with particular emphasis on mechanization-based solutions), and design action plans for interventions. A subregional report is also being developed to explore key actions and the possibility of having a subregional framework for cooperation to promote sustainable and integrated management of straw residues.

A hybrid meeting was organized on 15 November 2022 with the objectives to:

1) Share main findings of national studies carried out for Bangladesh, India, Nepal, and Pakistan to understand the status of crop residue management, good practices/technologies of straw management, and proposed action plans for interventions at national levels.
2) Present findings of a subregional report which identifies common challenges, technologies and best practices used, and explore an action plan and way forward to address the issue of crop residue burning at a subregional level.
3) Discuss the reasons for having a subregional framework for cooperation and identify common elements for the cooperation.
4) Collect expert's feedback on the proposed action plan and build consensus on common elements for a subregional cooperation framework on sustainable and integrated straw management.

Close to 100 participants from the Asia-Pacific as well as other regions attended the event. This report provides a summary of major issues presented and discussed.

2. Opening remarks

Ms. Mikiko Tanaka, Director and Head, ESCAP-SSWA opened the meeting and noted that the burning of crop residue is a key environmental hazard in many of the South Asian countries, particularly in the Indo-Gangetic plains which is densely populated and has been a food bowl for many centuries. As the burning of crop residues begins with the end of the harvesting season, plumes of toxic smoke increase the concentration of particulate matter and black carbon in the air and adversely affect the health of

rural and urban populations. A study conducted by the International Food Policy Research Institute in India found that agriculture crop residue burning exposes the general population to a threefold risk of acute respiratory infection and leads to over US$300 million losses in economic value every year.

The burning of crop residues also negatively affects soil fertility and can subsequently increase agriculture production costs through greater use of fertilisers. Greenhouse gases emitted from burning contribute to global warming and climate change. As such, the burning of crop residues adversely affects the achievement of the Sustainable Development Goals as it contributes to climate change (SDG 13), affects our health and wellbeing (SDG 3), has implications on food security (SDG 2), and affects the air quality of city inhabitants (SDG 11).

In light of the multi-faceted nature of crop residue burning, the ESCAP Subregional Office for South and South-West Asia and the Centre for Sustainable Agricultural Mechanisation (ESCAP-CSAM) have joined hands to undertake national studies in Bangladesh, India, Nepal and Pakistan to better understand the situation of crop residue management in these countries, collect good practices and propose action plans for interventions. A subregional report is also being developed to explore key actions and possibility of having a subregional framework to promote the sustainable and integrated management of crop residues. Ms. Tanaka hoped that the meeting would serve as a good platform for sharing experiences of various countries, provide information on productive uses of straw and collect expert opinions on the proposed action plan and possibilities for subregional cooperation.

Ms. Yutong Li, Head, CSAM noted that burning of crop residues was a common concern in many parts of Asia and the Pacific including South Asia. This issue has been drawing increasing attention due to the impact on the environment including air pollution which affects the lives of many people across countries, contribution to climate change and as a major impediment to progress on the Sustainable Development Goals. Ms. Li highlighted that people choose to burn crops despite the negative impact on soil fertility due to the high cost of straw collection, transportation and storage, partially caused by labour shortages, the limited time available to meet the seeding schedule for the next crop cycle and the lack of adequate methods to treat crop residue. While various approaches are being applied across different countries to utilize straw as fertilizer, fodder and other purposes, there is a need to test and promote integrated models of utilizing straw with the focus on enhancing the performance of machinery in specific local contexts.

As a regional institute of ESCAP, CSAM is helping member states in implementing sustainable agriculture solutions, including sustainable management of crop residue. Regional and sub-regional cooperation, which is the core of CSAM's work, is vital to address the problem of residue burning as air pollution often acquires a transboundary dimension and thus requires solutions that transcend borders. Moreover, areas with similar agro-ecological characteristics in the sub-region can also benefit from common solutions and good practices which implies that ongoing exchange of such solutions and experiences are important.

In 2018, CSAM launched a regional initiative in China and Vietnam to identify, test and promote an integrated model to utilize straw as fertilizer, fodder and base material in a circular manner. Building upon its success and positive results, this Initiative has expanded to two LDCs (namely Cambodia and Nepal) as well as Indonesia with funding support from the China-ESCAP Cooperation Programme. In March 2022, CSAM's regional initiative on 'Mechanization Solutions for Integrated Management of Straw Residue in Asia and the Pacific' was cited among 80 'Good Practices in South-South and

Triangular Cooperation in LDCs' by the United Nations Office for South-South Cooperation (UNOSSC) and other partners. Ms. Li was happy to be joining hands with the ESCAP SRO-SSWA to promote solutions for sustainable crop residue management through analytical studies and knowledge exchange.

3. Presentation of national studies

This session shared findings of national studies conducted in Bangladesh, India, Nepal and Pakistan on the status of crop residue management, good practices/technologies of straw management, and proposed action plans for interventions at national levels. This was followed by a short discussion of comments received from meeting participants.

Dr. Md. Israil Hossain, Agricultural Engineer & Former Director General Bangladesh Wheat and Maize Research Institute stated that farmers in Bangladesh understand the benefits that the soil derives from the incorporation of crop residue and that open field burning of rice straw is not widely practiced due to the manual cutting of crops. However, with the uptick of use of combine harvesters, some farmers are considering the option of straw burning. Farmers in Bangladesh tend to burn long straws and bad quality rice, wheat straw and maize residue which cannot be used as animal feed or domestic fuel. In 2020-2021, Bangladesh produced 73.36 million tonnes of crop residue of which 0.22 million tonnes were burned. Dr. Hossain mentioned that labour engagement in agriculture in Bangladesh has decreased from 51.7% in 2002 to 40.6% in 2017 which is placing increasing pressures on labour availability.

Dr. Hossain highlighted some good practices of straw residue use in Bangladesh. Firstly, rice straw and chopped green corn stalks are used as a feed for cows and buffaloes. Crop residues also are incorporated into the soil by ploughing and unused straw from cow sheds are used as fertiliser. Small farm holders and low-income families use straw for outdoor water heating and maize straw is used as a domestic fuel in rural areas. Cow dung along with wet straw is also used in biogas plants. Finally, rice and wheat straws are used as mulch for fruits and vegetable production.

Key recommendations from the study included the need to:

1. facilitate purchase of straw balers, straw and corn stalk choppers through subsidies provided in an ongoing farm mechanisation project and to update the Government's agriculture mechanisation policy of 2020.
2. provide agriculture input support to farmers who follow sustainable straw management practices.
3. place restrictions on farmers who violate straw burning rules by limiting loan facility, limiting grain purchase by government, charging higher rates for irrigation and lowering government seed support.
4. support entrepreneurs to make Biochar from straw used for mushroom production and straw crafts.
5. launch a promotional campaign sharing the harmful effects of crop burning and social benefits of alternative uses of straw.

With regard to follow up actions to be undertaken at the national level, it was recommended that an existing government agricultural advisory panel should identify different straw management interventions, form a work plan and efficiently follow up implementation with an inter-ministerial national task force committee. The national taskforce can regularly monitor straw management practices, conduct regular meetings to monitor status, gaps in work plan and identify corrective measures as well as prepare and distribute factsheets, leaflets to concerned agricultural departments. Dr. Hossain also suggested that support be given to the Bangladesh Agricultural Research Council to organise annual multistakeholder straw management workshops and broadcast key messages with the community through mass media.

Several recommendations that are relevant to other countries in the subregion from Bangladesh's experience were also proposed. Firstly, the promotion of appropriate conservation agriculture machinery which can work through moderate levels of crop residue as well as the introduction of straw balers and choppers to facilitate straw management was felt to be important. Secondly, the development of a strategy for installing more biogas plants in rural areas as well as the use of rice and wheat straw for use as base material of mushroom production could facilitate the productive use of surplus straw. Finally, the promotion of custom hire service models of agricultural machinery would facilitate farmers access to such technologies.

Dr. C R Mehta, Director, Indian Council of Agricultural Research (ICAR) - Central Institute of Agricultural Engineering noted that India generates 683 million tonnes of crop residue, over half of which is from three states - Punjab, Haryana and Uttar Pradesh. He mentioned that of the different crops, paddy straw constitutes 40% of all crop residue burned. The short time interval between harvesting and planting of the next crop, scarcity of labour, high cost of collection and transportation, lack of storage and market facilities, high cost of mechanically ploughing stubble back into the field, and paddy straw being less preferred as ruminant feed were key factors influencing farmers decision to burn crop residue.

Regarding good practices for in-situ management of crop residues, Dr. Mehta highlighted a scheme launched by the Government of India on the promotion of agricultural mechanisation and machinery for in-situ management of crop residue in the states of Punjab, Haryana, Uttar Pradesh and National Capital Territory (NCT) of Delhi. In this scheme, subsides have been provided for the establishment of farm machinery banks or custom hiring centres as well as for the procurement of agriculture machinery and equipment. The scheme also includes awareness-raising efforts on in-situ crop residue management. Through the promotion of in-situ management of paddy straw, Punjab State has seen a decline of paddy straw burnt areas, decrease of fire events, improvement of air quality and increase of soil organic carbon.

A number of ex-situ management practices have also been implemented in India such as the production of biomass pellets for use as fuel in power plants, power generation from biomass, ethanol production from crop residue, community level production of biogas/bio-CNG from paddy straw and composting of paddy straw.

A number of recommendations related to crop residue management (CRM) mechanization, laws and legislation and other interventions were provided to address crop residue burning in India, such as the:

1. need to improve existing CRM machinery to reduce power requirements and work better in moist straw;
2. need for more efforts to promote conservation agriculture machinery through financial incentives and custom hiring centres;
3. need for state-specific CRM policies that define competing uses of straw and promote in-situ management supplemented with ex-situ management of crop residue;
4. promotion of crop residue use for animal bedding, composting and mushroom cultivation;
5. need to incentivize power generation from biomass to make it more cost effective
6. use of biomass pellets for fuel substitution in thermal power plants, production of compressed biogas from paddy straw and promotion of second generation (2G) biomass-based ethanol plants in public-private partnership (PPP) mode are possible ways of using straw

In closing, Dr. Mehta recommended that for the sub-region, in-situ management of crop residues was the most relevant technique as it was environmentally and financially sustainable and would improve soil health and productivity in the long run. Ex-situ management techniques to be considered in other countries included domestic/community level biogas production from paddy straw, use of biomass pellets for thermal power generation as well as power generation from crop residues.

Mr. Madhusudan Singh Basnyat, Agricultural Mechanization Expert & Former Deputy Director General, Department of Agriculture, Government of Nepal noted that crop residue burning in Nepal has increased since the use of combine harvesters came into practice and that farmers who use combine harvesters are 54% more likely to burn their crop residue. There is a lack of farmer awareness on the negative effects of residue burning. The short turnaround time between rice and wheat crops leads farmers to burn residues as it saves both time and money as the collection of crop residue is a labour-intensive process. Changes in livestock rearing practices through commercial rearing and use of alternative feed has reduced demand for straw and the lack of alternative straw uses has lowered the market value of crop residue. Access to suitable techniques for integrated straw management is also lacking which leaves farmers with limited options for using crop residues.

Some of the best practices for straw management from Nepal included the use of straw as fertilizer by direct returning to soil. Such in-situ practices entail the use of Happy/Super seeders and zero-till seed cum fertilizer drills with straw used to cover soil as well as the incorporation of straw directly into the soil through the use of roto till (power tiller) seed cum fertilizer drills, rotary mulcher and ploughing, or direct ploughing using rotavators. For ex-situ straw management good practices, Mr. Basnyat spoke about the use of straw collecting machines (straw balers and reapers), straw being used as a fertiliser by composting, as base material for mushroom cultivation, bedding material for cattle or cooking fuel, as fodder and as material for craft production for handicrafts and cottage industries.

In terms of recommendations, some actions to be considered in the short, medium and long-term were recommended. In the short term (to be completed by five years) there was a need to:

- conduct a baseline survey on the status, availability and utilization of straw;
- advocate to policy makers about the importance of straw management;
- transfer knowledge of various straw management techniques through demonstration of straw management machines and techniques;

- change the hiring charge of a combine harvester from an area to a time-based approach as area-based schemes tend to leave longer straw in the field which is difficult to collect;
- pilot best practices for in-situ and ex-situ integrated straw management and replicate learning;
- provide incentives for not burning;
- include and prioritise crop residue management in the upcoming "Feed and Fodder" policy of federal government; and
- enforce requirement on importing of straw management machines along with combine harvesters.

In the medium term (to be completed in eight years), Mr. Basnyat recommended the need to validate and adopt the best practices from the neighbouring countries, develop and implement trainings and demonstrations, provide subsidies for integrated straw management technologies and machines, ensure no direct subsidies for combine harvesters, raise awareness of the impact of Crop Residue Open Burning (CROB) on human, environment and soil health and promote practice of conservation agriculture. In the long term, integrated straw management should be included in the policy and strategy of the federal and provincial governments and 75% of crop residue be targeted for return back to the field through a "save soil" campaign.

Mr. Basnyat made recommendations which would be relevant to other countries in the subregion. This included the starting of "no burn" campaigns, conducting baseline surveys, validating and adopting best practices from the neighbouring countries, providing incentives for not burning, enforcing a requirement on using straw management machines along with combine harvesters, provision of subsidies for integrated straw management (ISM) technologies and ensure no direct subsidies for combine harvesters, promoting conservation agriculture practices, and plan that 75% of crop residue are returned back to the field.

Dr. Shabbir Ahmed Kalwar, Agricultural Engineer & Former Director/ Chief Scientific Officer, Pakistan Agricultural Research Council mentioned that five major crops in Pakistan (wheat, rice, maize, sugarcane and cotton) produced 55 million tonnes of crop residue every year with more than 80% of rice straw and sugarcane debris burned in the field. Less than 5% of wheat straw is burned and it is utilized for animal feeding, paper production, export purposes, mushroom growing and other local uses. Maize straw is mostly used as animal feed and mixed in the soil using rotavators and disk harrows. As for cotton stalk, about 50% is used for firewood and the remaining amount mixed in the soil. The main reasons for crop residue burning in Pakistan are the low commercial value of residues, short time window between Basmati rice harvesting and wheat sowing, high cost of residue collection from the field and limited other uses.

In terms of best practices in Pakistan, rice straw is used to cover ornamental plants during the winter, create temporary animal shades in winter, cover seeds of spring floricultural plants, used as heating fuel in rural areas and for fruit and industrial packaging. Recently cotton growers have started to make pellets and briquettes as fuel. The Government of Punjab in Pakistan has also launched a programme to provide subsidies for Pak/Happy seeders and tractor operated straw choppers and laws have been implemented to impose penalties for burning crop residues.

Some recommendations for promoting integrated straw management included the organization of annual national workshops by the Pakistan Agricultural Research Council (PARC) to advise federal and provincial governments on crop residue management strategies, allowance of duty-free import of crop head feeding combine harvesters and formulation of appropriate laws and policies to control burning of crop straw. For provincial level policies, Dr. Kalwar recommended:

- expansion of subsidies on Pak/Happy Seeders and rice straw choppers;
- increase awareness and arrange travelling seminars;
- provide incentives to farmers to use track type head feeding combine harvesters that leave straw intact for easier collection and use for animal feed;
- enforce the attachment of straw spreading kits to combine harvesters used for rice harvesting;
- promote diversified uses of crop residue for power generation, ethanol production, biogas and composting;
- expansion of subsidy scheme to include straw spreading kits, tractor power take-off (PTO) driven disk ploughs;
- organise training seminars on effects of residue burning and adoption of conservation agriculture practices.

At the sub-regional level, Dr. Kalwar suggested the expansion of an ongoing ESCAP-led pilot project to Pakistan and initiation of new pilot projects at sub-regional levels.

During the **question and answer session**, a participant commented that Bangladesh was a bit of an unusual case in that straw has a high value as animal feed and can sometimes be worth more than the rice harvest itself. For this reason, it is frequently sold rather than tilled into the soil or burned. However, as the agricultural economy advances and begins to mechanize, the straw will have less and less value and so the rate of straw burning may very well accelerate.

In response to this statement, Dr Hossain mentioned that crop burning is beginning to be a problem as he found that some farmers who have adopted combine harvesters in Bangladesh are having difficulty in collecting the straw. He suggested that straw management policies should be advanced along with mechanisation. He said that although open field burning is not a problem, it is expected that some farmers may do so in the coming years and saw a role for CSAM to convince the appropriate ministerial personnel to take timely action on the matter.

Mr. Jha of the Nepal Agricultural Research Council also noted that policy interventions are key to solve this crop residue burning and there is a need to see coherence in agriculture policies.

4. Panel discussion on building subregional framework for cooperation and the areas for cooperation

The objective of the panel discussion was to explore opportunities for subregional cooperation in the area of sustainable, climate smart and integrated management of crop residues. In particular, the session discussed and provided comments/suggestions on a draft report titled *'Integrated Straw Management Regional Report'* which was presented. The report - once finalized – is expected to propose the components and a framework for subregional cooperation in South Asia to promote

integrated management of straw residue. The comments and suggestions received from the panelists as well as the audience were important for further improvement and finalization of the report.

4.1 Presentation for the panel

Dr. C R Mehta, Director, Indian Council of Agricultural Research (ICAR) - Central Institute of Agricultural Engineering, India, began by presenting data on biomass production from major crops as well as a crop-wise breakdown of residue produced in the four study countries. Residues produced by different crops differed from country to country. Most notably, rice constituted 90% of crop residue produced in Bangladesh, while wheat residue constituted 45% of Pakistan's total crop residue production.

In all the study countries, crop residues were used for animal feed, bedding for cattle, residue incorporation/mulching, domestic fuel, compost making, production of paper and other value-added items. India and Pakistan use crop residue for power production, while Bangladesh and India also use crop residues for producing biogas. India also uses straw for briquetting of crop residues as well as production of bio-CNG/compressed biogas (CBG), bio-ethanol and bio-char.

The main factors influencing farmers decisions to burn crop residues include the short time interval (10-20 days) for sowing the next crop (particularly in rice-wheat cropping systems), the introduction of combine harvesters which leave long straw and lack of straw management machinery, labour scarcity and high cost of collection and storage, lack of alternative uses and profitability of alternate options, lack of awareness about the negative effects of burning and low level of knowledge about CRM machinery. All these factors lead farmers to burn crop residues as it is the easiest and cheapest way to dispose of them.

Dr Mehta briefly outlined some of the consequences of crop residue burning, including the contribution of burning to greenhouse gas emissions, deaths due to high level of fine particles in the air as well as losses of nitrogen, sulphur, phosphorus and potassium. The need for sub-regional cooperation to address this issue was mentioned as air pollution from straw burning is also a transboundary issue.

From the studies, residue mulching and residue incorporation were identified as best in-situ management practices as they save nitrogen, potassium and irrigation water, increase soil organic carbon and restore microbial activity in the soil. Different machineries used in the four countries for in-situ and ex-situ management of crops residues were also highlighted. For the ex-situ management practices of crop residues, examples of paddy straw composting, biogas plants, biomass pellets, bio-CNG production and ethanol production were presented.

The common challenges and gaps in the management of crop residues identified from the studies were summarized. For in-situ management, some of these included the lack of adoption of conservation agriculture, use of combine harvesters and negative perceptions that farmers have on leaving crop residues as mulch in the field. In respect to ex-situ management, the high cost of collection and transport of residues, lack of assured markets for processed by-products, lack of technical and economic feasibility studies are major challenges for use of crop residues outside the field. For other common issues, the lack of relevant statistical information on availability, utilization and surplus straw resources, lack of crop residue management policies and incentives to farmers for not burning crop residue were identified.

In order to reduce the burning of crop residues, Dr Mehta opined that long-haul transportation and expensive technology are less likely to succeed and that sustainable solutions that feed crop residue

nutrients back into the soil should be prioritized. As such, methods of in-situ management of crop residues were preferred over ex-situ methods. A number of mechanization-based, institutional, socio-economic and other technical interventions, which are summarized in Annex II, were proposed as being needed to address this issue of crop reside burning.

In closing a common framework for sub-regional cooperation was presented. It was stressed that there is a need to have a combination of technologies and incentives to address the issue and that the key was to assign a real economic and commercial value to crop residue in order to make burning an economic loss to the farmer. The following areas for subregional cooperation were proposed:

- Conduct systematic studies to gather data on the availability, utilization, surplus and burning of crop residues in South Asia;
- Share equipment and technology especially for in-situ management of crop residues;
- Share knowledge of best practices of CRM in different countries;
- Harmonize testing standards of CRM machinery to promote their safety, efficiency and environmental soundness as well as to enable more integrated trade in such machinery;
- Explore policy harmonization for adoption of CRM machinery such as for combine harvesters to be imported/exported with super SMS (Straw Management Systems)

4.2 Panel discussion

After introducing the individual panellists, some key questions were posed for feedback from the experts.

Q1: Do you agree that there is a need for a subregional cooperation framework for South Asia to address the issue of crop residue burning and residue management?

Dr. Rajbir Singh, Director, Agricultural Technology Application Research Institute, Ludhiana, India agreed that regional and subregional cooperation were necessary to address straw management as it can help share experiences and success stories as well as ways to deal with problems and bottlenecks. He appreciated that the plan presented by Dr. Mehta as an integrated plan with both in-situ and ex-situ practices was practical and addressed the problem holistically. Dr Singh hoped that through such collaboration, progress to address this issue can happen faster.

Mr. Jawed Alam, Associate Professor and Head, Department of Agricultural Engineering, Tribhuvan University, Institute of Engineering (IOE)/Purwanchal Campus Dharan, Nepal also agreed that subregional cooperation is needed as greenhouse gas emissions and air pollution have no geographic boundaries. Pakistan only contributes to 0.9% of global greenhouse gas emissions, but is experiencing major impacts of climate change. Nepal is also affected negatively by air pollution with high incidence of asthma and lung diseases caused by air pollution. Dr Alam stated that such issues cannot be solved alone and need regional cooperation to find solutions.

Ms. Sandra Corsi, Coordinator of Projects on Conservation Agriculture and Climate-Smart Crop Production Intensification, Plant Production and Protection Division, Food and Agriculture Organization of the United Nations began by noting that straw burning is both a poverty and an environmental problem which requires policy support. It is a poverty problem because burning is the least expensive method to dispose of excess residue. It is a collective environmental problem because environment is agnostic to where the pollution comes from.

Policies are important as they are a glue to bring together the technologies, infrastructure and knowledge in a coherent way to provide farmers with feasible and viable alternatives for using straw.

Ms Corsi noted that the intensity of straw burning varies depending on the feasibility of alternatives of straw. She cautioned that where mechanization is used to replace animal power, straw burning can increase if technologies to help farmers manage straw are not made available.

She agreed that there is a need for a cooperation framework for residue management among the countries that in the same regions share the same issues because it will allow to co-develop solutions, facilitate knowledge sharing and create business opportunities for farmers and the private sector. She added that for the framework to be effective it would need to include cooperation of public, private, civil society stakeholders.

Q2. Looking at the 'Action Plan' proposed in the subregional report (*Mechanization-based Interventions, Institutional Interventions, Socio-economic Interventions, Other Technical Interventions as outlined in Annex II*), what issues do you feel are most important to address? And are there areas/elements for cooperation that are missing in the proposed 'Common Framework for Sub-regional Cooperation'?

Dr. Muhammad Azeem Khan, former Chairman, Pakistan Agricultural Research Council, Pakistan found the subregional report to be very comprehensive and touched upon almost all-important aspects of crop residue burning and management in the region. He highlighted a few areas that he felt could be further considered or developed including:

1) **Soil organic matter**: Outside of a few areas, increases in agriculture production in the subregion have mostly been due to enhanced cropping intensity as agriculture productivity has been stagnant for the past 10-20 years. In Pakistan, organic matter in the soil is less than 0.4% and this increases use of chemical inputs. If data was available, it would be interesting to examine the status of soil organic matter under different production systems and cropping patterns and how it has changed over time with intensification of agriculture and crop residue burning. This would help to further emphasize the importance of in-situ management practices such as conservation agriculture that was recommended in the study.

2) **Crop residue data**: Of the four study countries, India was the only one with comprehensive data on surplus crop residues and it could only be estimated in other countries from the crop harvest index. This is an area of work that could be looked into further.

3) **Analysis by production systems and cropping patterns**: The study has made mention of driving factors for burning, but it would be helpful if this could be further pinpointed by production systems, particularly where crop residue burning is high. Differentiations by different varieties, e.g. coarse, fine, early and late maturing varieties, could also be considered to help further focus efforts under the cooperation framework.

4) **Documentation of best practices**: The sharing of best practices has been mentioned in the report and this is something that is very important. There are a few farmers in Pakistan that are doing some novel things that can increase agricultural productivity with less use of machinery. The documentation and sharing of innovative practices that have higher productivity, improve soil structure and lower production costs in various countries is important.

Dr. Sultan Ahmmed, former Member Director, Natural Resources Management, Bangladesh Agricultural Research Council, Bangladesh noted that amongst the mechanization changes suggested, he supported the ideas to improve access to conservation agriculture machinery at subsidized rates,

the promotion of custom hiring and having large scale demonstrations and training and workshops among the stakeholders.

Amongst the institutional changes suggested, the need for a baseline survey was important as primary data on total production and burning of straw is essential for researchers, farmers and policymakers. He added that a carbon credit scheme for farmers using conservation agriculture and not burning residue should be adopted.

Dr. Ahmmed agreed for the need for awareness creation about the negative impact of crop residue burning on human health and environment through media campaigns and community programmes, establishment of self-help groups and encouraging unemployed youth to be involved in custom hiring of CRM machineries.

With regard to other technical interventions, Dr Ahmmed supported the promotion of 2G biomass-based ethanol plant in PPP mode. He also suggested to explore the use of mature or suitable technologies that are available in developed or other developing countries for use in this region.

Ms. Juliana Albertengo, Coordinator for Black Carbon Mitigation — Agricultural Open Burning, International Cryosphere Climate Initiative, USA felt that any interventions undertaken should have a focus on long-term sustainability. Changing agricultural practices is a cultural/paradigm change which required time for farmers to get habituated. Outreach and training of farmers should take care that they do not lose sight of the goal and return to burning.

From her experiences in Latin America, the mapping of fires through satellite images can give a lot of information on what is being burned. Fire maps that are created on a regular basis can help to identify location of fire spots, the density of burning and help to understand whether burning is related to specific crops or certain events for a specific year. Looking at such maps over a number of years can provide information to better understand the situation of crop residue burning.

Dr. Rajbir Singh mentioned the need to have all stakeholders involved in the process of solving the issue of crop residue burning. He shared a successful practice being conducted in India of developing learning sites near farmers' fields. He added that capacity development, sharing of success stories, and having strong partnerships are important. He particularly emphasized information and communication technology (ICT) use as crucial as it can support quick changes.

Q3: What are the key risks and challenges that you see in the implementation of the 'Action Plan', and/or the 'Common Framework for Sub-regional Cooperation'?

Dr. Sultan Ahmmed highlighted that in the case of Bangladesh, straw burning is not currently a major problem. As such, actions proposed for the harmonization of testing of CRM in the region and exploring policy harmonization for adoption of CRM machinery are important although they may have challenges in Bangladesh. An international programme for developing awareness of potential problems that countries such as Bangladesh may face in the future is needed.

Ms. Juliana Albertengo reiterated that sustainability is one of the most common issues for long term. She also mentioned that field trials are vitally important so that farmers can see and gain first-hand experience on practices such as conservation agriculture or use of agricultural machinery. In addition, adaptation of machinery to local contexts is important. Machines that have been developed may work

well in the areas where they are built, but when they are used in other locations some adaptation may be necessary.

Q4: What is the role of a regional United Nations entity like the Economic and Social Commission for Asia and the Pacific (ESCAP), or its Centre for Sustainable Agricultural Mechanization (CSAM), in promoting such cooperation?

Dr. Muhammad Azeem Khan began by complementing the quality of the subregional report that has been developed. The report has synthesized the issues and prospects for ex-situ and in-situ management based on the findings of experts and experiences from the respective countries. Dr. Khan noted that there was a lot of potential for biochar to provide a sustainable and long-lasting solution to the issue, but it requires strategic investments.

The report as well as interventions made by the panellists have identified various gaps that need to be addressed. ESCAP and CSAM can develop an organized and comprehensive programme which can be shared with national governments and find support from donors. He stated that conservation agriculture requires attention as it has potential for increasing productivity, reducing production costs, and increasing profitability that will contribute to poverty alleviation.

He felt that forums such as this one should continue to be held as they can present the case to national governments, develop consensus, share international know-how and success stories.

Mr. Jawed Alam mentioned that CSAM is already playing an important role in facilitating regional cooperation, sharing experiences and organizing study tours to control crop residue burning. While there are country-specific plans being developed, ESCAP and CSAM can help to develop regional policies as this issue of crop residue burning cannot be solved by individual countries alone. ESCAP can also provide a platform for discussion of common problems and solutions, help in conducting surveys of the crop residue status and level of burning of different countries, and support sharing of technology and machinery as is being done in pilot projects which are demonstrating in-situ and ex-situ management practices.

Ms. Sandra Corsi noted that straw burning is an issue with economic, health and food security externalities and ESCAP's work to give visibility on this issue was important. ESCAP should continue to facilitate cooperation on crop residue management and ensure an inclusive approach to its interventions. The establishment of a network of organizations and agencies that can provide technical and policy support to fit the needs of countries was mentioned. This network should go beyond the agriculture sector as off-farm solutions to the management of straw exist and coordination amongst sectors was fundamental. The development of resilient and efficient cropping systems is core to FAO's mandate and she welcomed collaboration with ESCAP to promote sustainable residue management. For both the on-farm and off-farm solutions that exist, access to the right equipment is pivotal and knowledge of good management practices based on direct seeding and mulching is essential. FAO stands ready to collaborate with ESCAP to co-formulate recommendations for a subregional roadmap for crop residue management.

Based on the discussions, some key messages emanating from the panel session included:
1) Importance of **making sustainable straw management economically attractive** and profitable for farmers.

2) Importance of **availability of data and analytical studies** to provide a foundation for designing effective interventions.
3) Need for **sharing of knowledge and practices** as well as **building capacities** at the institutional and farm levels.
4) Need for **sustainability** in the long-term to be considered for all interventions.
5) Need for **alignment of agriculture policies** or development of a dedicated policy for straw burning to ensure that straw management is prioritized and supported.

5. Closing session

Dr. Rajan Sudesh Ratna, Deputy Head, ESCAP-SSWA thanked all the presenters, panellists and meeting participants for the comments provided on the national studies and subregional papers. This feedback would help in the finalization of the papers and provide useful insights for subsequent policy and advisory work. Dr. Ratna added that despite the recognition by governments and efforts made to manage crop residues, there are still gaps that exist in resolving the problems faced. The discussions and issues raised in this meeting would help in narrowing down areas of intervention that ESCAP can engage in to fill the gaps in sustainable management of crop residues.

Annex I: Meeting programme

Crop Residue Management in South Asia

Advancing Subregional Cooperation for Sustainable, Climate-smart and Integrated Management of Crop Residues

15 September 2022
13:00 – 15:00 (Indian Standard Time)

Hybrid mode
Venue: ESCAP Subregional Office for South and South-West Asia (SSWA)
New Delhi, India

Final

Programme

15 September 2022	
13:00 – 13:10	**Welcome and Opening** Ms. Mikiko Tanaka, Director and Head, ESCAP-SSWA Ms. Yutong Li, Head, CSAM
13:10 - 13:40	**Presentation of national studies (7 minutes each)** Moderator: Mr. Takashi Takahatake, Economic Affairs Officer, ESCAP-SSWA (Each presenter will highlight the main findings and recommendations of their study) ***Bangladesh*** *Dr. Md. Israil Hossain, Agricultural Engineer & Former Director General Bangladesh Wheat and Maize Research Institute* ***India*** *Dr. C R Mehta, Director, ICAR- Central Institute of Agricultural Engineering* ***Nepal*** *Mr. Madhusudan Singh Basnyat, Agricultural Mechanization Expert & Former Deputy Director General, Department of Agriculture, Government of Nepal* ***Pakistan*** *Dr. Shabbir Ahmed Kalwar, Agricultural Engineer & Former Director/ Chief Scientific Officer, Pakistan Agricultural Research Council* **Q&A**

13:40 - 14:55	**Panel discussion on building subregional framework for cooperation and the areas for cooperation** Moderator: Mr. Anshuman Varma, Programme Officer and Deputy Head, CSAM **Presentation by (15 minutes):** *Dr. C R Mehta, Director, ICAR- Central Institute of Agricultural Engineering, India* **Panel Discussion** • **Dr. Sultan Ahmmed,** former Member Director, Natural Resources Management, Bangladesh Agricultural Research Council, Bangladesh • **Dr. Rajbir Singh,** Director, Agricultural Technology Application Research Institute, Ludhiana, India • **Mr. Jawed Alam**, Associate Professor and Head, Department of Agricultural Engineering, Tribhuvan University, Institute of Engineering (IOE)/Purwanchal Campus Dharan, Nepal • **Dr. Muhammad Azeem Khan**, former Chairman, Pakistan Agricultural Research Council, Pakistan • **Ms. Sandra Corsi**, Coordinator of Projects on Conservation Agriculture and Climate-Smart Crop Production Intensification, Plant Production and Protection Division, Food and Agriculture Organization of the United Nations • **Ms. Juliana Albertengo**, Coordinator for Black Carbon Mitigation — Agricultural Open Burning, International Cryosphere Climate Initiative, USA **Open discussion**: Questions/comments from floor
14:55 - 15:00	**Closing session** Dr. Rajan Sudesh Ratna, Deputy Head, ESCAP-SSWA

Annex II: Actions proposed for addressing crop residue burning in South Asia

Mechanization-based Interventions	• Promotion of CRM machinery through promotion of conservation agriculture (CA) practice • Development of small tractors/power tiller operated CRM machinery for small farmers • Development of multi-functional CRM farm machinery – increase use • Improve access to CA machinery at subsidized rates, promote custom hiring system and provide soft loans to purchase implements • Large scale demonstrations, trainings and workshops
Institutional Interventions	• Conduct surveys to collect information on availability, utilization and surplus straw resources • Need of crop residue management policy for rationalizing various issues • Develop mechanism for crop residue biomass aggregation • Carbon credit schemes for farmers using CA and not burning residue • Enforcing appropriate legislation on prevention of burning through incentives and deterrence
Socio-economic Interventions	• Bio-gas production from crop residues at domestic/community level (Bringing back fertilizer to field) • Awareness creation about negative impacts of crop residue burning on human health and the environment through media campaigns and community programmes • Capacity building on adaption of conservation agricultural practices • Establishing self-help groups and encouraging unemployed youths to take up custom hiring of CRM machineries as a profession
Other Technical Interventions	• In-situ management is to be supplemented with ex-situ management techniques • Biomass pellets from crop residues for fuel substitution in thermal power plants • Industrial level production of Bio-CNG/Compressed Biogas (CBG) from paddy straw • Incentivise power generation from biomass • Promote 2G biomass-based ethanol plants in PPP mode.