

FIRES IN AGROFORESTS - A CASE STUDY OF POPLAR BASED AGROFORESTRY

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ABSTRACT

Agroforests are the major source of wood production in India and also suffer damage from fires like forests. There are numerous causes of fire viz., burning of agriculture waste and left over tree parts inside and around agroforests, spread of fire from burning of agricultural residues from the adjoining fields, accidental fires due to spark in transmission lines and machinery operated on farm land, mischief by others etc. The paper presents a case study of poplar based agroforestry (PBAF) which is extensively practiced in the Indo-Gangetic plains of northwestern states. Poplar is highly sensitive to fires and it is affected even from distant fire flames. The damage varies from a little check on growth of trees/saplings to complete mortality of trees and damage to agriculture crops. Fires damage to PBAF could be controlled by safe disposal of agriculture residue from within and around agroforests, creating a deep ploughed fire line between agroforests and adjoining fields where agriculture residue is put on fire, counter firing from the side of agroforests, ploughing crop a little away from the fire to save the rest of the agroforests, hiring fire tenders and beating the fire with green foliage

Key words: Agroforests, Fire, Causes, Damage, Control measures, PBAF.

Introduction

Indian Forest Policy, 1988 has emphasized for the conservation of forests for preservation of biodiversity, land, soil and environment. It also categorically advised the wood based industry not to depend for raw material supply on the government forests and to grow wood raw material by developing synergies with the farming community. It led to emergence of a new form of land use in the form of commercial agroforestry where farmers started growing trees in association with normal agricultural crops on their agriculture fields. According to an estimate around 5 million ha area is under commercial agroforests in different parts of the country (Dhiman, 2013). According to numerous estimates timber availability from government forests is now reduced to 2 to 3 million cum and the major portion of it is now procured from agroforests and some from imports (Dhiman, 2015). Production forestry has thus now shifted to agroforests where trees and agriculture crops are grown together on the same land.

Poplar based agroforestry (PBAF) is one of the dominant land uses in parts of northwestern states of Punjab, Haryana, Uttar Pradesh, Uttarakhand and some other adjoining states. According to a recent estimate

around 0.3 million ha is under poplar culture mainly in the form of PBAF (Kumar and Dhiman, 2015). It is one of the ideal land uses that incorporates multiple cropping system integrating a large number of cereal and other crops with trees for the greater period of their retention on the same land. Dhiman (2013) diagnosed the intercrops grown in PBAF through a survey covering a greater part of its culture in Indo-gangetic plains. The author reported that based on total poplar planted in the country, Uttar Pradesh leads with 36.59% of block plantations followed by 30.05% in Punjab, 14% in Uttarakhand, 13.72% in Haryana and 5.62% in other locations. Punjab plants maximum poplar in compact blocks (85.49% of the total poplar planted within the state) followed by Haryana with 64.89%, Uttar Pradesh with 54.59%, Uttarakhand with 45.07% and others with 33.33% share in block plantations. The remaining poplar in each state is planted on field boundaries.

Like forests, agroforests are also subjected to damage from number of biotic and abiotic agents of which fire is one of the major causes of damage to both the trees and agricultural crops (Fig. 1). World over, forests and agriculture are the major land uses and sources of fire related emissions. Fire from agriculture sector contributes nearly 2020 Tg (Approx. 25% of the total biomass burnt)

Agroforests, like forests, are also prone to fires which cause heavy economic losses to growers.



Fig. 1: Fire in PBAF (left bottom), foliage burnt scattered mango inside field (left top) and fire burnt boundary eucalypts plantation.

(Adreae *et al.*, 2001; Chang and Song, 2010). Fires in agroforests also cause nutrient and resource loss. According to IPCC (2006), 25% of the crop residues are burnt on farm. The problem of burning agriculture residue has increased on introduction of mechanization in which only the economic component of the crop is harvested and rest of the vegetative components of the crop is put on fire (Gupta *et al.*, 2003). According to Jain *et al.* (2014) burning of 98.4 Mt of crop residues led to the emission of 8.57 CO, 141.15Mt of CO₂, 0.037Mt of Sox, 0.23 Mt of NOx, 0.12 Mt of NH₃ and 1.46 Mt NMVOC, 0.65 Mt of NMHC, 1.21 Mt of particulate matter for the year 2008-09. CO₂ accounted for 91.6% of the total emissions, out of which rest (8.43%) 66% was CO, 2.2% NO, 5% NMHC, and 11% NMVOC. Burning of rice straw contributed the maximum (40%) to the emission followed by wheat (22%) and sugarcane (20%). Highest emissions were from Uttar Pradesh, accounting for 23% followed by Punjab (22%) and Haryana (9%). Since lakhs of farmers are engaged in the practice of agroforestry over a large area, the environmental and economical losses due to fires are of a serious concern. The paper identifies the causes, damage and management of fire in agroforests with special reference to PBAF.

Causes of fires in agroforests

Burning of agriculture residue: Fires in forests and agroforests have many similarities. Whereas; fuel load, weather conditions especially extremely warm conditions, and mischief by some bad elements remained the same in both cases, deliberate use of fires to burn the agriculture residue remain the major factor of fires in agroforests.

Poplar is one of the ideal trees for agroforestry in India. There is a large list of publications those advocate

growing of different agriculture crops in PBAF. Farmers generally grow sugarcane in the initial two years as an annual crop and wheat thereafter throughout the retention of trees in agriculture fields. In a detailed field survey conducted throughout the poplar growing region, Dhiman (2013) concluded that 97.73% of the farmers grew agricultural crops in PBAF. Approximately 96% farmers grew winter crops in the first three years and this figure decreased to 93.61% in 4th year, 84.33% in 5th year, 62.64% in 6th year, 23.58% in 7th year and 14.71% in 8th year. Whereas, 80.45% farmers grew summer crops in first year which increased to 84.09% in 2nd year and then decreased to 34.77% in 3rd year, 15.98% in 4th year, 9.68% in 5th year, 4.95% in 6th year; and 2.83% in 7th year. Wheat emerged as a major crop grown maximum times (51.67%) followed by sugarcane (29.81%), fodder (6.75%), maize (2.69%), bajra/jawar (1.97%), paddy (1.49%), dhencha (1.14%) and others (4.68%) when both summer and winter crops were considered collectively.

Agriculture residue is the major biomass left after harvesting the economic components i.e., grain etc. and generated in the form of cereal straw, woody stalks and sugarcane leaves/tops and root stumps. In addition; lops, tops, roots and foliage from trees on their harvest along with agriculture residue are burnt on the farm itself for their easy and low cost mean of disposal. Many a times, fire also spreads from the adjoining fields and engulfs trees and agricultural crops and/or residues inside the agroforests. The major agriculture residue burnt in PBAF are sugarcane trash in young plantations, wheat straw in all ages of plantations and paddy straw within and around PBAF. As the interval between harvesting of old crop and sowing of new crop is very short and the natural processes of decomposition takes longer period, the farmers opt for its burning as a quick and easy way to prepare fields for the next crop.

Fires sparked from electric transmission lines and machinery: Such fires are common during summer months when wheat and sugarcane are mature and many fields catch fires from transmission lines passing over the fields having agriculture crops alone or agroforests. In agroforests, the tree's canopy invariably touches the transmission lines and sparks ignite the fire. Some cases have also been recorded when tractors and other machines used in harvesting of crops caused sparks and fire in agroforests. Such fires are quickly controlled by the persons operating machinery as they are detected early and thus the damage is low.

Mischief to burn mature agriculture crops grown in agroforests: Some cases have been noticed in the poplar growing region where some bad elements settle their scores by putting the crops grown with or without poplar, of their enemies, on fire. These fires may be ignited during odd hours when the owner may not be able to control them immediately.

Fire damage

Agroforests are multiple cropping land uses and hence they provide a barrier of green vegetation against the spread of the fires on the dried crops. Small land holdings provide diversity in production systems including scattered-ness and variety in agroforests and hence fire and their damage is restricted to a few fields. In trees, there is a wide variation to the fire resistance/susceptibility, some trees like old shisham, mango, acacias etc showing high resistance while many others especially at younger age are highly sensitive to fires. The affect of fires on agroforests depends on the season, tree and crop type, their age, stage of growth and other factors. The damage to trees and intercrops grown thereunder increases with the increase in intensity of fire, and fuel load present inside and around agroforests. There are

three types of fires viz., surface, ground, and crown fires recorded in forests. Agroforests, hardly record crown and ground fires. In PBAF, the surface fires are common which are ignited on the seasonally available fuel load from agriculture residue and/or tending operation and final harvest of trees

Poplar is highly sensitive to fires. Even short exposure of abnormally high temperature due to fires may cause irreparable losses to trees. Dhiman (2012) ranked the 25 possible biotic and abiotic agents causing damage to poplar, out of which fire was the 8th major agent. The ranking according to the severity of damage varied from state to state and within states as well. It ranked 6th major agent in Punjab, 5th in Haryana, 7th in Uttar Pradesh and 12th in Uttarakhand.

The major damages and losses to PBAF are depicted in fig. 2. Poplar in natural range occurs in locations where summer temperature goes up to 45°C. Increase in temperature above this limit starts affecting poplar growth and productivity. Fire flames even from a distance exposes poplar to high temperature and its foliage get desiccated, bark and sap wood get damaged which in due course may dry. Such dried stem portions may form scars



Fig. 2: Different forms of fire damages to PBAF and poplar nursery.



Fig. 3: Fire line by ploughing field around poplar nursery (left top), low damage to foliage of poplar nursery from counter fire (right) and ploughing the sugarcane burnt crop in PBAF (left bottom).

and wounds which act as points for pathogen entry and stem breaking during strong winds. When fires are of little higher intensities, the entire plantations may dry. In many cases when above ground portion of trees is dried, coppice shoots emerge from the stem near ground surface which are not able to catch up with the left over trees (Fig. 2). Most cases of fires in PBAF are reported when wheat and sugarcane are grown as intercrops.

Burning of agriculture produce affects air quality by emitting greenhouse gases (CO_2 , NO_2 , CH_4), air pollutants (CO , NH_3 , NO_x , SO_2 , NMHC, volatile organic compounds), particulate matter and smoke (Jain *et al.*, 2014). These affect every organism including human beings. According to an estimate, the total amount of agriculture residue generated during 2008-09 was 620 million tones out of which approximately 15.9% residues was burnt on farm. Rice straw contributes 40% of the total residue burnt followed by wheat straw (22%) and sugarcane (20%) (Gadde *et al.*, 2009).

Control measures

Fires in agroforests cause damage to both crops and trees and hence economic losses to the growers. Though fires in agroforests are not as extensive as they are on forest land due to accumulated fuel load of many years, however, when dried fuel load are present under favourable weather conditions for spread of fire, they do cause extensive damage to the green trees in addition to crops grown thereunder. The following methods could help in checking the fires and their damage.

Enforcing law: In a major portion of poplar growing region summer and monsoon paddy is grown over a large acreage for which fields on its harvesting are quickly prepared by burning the left over paddy straw for another crop. There are legal provisions for not growing summer paddy and for not burning agriculture residue but they are invariably not followed. Punjab and Haryana states enacted the Preservation of the Sub Soil Water Acts in 2006 and 2009 (Annon. 2006, Annon. 2009) respectively which debar transplanting of paddy before 10th June and 15th June respectively. Similarly summer paddy is also grown in greater part of Tarai Region in Uttarakhand and western Uttar Pradesh. Summer paddy is transplanted around April and harvested before monsoon rains. In South India, *eucalypts*, *casuarina* and su-babul pulpwood are debarked inside the fields and later burnt at the site as such or by making heaps on the existing fields. Burning of leftovers of tree parts and agriculture residues need to be restricted for sustaining the productivity of agriculture fields.

Management of crop residue: With mechanization in agriculture major cereal crops like wheat and paddy are harvested using machinery leaving behind the vegetative parts on the farm land. In some crops like wheat, additional straw harvesters are used to harvest and collect the left over straw for sale to paper mills and also as animal fodder. However this is not uniformly collected and is dependent on its price and demand in the market. The old method of manual harvesting such crops near the ground level used to leave very small portion of plant stubs and were not serious threat to fires. The management of residues should be done in a manner not to become a fire hazard.

Use of water: Use of water is the best mean to suppress the fires. However, fire in general occurs in nearly mature agriculture crops and just harvested fields having agriculture residue. In such cases, main irrigation channels should be filled with water as barriers against advancement of flames and possible use for fighting fires (Luna, 2007). Fire tenders should be deployed at strategic locations in the fire season from where agroforests are accessible in the shortest time.

Plough a strip to create a fire line and counter-fire: This practice is *in-vogue* in poplar nurseries and young plantations during fire season when a strip of wide width around such nurseries and plantation is ploughed. Fig. 3 depicts one such case when a strip of twenty five feet was ploughed around a poplar nursery in Jalandhar District,

Punjab during 2016 summers before putting the agriculture residue on fire yet it had affected at least the border line of poplar sapling by desiccating its foliage. In many cases, when sugarcane or wheat fields around and within PBAF get fire, such fire lines are created at a distance so that fire does not spread to new locations.

Beating the fire with brushwood: This is the most common method when fire is of low intensity and the agriculture residue is scattered. The use of this method works well when the fire just starts and is localized. However, in cases of fire engulfing large areas the method fails as brush wood is not readily available nearby and number of persons required for doing this exercise is not readily available. The burnt portion of poplar stem is applied with copper based paste to avoid invasion of insects and diseases.

Conclusion

Agroforest is a land use which has a high degree of human vigilance and intervention as it is a mean of livelihood and life support system for growers. This land use receives a very high degree of cultural, pesticide, weedicide, and fertilizer protection. However, the land use

is also exposed to a number of biotic and abiotic threats and intentional and/or unintentional fires are one of the major threats that erode nutrients, cause damage to the seasonal crops and to tree crops eroding cumulative returns. The damage during the early growth period causes serious concerns as scattered trees exposed to intense fire are seriously affected while many others may still be growing well. Many a times, farmers fail to take a decision to remove the partially leftover trees after fires and/or to replant the fields afresh. In both cases farmers suffer heavy economic losses.

Fire management in agroforests has different dimensions when compared with natural or planted forests. Fires in agroforests are largely dependent on seasonal built up of fuel load due to growing agricultural crops inside and around agroforests. Individual farmers being the owners of agroforests need to pay full attention to prevent fires to their agroforest resources by keeping a close watch and ward, suppress the fires as soon as they are noticed, collect the residue and put it in pits in safe places for decomposition into organic matter, and get both the trees and crops insured against fire damage.

कृषि वनों में अग्नि : पॉपलर आधारित कृषिवानिकी का एक अध्ययन

आर.सी. धीमान

सारांश

भारत में कृषि वन काष्ठ उत्पादन के प्रमुख स्रोत हैं तथा ये वन जैसी अग्नियों से क्षति का सामना भी करते हैं। आग के अनेकों कारण हैं, उदाहरणार्थ- कृषि वनों के भीतर और इसके चारों ओर वृक्ष भागों के अवशेष तथा कृषि अवशिष्टों का दहन, समीपवर्ती क्षेत्रों से कृषि अवशिष्टों को जलाने से आग का फैलाव, फार्म भूमि में संचालित मशीनरी और पारेषण लाइनों में स्पर्क होने के कारण आकस्मिक आग, अन्य द्वारा शरारत करना आदि। इस शोधपत्र में पॉपलर आधारित कृषिवानिकी, जिसे उत्तर पश्चिमी राज्यों के हिन्द-गंगाई मैदानों में व्यापक रूप से व्यवहार में लाया जाता है, का एक केश अध्ययन प्रस्तुत किया गया है। पॉपलर आग के प्रति अत्यधिक संवेदी है तथा यह दूर से आ रही आग की लपटों से भी प्रभावित हो जाता है। क्षति वृक्षों/बालवृक्षों की वृद्धि पर आंशिक नियंत्रण से लेकर वृक्षों की पूर्ण मर्त्यता और कृषि फसलों की क्षति तक होती है। पॉपलर आधारित कृषि वानिकी की अग्नि क्षति को, कृषि वनों के भीतर तथा इसके चारों ओर से कृषि अवशिष्टों का सुरक्षित निपटान करके, कृषि वनों एवं समीपवर्ती क्षेत्रों, जहाँ कृषि अवशिष्ट को जलाया जाता है, के बीच एक गहरी खोदी गई अग्नि लाइन का सृजन करके, कृषि वनों की तरफ से काउन्टर फाइरिंग, शेष कृषि वनों को बचाने हेतु आग से थोड़ा दूर फसल की जुताई करके तथा फायर टेन्डर खरीदकर एवं हरी पत्तियों से आग को बुझाकर किया जा सकता है।

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