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Standard Operating Activities for Poplar Based Agroforestry

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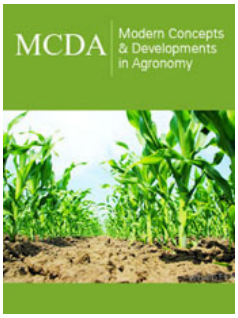

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Abstract

Poplar (*Populus deltoides*) based agroforestry (PBAF) is one of the highly successful and remunerative production system that is significantly contributing towards economically empowering the tree growers. The success of this productive model is based on adopting a set of standard operating activities at every stage of tree growth. In the beginning, promotion and development of PBAF was under Public Private Partnership (PPP) model in which its promoters provided technical know-how through a well nit extension team. With termination of PPP model, poplar culture moved to open marketing system for supply of planting stock from commercial nurseries and for sale of wood from harvested trees to open market channels. Under this transformation, poplar growers, especially new ones remain ignorant regarding the actual and standard operations to be carried out for growing good plantations. Based on four decades experience, the authors compiled the standard operating activities for the full rotation of poplar production and its month-wise activities are presented in this paper.

Keywords: Poplar based agroforestry (PBAF); *Populus deltoides*; Standard operating activities; Plantation age; Intercrops

Introduction

Poplar based agroforestry (PBAF) is one of the highly successful integrated tree-crop production systems that virtually integrates agriculture crops throughout the retention of trees on farmland [1]. It is being practiced in one of highly productive land-use in Indo-Gangetic plains of North India by thousands of farmers for wood production to the wood-based industry. Poplar (*Populus deltoides*) is now grown around 1000 Km from Pakistan border in the west to northern districts of Bihar and around 100Km from the foothills of North Indian Himalayas to south towards New Delhi and central parts of Uttar Pradesh (Figure 1). Some stray plantations of the tree are also grown in other locations including some southern states. According to an estimate around 0.3267 million ha area is under native and introduced poplars in India, out of which 0.312ha area being under *P. deltoides* [2] which is largely grown on farm fields under agroforestry. India raises one of highly productive poplar plantations and many of them (around 90%) are now routinely harvested between 3 to 3.5 years ago with some stray cases of harvesting between 2 years age and around 5 years for peeling log production [3]. The Current Annual Increment (CAI) and Mean Annual Increment (MAI) are found to culminate at around 3 years production cycle (Figure 2) and there is no such parallel example of fast-growing poplar plantations being grown anywhere in any other country [4]. PBAF integrates suitable agriculture crops during different stages of tree growth and the intensive inputs provided to crops are also shared by trees enabling them to grow very fast. Higher net returns from PBAF compared to traditional agriculture productions systems is the main motivational factor for its adoption in the region of its intensive culture (Figure 1). The net economical returns from combined trees and intercrops of PBAF were estimated to be around Rs. 1lakh/acre/year around a decade back [5] which have now increased to Rs. 2 lakh/acre/year as its wood is now being traded at all time high prices [3].

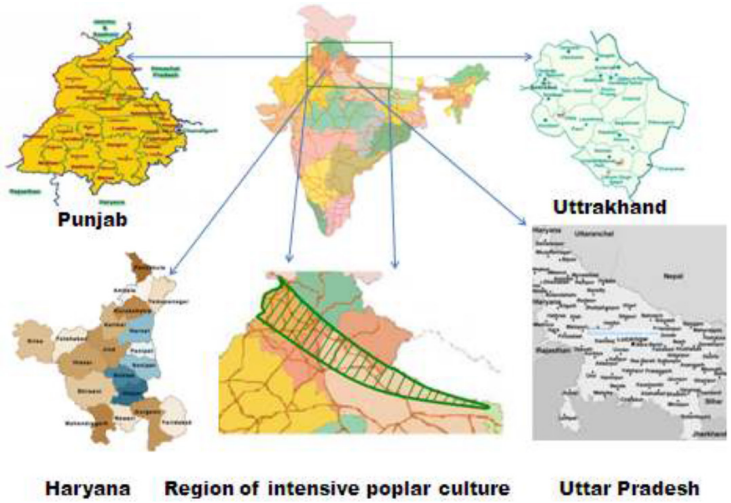

Figure 1: Region of intensive popular culture in India [4].

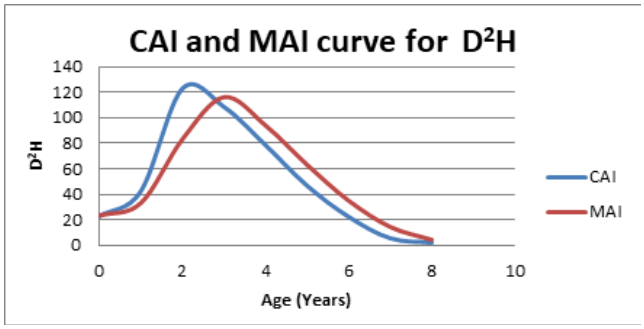

Figure 2: CAI and MAI curve for D_2H for eight years rotation poplar.

Poplar plantations on farm fields were initiated and promoted by the private sector safety match company WIMCO Ltd. for match wood production from mid-1970's and since then it expanded in volume and geographical locations. The tree was initially planted under Public Private Partnership (PPP) model in which company provided technical knowhow, supplied quality planting material, and procured wood on harvest whereas farmers received financial loan from the designated banks which was returned by them from sale of wood proceeds [6]. Poplar culture thus could largely remain a private-private partnership between farmers and its promoter company in the beginning and the knowledge base for raising good quality plantations largely among the select good growers along with WIMCO and its employees. Some families have grown this tree for many rotations and the information on standard operating activities has also been passed on to the next generation, the current being 4th generation now. With expanding poplar culture and termination of PPP model in late 1990's, numerous commercial nurseries mushroomed in different locations which started supplying poplar saplings to the growers. Many new farmers gradually started growing it and a majority of them were lacking easy access to the complete list of standard operating activities. As a result, many of them fail to grow good poplar plantations. This is illustrated in Figure 3 in which poplar was grown by an ignorant grower in paddy fields where it is seen struggling for survival and growth in inundated water. Paddy and chari (*Shorghum spp*) are two crops which are avoided under PBAF. Whereas paddy creates water inundation and chari does not favour agri-operations suitable for good poplar growth besides its root system being highly competitive with tree roots for growth inputs. This paper documented the standard operating activities based on the experience of the three authors who have been deeply associated with poplar farming, R&D, and extension activities for around 4 decades while being in WIMCO Ltd, Wimco Seedlings (ITC-PSPD) and elsewhere from the very beginning and the compiled list is placed in a tabular form.

Figure 3: CA good growing 1 year poplar bock plantation in PBAF (left), and poorly grown 1year old poplar in paddy fields which is not a recommended crop under PBAF (right).

Standard Operating Activities under Different Aged Plantations

Month-wise standard operating activities for growing good poplar plantations for the full rotation period are presented in Table 1 below. Any repetitive activity in subsequent years is explained in the beginning and its reference is cited thereafter to avoid overlapping.

Table 1: Monthly operational activities for all ages of poplar plantations.

Month	Code	Operations
Jan.	**Fresh Year Plantations**	
A	1.1	Ensure booking/availability of quality saplings from trusted nurseries. If you are first time planter, take guidance from the growers making good quality plantations around your site, and accordingly select the nursery.
	1.2	Remove subtle and roots of past crops to avoid disease and pest infection especially termite attack.
	1.3	Start preparing the fields. Deep plough fields with disc plough including cross plough for better soil working.
	1.4	Align the fields for digging pits for planting.
	1.5	Recommended spacing are 15'X15', 14'X14', 13'X13', 12X12', 12'x15', 18'x10', 20'x9' etc. in block plantations and 5 to 10' in boundary plantations
	1.6	Use at least4-6" wide augurs to make 2 to 3' deep planting pits depending upon the size of saplings. Keep the topsoil aside from dug out pits for refilling them during planting.
	1.7	Collect saplings yourself or through your trusted person from the nursery and ensure their uprooting in own presence. Transport them to the planting site by placing paddy straw (pual) inside tractor trolleys to avoid damage to saplings during transportation.
	1.8	Soak at least the lower 1/3rd basal portion of saplings in pits having fresh running water for 24 to 48 hours before planting. Ensure making of soak pits before transporting saplings to the planting site. In case there is delay in planting, always keep saplings in fresh running water and do not allow them to desiccate.
	1.9	Suggest additional soaking base of the saplings in 0.02% Chlorpyrifos immediately before field planting, in case field is having history of termite attack. Make arrangement of 200-liter capacity drum in advance before procuring saplings for treating saplings with Chlorpyrifos solution.
	2	In heavy soils, where there is an apprehension of water stagnation, soak saplings in 0.5% Emisan solution for 5 minutes to avoid root rot and stem rot.
	2.1	Mix the recommended dose of fertilizers in the top field soil (not in dug out soil). Normally 50g Single Superphosphate/sapling is recommended for fresh planting, in case there is normal nutritional status of soil.
	2.2	Put the sapling up-right in the pit/hole, half fill the pit with soil mix containing fertilizers. Planting team should have at least 2 persons, one holding the sapling straight and another filling the soil mix in the pit. The top 15-20cm pit may leave empty without filling the soil. Do not compact the pits.
	2.3	Make water channels along the planting rows to facilitate irrigation. Irrigate the saplings immediately after planting; let the soil of filled pit to allow self-settling with irrigation water.
	2.4	After around 2 weeks, refill the remaining half pit with upper soil and irrigate again. Those saplings which get leaned during this period be straightened during this irrigation.
	2.5	Suggest planting sugarcane or any other intended crop soon after replanting, if not planted earlier. Suggest avoiding paddy, wheat and chari fodder as inter crops in fresh year planting; sugarcane, summer vegetables & mentha are better options. Apply fertilizers for intercrops with a multiplication factor of 1.25 that will serve the nutritional needs of poplar as well.
	Old Plantations	
	2.6	Harvest Sugarcane from last year plantations for its better ratooning (coppicing after harvest).
	2.7	Irrigate the fields on harvesting sugarcane from last year plantations for its better ratooning.
	2.8	Remove plant subtle and debris on harvesting crops and do not put it to fire inside the fields.
	2.9	Prune the old trees to one third height from the base, if not done so far. Remove the competing forked shoot, if any, to avoid formation of double stems in last year's plantation. Also cut extra ordinarily thick branches. Remove the pruned material from the fields. Avoid pruning old trees intended for harvesting during the year.
	3	In 2nd year old plantations, prefer to plant wheat as winter crop if sugarcane has been harvested before November or else grow vegetables or any other local crop during spring and summers. Apply recommended dose of fertilizers for intercrops with multiplication factor of 1.25.
	3.1	In 4th-5th year plantations, suggest to plant turmeric.

Feb.	Fresh Year Plantations	
B	1.1	Complete the operations as mentioned for January month, if not completed during that month. February is better month for planting poplar as it starts sprouting soon after this month when temperature start rising.
	1.2	Provide at least 2 irrigations at 15 days interval to January planted poplar.
	1.3	Observe the planted saplings. If buds in some saplings are drying or turning black, better to replace them during this month itself.
	1.4	Blue bulls cause heavy damage to newly planted saplings. Provide covering of palm leaves/paddy straw around the main stem for protecting them from blue bulls in locations where damage from them is high.
	1.5	Spray solution made with excreta of blue bull & other animals on the 3.0 wide boundary of plantation which has repulsive effect on animals. Farmers also hang small packs of Furadon insecticide covered in cloth on the boundary of plantations. It has a pungent smell and keeps the animal away from plantations
	Old Plantations	
	1.6	Complete the operations as mentioned for January month, if not done so far.
	1.7	Harvest the ratooned (coppiced) sugarcane from 2 years old plantations, its retaining for another growing season not economically viable and not recommended.
	1.8	Don't replant mortality with fresh saplings inside last year's plantations as they remain stagnated due to shade of side trees. If mortality is more, dug out the last year planted poplar rows from the southern side of the field and replace the dyed ones. They match the size of adjoining trees and grow normally.
	1.9	Make fresh plantation of the uprooted line(s) for replacing the mortality. This planted row being in southern direction is hardly affected by shade
	2	Repeat the remaining activities for old plantations as suggested for January month.
Mar.	**Fresh Year Plantations**	
C	1.1	A small window period is available for fresh planting during the start of month, avoid planting once buds start swelling/sprouting. Complete plantations and other activities during the first week of March, if not done so far
	1.2	Replace mortality, if any, as suggested for February month. It could also be done with sprouted saplings maintained in large size polythene bags.
	1.3	Debud lower one third portion of the main stem of planted saplings.
	1.4	Provide 2 irrigations at 15 days interval during the month.
	Old Plantations	
	1.5	Provide 2 irrigations during the month or as per the need of the intercrops grown in the fields especially wheat.
Apr.	**Fresh Year Plantations**	
D	1.1	Debud saplings to remove sprouted buds as suggested for March month.
	1.2	In areas subjected to heavy wind damage, start cutting the main branches around 3' from the main stem (lateral pruning), this will help to narrow down the crown and in decreasing wind pressure on trees and their damage.
	1.3	Provide 2 Irrigations during the month or as required for intercrops. The second flood irrigation in wheat fields is avoided at the end of this month as the crop is near to maturity. In such cases, may provide portable irrigation to saplings if they face water stress.
	Old Plantations	
	1.4	In sugarcane (ratoon) fields of second year plantation, apply hoeing followed by irrigation that helps both poplar and sugarcane to grow better.
	1.5	Provide 2 irrigations at 15 days interval during the month.
	1.6	Apply the recommended doses of fertilizers of integrated crops with 1.25 multiplication factor during irrigation.
May	**Fresh Year Plantations**	
E	1.1	Provide 2 Irrigations at 15 days interval for crops other than wheat.
	1.2	Keep a watch to avoid damage due to fire that may be intensely caused by some mischievous element or from transmission lines crossing over the plantation fields. Wheat fields are prone to fire during this month that causes heavy damage to poplar and intercrops, especially dried wheat.
	1.3	Towards the end of the month slight yellowing of leaves in some plantations is an indicator of water stress due to increasing temperature, irrigate such fields
	1.4	Complete the remaining activities for the month.
	Old Plantations	
	1.5	Provide 2 irrigations at 15 days interval during the month.
	1.6	Apply the recommended doses of fertilizers during irrigation.

June	Fresh Year Plantations	
F	1.1	Repeat the operations of 2 irrigations.
	1.2	Compact the base of the planted saplings before monsoon as they start lodging in sites with impounded water during rainy season, may make small soil mounds around saplings to avoid water stagnation at the base of saplings.
	1.3	Observe saplings for shoot borer, put burnt oil inside holes and plug them with mud.
	Old Plantations	
	1.4	Some plantations start showing yellowing of leaves and in some old plantations wet patches appear on the main stem. These are again signs of imbalance of water in trees as absorbed water does not transpire from leaves during summers and comes out of stem bark. It subsidizes on onset of rains.
	1.5	Provide 2 irrigations at 15 days interval during the month.
	1.6	Apply the recommended doses of fertilizers during irrigation.
	1.7	Make arrangement of ropes as their availability becomes scares during monsoon season for straightening the dislodged trees.
July	**Fresh Year Plantations**	
G	1.1	Wind creates holes around the base of the fresh planted saplings on account of their vibration with wind. Continuous rains may result such holes. May fill them with sand.
	1.2	Dislodged trees may be straightened by tying them with ropes and straitening by pulling opposite to bending.
	Old Plantations	
	1.3	Improve water drainage and general watch and ward.
	1.4	Balance the tree crown by half cutting the branch length and clear the co-leader.
Aug.	**All Plantations**	
H	1.1	Improve drainage and avoid water stagnation in poplar plantations for longer periods.
	1.2	Look for loosening base and holes around sapling stem. Fill them with sand to avoid rot infection.
	1.3	Straighten the saplings that got dislodged with wind, tied them with ropes after straightening.
Sep.	**All Plantations**	
I	1.1	Repeat operations of August based on the need of crops and poplars.
	1.2	Leaf eating caterpillars (*Clostera spp*) start emerging around this month depending upon weather conditions, keep watch and manually destroy the caterpillars by putting them in buckets containing water with some burnt oil to kill them.
Oct.	**All Plantations**	
J	1.3	Keep watch on fires in sugarcane fields planted with poplar. Dry foliage of sugarcane is fire-load that catches fire easily and seldom causes heavy damage to both trees and intercrops.
	1.4	Start preparing fields for wheat sowing which is around the corner during this month.
	1.5	Wheat is the main intercrops grown in poplar plantations second year onward and apply 1.25 times fertilizers in fields with poplars.
	1.6	Some farmers also prune their trees before wheat sowing to avoid damage to germinating intercrop seedlings.
	1.7	Irrigation to sown intercrops will suffice the need of poplar during this lean period.
	1.8	Manually collect the caterpillars to kill them as suggested for October operations.
Nov.	**All Plantations**	
K	1.1	Complete sugarcane harvesting in 1- and 2-year plantations, avoid damage to poplar during sugarcane harvesting.
	1.2	Complete wheat sowing inside plantations.
	1.3	Irrigate fields as per the needs of intercrops, no need for a separate irrigation to poplar at this stage.
	1.4	Prune the trees as suggested earlier, if not done so far.
Dec.	**All Plantations**	
L	1.1	Poplar plantations are started during the last week of December, ensue booking of quality saplings from trusted nurseries.
	1.2	Complete sowing with late varieties of wheat under plantations, if not done earlier.
	1.3	Carry out the plantation activities as suggested for January to March months above.
	1.4	In case of fresh plantations apply irrigation immediately on planting; in old plantations apply irrigation to intercrops which is also available for poplars.
	1.5	Prune the trees as suggested earlier, if not done earlier.

Discussion

The list of standard operating activities provided here is broad based and is followed by numerous good poplar growers. There are many local level innovations/crops being tried by some farmers in some parts of its farming which may need additional and specific intercrop-based activities and inputs. Similarly specific diseases and insect pest infections are treated on a case-to-case basis. Unlike many forest trees planted on forest land, poplars are grown on farmland and their growth and productivity is in consonance with the quality of inputs provided at different stages of tree growth. Limited poplar plantations grown on forest land in Uttarakhand are harvested at 12 years rotation and they produce much less wood even at half the rotation grown and harvested on farm fields [4]. The only difference is that standard operating activities applied for both the trees and intercrops in PBAF help in growing good quality poplar plantations and wood on farmland compared to that in forest land.

Poplar is one of the highly domesticated trees. It suitably responds to cultural and silvicultural operations. If the tree is grown with the proper standard operating procedure, it grows well and thus it needs appropriate inputs for exploiting the biological potential of tree and site. The well trained integrated multidisciplinary extension team engaged during the beginning of poplar culture is now largely missing. With extensive value chain evolved around its production and utilization process [7] has led to shifting of extension mechanism to the background and marketing forces are playing a leading role in its culture and quality. Currently, information is largely exchanged through print and digital media. The standard operating activities enlisted here would be available on digitally accessible publications like this for making better use of the given information by numerous growers for growing good quality poplar production.

Conclusion

PBAF has already established a benchmark of high economic returns compared to other land use options practiced in the region of its growth. Besides, being economically and agro-silviculturally sound practices, PBAF provides a very large number of fringe area benefits from other goods and services generated directly or indirectly. The standard operating activities reported here will help a great deal in producing good poplar plantations in addition to encouraging tree growers to remain engaged in its culture.

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