Silvipastoral Systems in Arid and Semi-arid Ecosystems

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ABSTRACT

The abstract provides an overview of silvi-pastoral systems in India, emphasizing their potential in addressing challenges related to land use, resource management, and rural poverty alleviation. It discusses the importance of agronomic research in optimizing crop-tree combinations for sustainable agricultural production, particularly in arid and semi-arid regions. The abstract highlights ICRAF's diagnostic approach in identifying silvi-pastoral potentials and emphasizes the significance of thorough planning, including seed production, tree selection, layout design, and tree protection. Livestock integration and forage management strategies are also outlined, emphasizing the role of silvi-pastoral systems in providing short-term income, weed management, and nutrient recycling. Furthermore, it stresses the dynamic nature of silvi-pastoral systems, necessitating ongoing monitoring and management to maintain productivity and optimize economic returns. Overall, the abstract underscores the potential of silvi-pastoral systems as a multifaceted approach to sustainable land management and rural development in India.

INTRODUCTION

Agronomic researches- have shown that under specific soil and climatic conditions, planting certall1 combinations of crops and trees simultaneously and/or sequentially can increase efficiency resource use (Gupta and

Gupta 1993). India accounts for about 15% of the total livestock population of the' world with only 2% of the total geographical area. Due to ever Increasing population pressure of human and associated demands, there is little possibility of allocating arable areas for forage production. Therefore, the increase in forage production is expected from the lands otherwise suitable for sustainable agricultural production. Vast tracts of such lands which are suitable for forage production are available in arid and semi-arid regions of the country. In India 12 million ha area. is said to be under permanent pastures and grazing lands but biomass production for this land meagre (Sinih 1989). Similarly, based on the recent surveys, 158 million ha area is classified as wastelands (Singh 1989)

Silvi-pastoral Systems:

Some Crucial Issues: The agro-forestry research and development, whose silvi-pastoral system is an important. Component, is highly useful because rural poor are commonly portrayed as being its primary beneficiaries-. Silvi-pastures. like other agro-forestry based systems is a land use particularly suitable for resource poor marginal lands, even for wastelands. Because such lands are usually owned and cultivated by poor and small farmers and therefore, researches in silvi-pastoral systems should be promoted as a way to improve social equity by increasing productivity of poor lands. Before, initiating any silvi-pasture development programme, thorough knowledge of local socio-ecological environs should be gathered.

ICRAf's diagnosis and design (D and D) methodology has been found highly useful in identifying silvi-pastoral potentials for a particular locality or area or region and this in tum is quite helpful in setting priorities for research. In fact, these are the fundamentals for the success of any silvi-pasture establishment programme. Stand Management:

To manage the silvi-pasture stands. it is absolutely essential to I have clear cut idea of general objectives of the programme-such as to improve the wellbeing of poor people in a defined social and bio-physical circumstances-and also the specific objectives such as to sustain yield at certain level In silvi-pasture research and development programmes it is always assumed that objective is to increase yield.

Seed Production Aspect:

Perennial grasses and tree species often pose seed production problem seed opening, sudden and untimely seed collection and storage, etc., are common problems associated with grass seed production. In case of tree species, light fluctuations in seed setting, seed dormancy, collection and storage problems. poor germination, silvi-pasture development programme and therefore. maximum attention should be given to production aspect of grass as well as of tree seeds.

Planning for silvi pastures Anyone wanting to implement silvi pastures should “build a team and plan, plan, plan.” Seeking advice from those who have implemented silvi pastures, working with others who have expertise in trees, forages and livestock, and getting feedback from those who contribute to the farm operations (e.g., custom applicators) can save time, money and frustration. Consideration, too, must be given to layout, compatibility with forage species, appropriate protection from livestock and equipment, and long-term management needs.

Tree selection

Tree selection is critical because, as one Virginia forester says, “You can grow almost any tree almost anywhere for a period of time – but not necessarily well.” As much as possible, trees should complement the farm operation, not compete with it. Typical attributes for tree selection include marketable

timber, high-quality wood, rapid growth, deep-rooted morphology to reduce competition with forages, open canopy to allow more light to the forage understory, early leaf-out and late leaf-drop dates, drought tolerance, production of additional products (e.g., nuts, fodders, pine straw) and provision of environmental conservation services. Other important criteria include cost, labour, site suitability, resources required for establishment and management, and the land's tenure constraints. Because no tree species will meet all of these criteria, selection should be a "best match" with the producer's goals and resources. For many, trees will first be part of an animal comfort strategy – to relieve heat stress in summer or to provide windbreaks and shelter in winter – or as secondary feed sources. Others may be as interested in tree products, whether marketed as commodities (e.g., pine straw or greenery, nuts or fruits) or as value-added goods (such as wreaths, ciders, acorn-fattened or apple-fattened hogs) Patidar *et al*., (2017).

Creating wildlife habitat for hunting leases is another common goal. Of course, these aims are all academic if on-the-ground resources such as soils or climate aren't amenable to a producer's trees of interest. Combining different tree species may be a useful practice that can serve multiple functions. Planting rows of conifers on either side of hardwood timber trees can provide a windbreak and simultaneously force the hardwoods to adapt a straighter and less spreading growth form, thus reducing pruning Rao, A.S., *et al*., (1997).

The conifers may be harvested for pulpwood, providing much earlier returns to the system than possible with hardwoods alone. Mixed plantings also may be useful where trees have complementary or off-setting features. For example, black walnut trees have long rotation times and release compounds that are detrimental to legumes. Thus, planting several black locusts between the walnut "leave" trees within rows could offset the negative effects to clovers because the locusts fix nitrogen and reach harvesting size at an earlier age.

Layout

Planning the silvi pasture layout should not be underestimated. Tree planting density and spatial arrangements will vary based on the amount of shade the species casts or the water required. Layout also should consider prevailing winds, animal movement, infrastructural needs and aesthetic appeal. Clumped arrangements can be visually appealing and beneficial for some tree species, but most plantings are laid out in rows. Thus, row orientation becomes an important factor for optimizing light to the forage understory, with north-south rows preferred at mid-to-higher latitudes, and east-west orientations favoured at low latitudes. However, this must be balanced with other considerations. For instance, layout must accommodate rotational grazing and appropriate feeder and waterer placements, which are essential parts of good silvi pasture management. And to avoid serious headaches, designs also must account for future tree growth and leave room to move or turn around equipment in the field (Yadav, M.S., *et.al.*,1997).

Tree protection and management

Tubes rarely are used to protect conifer seedlings. Given low costs of the seedlings, high tree density per acre and lower levels of predation, this would seem uneconomical in most cases. In contrast, tubing a hardwood tree typically is standard practice. Whether this truly is needed likely depends on predation pressure, but risk of herbivory by rodents, deer or livestock typically is high, especially with low-density plantings. Once the trees grow out of the tubes, a single hot wire can be positioned about 3 feet from the tree row, allowing cows to graze near the tree but not to browse the tree itself.

A three-dimensional fence may be adequate to keep deer at bay. Keeping the wires high enough to allow sheep or calf access also can be effective for vegetation management. Of course, if fencing is not an option, it may be best to make hay in the alleys until the trees are of adequate size to integrate with livestock. Consider livestock class, age and condition as well as tree types when making protection decisions. Some studies have shown that mama cows won't browse slash-pine seedlings if they have adequate forage, and trampling losses may be offset by the savings from not protecting the trees. However, young steers have been observed making a game of pulling newly planted pine seedlings from the ground, and bulls will "walk down" sizeable pine trees to get a belly rub.

Establishing silvopasture

Silvi pasture systems can be established in one of two ways by: 1) thinning existing woodland, or 2) planting trees on existing pasture. The former requires thinning of trees to a level that supports forages, and requires removing trees to create corridors. The latter involves planting of single or double rows of trees with forage corridors between them or in groups or blocks (non-linear plantings).

From Woodland to Silvi pasture Site Preparation:

Faroda *et al*., (1997) stated that thin the stand to reduce its canopy density to establish forage. Tree density must vary based on existing woodland. The goal is to increase the light levels to 30-50% that of open pasture. Light penetration required depends upon the shade tolerance of the forage species selected.

- Work with a Forester to select the highest quality trees to maintain as crop trees.
- Remove slash. Use an herbicide or goats to remove unwanted weedy vegetation from the area.
- Prepare the site for seeding as soon as possible after thinning or harvesting so undesirable herbaceous vegetation does not have a chance to invade the site.

Forage Establishment:

- Seed immediately to give forage seed an advantage over unwanted weeds A fall or dormant seeding before ground freezes is advisable. Consult your Agronomist or Grazing Specialist for appropriate forage to use.
- Using standard grass establishment techniques may not be appropriate for silvipasture. Instead, use alternative grass establishment approaches such as hand broadcast seeding using an ATV or hand, and have cattle work in the seed to allow seeds to contact on the soil.
- Manage understory vegetation to facilitate the establishment of the desired forage crop through browsing, mechanical treatment or herbicide application.
- Control noxious weeds or invasive species if present in the area.

Livestock

Livestock used silvi pasture systems include cattle, sheep, goats, horses, turkeys, and chickens. Livestock in silvi pasture can:

- Provide short term income
- Help manage weeds and tree-forage competition
- Reduce fertilizer needs by recycling soil nutrients.

Forage

The level of forage production in a silvi pasture depends upon

- The established rotational grazing system, the tree species, spacing and age, Forage species and shade tolerance The tree canopy density must allow sufficient light to reach the understory in order for forage crop to flourish. Reducing tree density, managing tree spacing and pruning adjust light. Forage Species Selection

The forage crop in a silvopasture must:

- Be suitable for livestock grazing and be able to meet the nutritional needs of the chosen livestock.

- Be compatible with site.

Some additional considerations

Silvi systems are dynamic and change (and will require input) over time. Maintaining adequate light to the forage understory may require thinning or pruning – but this can have other benefits. For instance, trees with clean boles can have substantially greater timber values when premiums are available for high-quality logs, and removing small limbs can be done fairly readily during the off season. Although economic analyses are limited, greater returns generally accrue to silvi pasture systems that incorporate routine tree maintenance.

CONCLUSIONS

In conclusion, the introduction highlights the critical role of silvi-pastoral systems in addressing the complex challenges of land use sustainability, resource management, and rural poverty alleviation in India. It emphasizes the findings of agronomic research, which demonstrate the potential benefits of integrating crops and trees in specific soil and climatic conditions to enhance resource efficiency. With India's limited arable land and increasing population pressure, the promotion of silvi-pastoral systems becomes imperative to meet the growing demands for forage production. The introduction underscores the importance of thorough planning and knowledge gathering, particularly regarding local socio-ecological contexts, in initiating successful silvi-pasture development programs. Furthermore, it highlights key issues such as seed production, stand management, tree selection, layout design, and tree protection, which are essential for the effective establishment and management of silvi-pastoral systems. Overall, the introduction sets the stage for exploring the intricacies and potentials of silvi-pastoral systems as a sustainable land management strategy with multifaceted benefits for rural communities and ecosystems in India.

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