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Theme 2. Grassland production and utilization
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Forage production in peach based hortipastoral system in Indian Himalaya

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Introduction

The North West Himalayan region (NWHR) exhibits a great diversity in geology, physiography, climate, socio-ecology and land use pattern and supports vast livestock population. The annual average rainfall varies from 80 mm in Ladakh to over 2000 mm in some parts of Himachal Pradesh and Uttarakhand. Livestock rearing is an integral part of hill agriculture. The huge animal population (190 lakh) and poor fodder availability (30 to 40 % of the requirement) has widen the gap between demand and supply of forage crops in the region. The area under permanent pasture and grasslands in NWHR is said to be of 15.8 lakh ha and a major portion of it is located in Himachal Pradesh (HP). Considerable area is under grazing lands and but on the whole their productivity (quantity and quality-wise) is rather poor and is continuously deteriorating. The availability of green grasses during winter season is practically nil due to severe winter and burning of forest (Bisht and Yadav, 2014). Thus, livestock is facing acute nutritional stress due to shortage of nutritional fodder and high cost of concentrates.

The commonly preferred horticultural based agro-forestry systems are agri-horticulture, silvi-horticulture and silvipastoral in the NWHR. Various studies showed that peach (*Prunus persica* L.) which belong to family Rosaceae can be intercropped with crops and grasses in Himalayan region. Turmeric performed better than ginger in the peach garden (Arora and Mohan, 1986). The perennial vegetation have been the primary source to rejuvenate productivity of land through recycling of nutrients and make soil physico-chemical properties favorable for plant growth. Farming system approach integrating all the components *viz*., soil-plant-fodder-animal management is necessary for the economic well being of the inhabitants. Hence, it is suggested to develop hortipastoral systems/models by introducing pasture and foliage component under fruit trees so as to provide nutritious green forage and foliage (Pathak and Roy, 1994) to animals for getting higher production from unit of land in rainfed areas.

Hortipastoral system, where in the inter spaces between fruit trees species are utilized for cultivation of grasses and grass legume mixtures. Winter grasses *i.e.*, Perennial rye, Tall fescue, Grassland manava and Hima are grown in Sikkim, J&K, HP, Nilgiri hills and Kumaon and Garhwal hills of Uttaranchal. Under irrigated conditions it can also be grown successfully in subtropical region as winter forage. These grasses are extremely resistant to cold and frost, a good crop can be raised between 1800 to 2500 m altitudes, but in mid hills its cultivation is feasible under irrigated condition. Hortipastoral is a fodder production system to meet the acute shortage of fodder, to improve the soil and to increase the farmer's income. This will combine horticultural trees, grasses and use of wasteland for fodder production. Therefore, the production techniques for ensuring green fodder supply during winter months, and total fodder supply for the larger period of the year by adoption of hortipastoral system with improved grass species needs to be exploited.

Materials and Methods

The study was conducted during 2012 and 2013 at experimental farm Hawalbagh (29^{o} 36' N and 79^{o} 40' E, 1250 m amsl) of Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, India. The climate of this region is sub-temperate and temperature ranges between 32^{o} C. during summer and the minimum temperature from below freezing during winter. Average annual precipitations range 1000 to 1100 mm with 96 + rainy days and mean annual relative humidity is about 79%. About 70% of rainfall is received from June to September and the remaining from October to May. The soils of the experiment sites were sandy loam. The peach trees were planted in 2007 at a distance of 3.0 m from plant to plant and 6.0 m between rows. Treatment combinations include winter grasses *viz*., tall fescue, perennial rye, grassland manava and hima-14 grown under tree and in open conditions. Winter grasses grown with recommended practices and irrigated whenever required. All the treatments replicated three times and factorial randomized block design was followed for the statistical analysis.

Results and Discussion

Green forage yield: In hortipastoral production system four Rabi *viz*., perennial rye, tall fescue, hima 14 and grassland manava grasses with and without peach tree were grown for utilization of marginal land. Grassland manava produced significantly higher mean green forage yield (284.1 q ha^{-1}) followed by perennial rye under peach tree, while in open perennial rye gave higher mean green forage yield (299.6 q ha^{-1}) which was at par with the grassland manava (294.7 q ha^{-1}) (Fig. 1). Grassland manava produced significantly higher green forage yield under peach (282.8 q ha^{-1}) and in open (325.4 q ha^{-1}) conditions by perennial rye during *Rabi* 2012-13 followed by perennial rye and Grassland manava, respectively, while during *Rabi* 2013-14 Grassland manava gave significantly higher green forage yield both under peach (285.45 q/ha) and open (294.95 q/ha) followed by perennial rye.

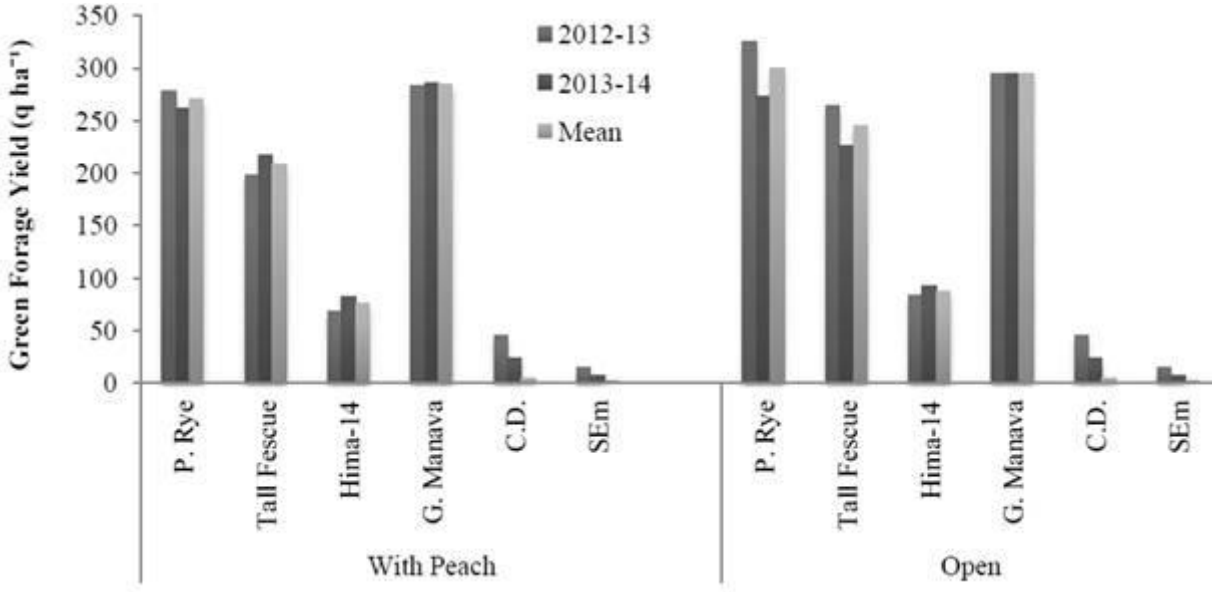

Fig. 1: Green forage yield (q ha^{-1}) of winter grasses in peach based hortipastoral production system

As shown in Table. 1, significantly higher mean green forage yield obtained in without peach (232.7 q ha^{-1}) compared to with peach tree (207.8 q ha^{-1}). Among grasses perennial rye and grassland manava produced (287.2 & 287.6 q ha^{-1}) green forage, which was at par to each other but significantly higher than tall fescue and hima 14 grasses. In *Rabi* 2012-13, significantly higher green forage yield obtained without peach tree (241.8 q ha^{-1}) as compared to with peach tree (207.1 q ha^{-1}) and among grasses perennial rye yielded highest green forage (302 q ha^{-1}) which was at par with grassland manava (288.6 q ha^{-1}). During *Rabi* 2013-14, highest green forage was produced without peach tree (221.7 q ha^{-1}) which was at par to with peach tree (211.8 q ha^{-1}). The results are in conformity to the findings of Welker and Glenn (1990).

Table 1: Green forage yield (q ha^{-1}) as affected by growing condition and grasses

Treatments	**Green Forage Yield (q ha^{-1})**		
	2012-13	**2013-14**	**Average**
A. Growing condition			
With peach	207.1	211.8	207.8
Without peach (Open)	241.8	221.7	232.7
C.D.	22.6	11.7	2.6
SEm	7.4	3.9	0.8
B. Grasses			
Perrenial Rye	302.0	267.7	287.2
Tall Fescue	231.2	221.5	224.8
Hima-14	75.9	87.5	81.3
Grassland Manava	288.6	290.2	287.6
C.D.	32.2	16.8	3.7
SEm	10.5	5.5	1.2

Growth and yield of peach: The highest height growth, girth and number of branches per plant were recorded (397.7 cm, 35.9 cm & 5.2) in perennial rye plots, whereas wood yield (7.9 kg/plant) was obtained with tall fescue plots (Table 2). Macrae *et al*., (2007) also studied influence of grasses on the peach growth and yield.

Table 2: Peach tree growth and yield parameters with grasses

Treatments	Height (cm/plant)	Girth (cm/plant)	Branch (No./plant)	Wood yield (kg/plant)
Perennial Rye	397.7	35.9	5.2	5.2
Tall Fescue	376.3	32.5	4.2	7.9
Hima-14	313.3	28.4	5.0	3.6
Grassland Manava	374.7	29.5	4.8	5.2

Conclusion

The inter spaces between peach tree can be utilized for forage production during winter season by integration of winter grasses *viz*., perennial rye and grassland manava. This peach tree based hortipastoral system will help in reducing unavailability of green grasses due to severe winter in Indian Himalaya.

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