The Bioscan 15(2): 219-223, 2020
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

IMPACT OF CROPPING PATTERN ON BIOMASS PRODUCTIVITY AND FARMING COMMUNITY OF COLD DESERT AGRO ECOSYSTEM OF HIMACHAL PRADESH

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KEYWORDS
Agro ecosystem
Cash cropping
biomass production
Farming community

Received on :
25.03.2020

Accepted on :
13.05.2020

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ABSTRACT

The present investigation was conducted during 2011 to 2013 to study the impact of cropping pattern on biomass production and farming community of cold desert agro ecosystem of village Goshal, located in Lahaul and Spiti district of Himachal Pradesh, India. Study was carried out by dividing the agro ecosystem into nine different grids for sampling following quadrate method. We calculated the Biomass production and input output ratio of traditional crop (barley) and cash crops (potatoes and peas) and found major differences between the two. Potato showed the maximum total above ground and belowground biomass (3.50 kg/m^2), pea (4.42 kg/m^2) and least was found for barley (1.66 kg/m^2). Input output ratio for potato was 1:3.47 with total inputs and 1:6.12 without labour and FYM cost. The input and output ratio for pea crop was 1: 2. 43 including all the inputs and it was 1:4.76 if labour and FYM cost is excluded which is still higher than potatoes. For barley it was 1:1.29 (if labour and FYM cost is added), hence less profitable than cash crops. Thus biomass productivity and economic gains through traditional crops was lower with lower profits to the farming community.

INTRODUCTION

Cold deserts are the lands and the polar fringes of the northern hemisphere continents and the ice covered water of Greenland and Antarctica (Khosla *et al*., 1993). Cold deserts mainly occur in the interior of Asia and in the mountain zone of North America. They cover an overall area of 16 per cent of the total land mass, *i.e.*, 5.2 billion ha (Anonymous, 1977).

Lahaul and Spiti a tribal district of Himachal Pradesh falls under the cold desert region. The district is situated in the west of greater Himalayan ranges between 30º41′76" and 30º59′57" N latitudes and 76º45' 29" and 78º41' 84"E longitudes. The topography of Lahaul and Spiti district is entirely hilly. The region is characterized by low precipitation, a short growing season, low primary productivity and high stocking density (Mishra, 2000). Temperatures generally do not exceed 30ºC with July and August as the hottest months. January and February are the coldest months, with a mean temperature of -20.00ºC (Sinha and Samant, 2006). The growing season in cold deserts is restricted to less than six months in a year. The key to settlement is through the intelligent use of glacial melts. Snow and glaciers are the only sources of water. At first glance, one would think that human survival is impossible in this harsh climate. Yet, the local people have learnt to make judicious and optimal use of their limited resources and have built a glorious civilization in the process. Eonomy of the district is predominantly agriculture based. More than 80 per cent of the population is engaged in agriculture and its allied activities. Potato, peas and hops fetch good price to the inhabitants in the district. Beside agriculture, animal husbandry also plays an important role in the life of the people in Lahaul and Spiti. During the past few decades with the upcoming of the developmental activities such as education and communication facilities, the area experienced drastic change in the land use pattern from subsistence to cash cop economy as food security is one of the most important challenges in present era of agriculture production system (Mukharjee, 2016). Barley and wheat were the main cereal crops in earlier days in this area but now cash crops like pea and potato have replaced these traditional crops and have become major cash crops contributing to food security and income generation further improving the economic conditions of the farmers owing to higher price and higher volume. Moreover due to favourable influence of legumes on soil health and fertility, legume based cropping system may be economically viable and give sustainable profitable production (Singh and Verma, 1998). Regenerative and traditional environment friendly practices were and are still being replaced by modern technology in the Himalayan belt. Thus the paper deals with the comparison of two cropping patterns (traditional and cash cropping pattern) through biomass production and their impact on farming community.

MATERIALS AND METHODS

The present investigation was conducted during 2010 to 2013 in village Goshal, located in Lahaul and Spiti district of Himachal Pradesh, India. Goshal is one of the largest villages in the district with maximum cropping diversity, abundant alpine pastures and adjoining forest area. Himachal Pradesh forms part of northwestern Himalayas. Lahaul valley comprises an area of 1,761 miles2. Village Goshal in the Lahaul Valley is situated on the left bank of the river Chandra just before it merges with river Bhaga (Fig 1). Goshal village is located on a fan shaped alluvial deposits and occupies 28.90 ha of land. It is one of the largest villages in the main Lahaul valley. Above the agricultural fields of this village, the area supports grazing lands. On higher reaches, the area supports conifer forest and above that the glacial level exists from where the melt flow down through gorges and feeds the entire village. The village is well known for its productive fields and farmers prefer to grow peas, potato, vegetables (cabbage), apple, barley and medicinal plants.

Study was carried out in the agro ecosystem of Goshal by dividing the study area into nine different grids for sampling. Sampling in each grid was carried out following quadrate method. Size of quadrate was estimated following Species Area Curve as proposed by Oosting (1958). On the basis of Species Area Curve, the quadrate size came out to be 1 × 1m. Three quadrates were laid in each grid for sample collection for aboveground and belowground biomass studies. Performance of various vegetational units was studied in terms of total biomass production per kg per m^2 and then further converting it into Kg/bighas for monitory calculation. All the crops were sampled at the peak biomass harvesting stage for each crop. The estimation was carried out through quadrates for aboveground biomass studies. Belowground estimates were done through digging of monoliths (25 × 25 × 25 cm). Minimum of three quadrates and three monoliths each were taken from each sampled field. The aboveground samples were cut, packed separately in paper bags, brought to laboratory, dried in oven at 80ºC till constant weight and weighed for biomass estimations. The belowground parts were first washed to remove all the adhering soil particles, packed collectively in paper bags, oven dried at 80ºC and weighed. Estimation of the economic benefits from traditional crops and cash crops being planted nowadays was calculated by multiplying the market rates of the different plant parts with their corresponding biomass values and then calculating their price. While the input estimations, cost of all the inputs starting from the beginning were estimated and the cost benefit values were calculate for the flow charts.

RESULTS AND DISCUSSION

Aboveground and belowground biomass production of crops

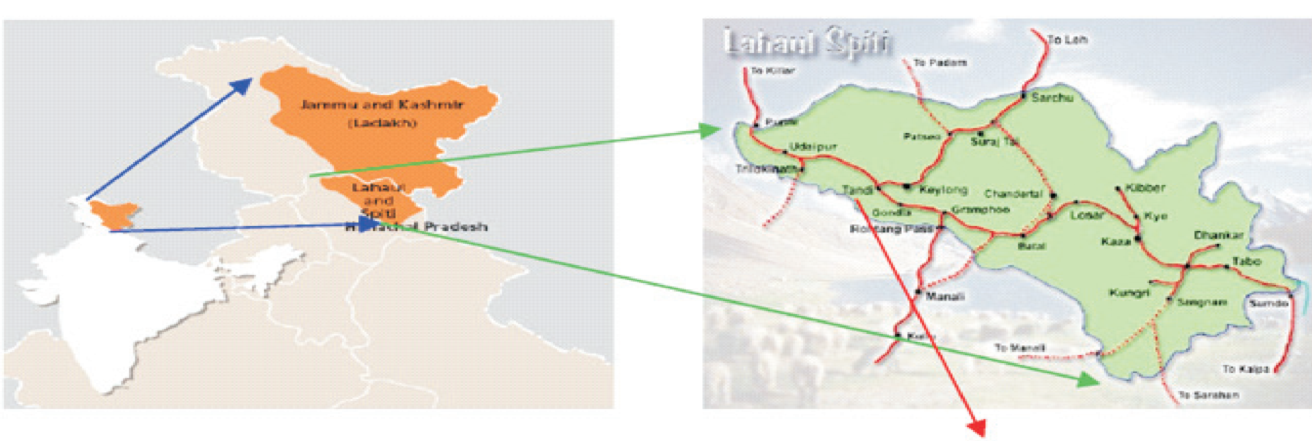
The total biomass production (aboveground and belowground) on grid basis for all crops is depicted in the table we found that the maximum aboveground biomass was reported for pea while potato exhibited maximum belowground biomass of 6.34 kg/m^2. If we calculate the total of aboveground and belowground biomass, in all the nine grids, potato showed the maximum total biomass 7.29 kg/m^2 and minimum total biomass was reported for barley 1.66 kg/m^2. In a similar study on agroforestry ecosystem dynamics, Nayar (1989) assessed the aboveground plant biomass productivity. Bijalwan (2009) studied the reduction in yield of agricultural crop under fruit trees. Sharma and Upadhyaya (2002) studied biomass productivity and nutrient content of herbaceous vegetation on the Aravalli hills. Sahu *et al*. (2013) studied total fine root biomass of vegetation. In a similar study Sharma *et al*. (2014) carried their biomass studies on D. falcatum .

Biomass production and economic values of barley crop

If we calculate the economy involved in case of barley crop it was observed that of the total input of Rs 5450 including ploughing, FYM, seed, labour and thrashing biomass produced was 165 kg/begha of grains and 226 kg/begha of straw. Total monitory output comes out to be Rs 7012 with input output

Table1 : Aboveground and belowground biomass production (kg/m^2) of cash crop and traditional crop in agro ecosystem of village Goshal.

Species	Biomass production (kg/m^2)		
	Above ground	Below ground	Total
Pea* (cash crop)	3.5	0.92	4.42
Potato* (cash crop)	0.95	6.34	7.29
Barley (traditional crop)	1.49	0.17	1.66



Cold desert area in Northwest Himalayas

Village Goshal

Figure 1: Location of Study Site

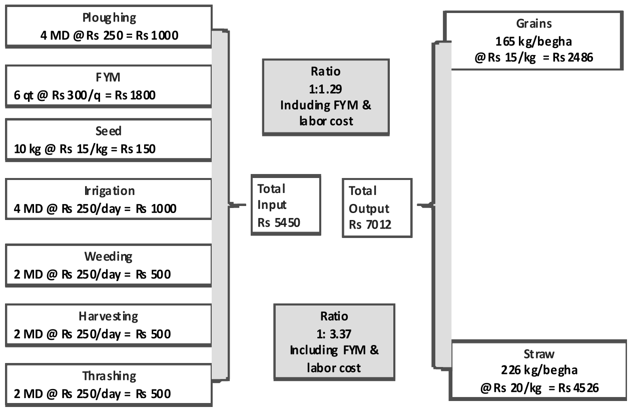


Figure 2: Economy involved in barley crop in agro ecosystem

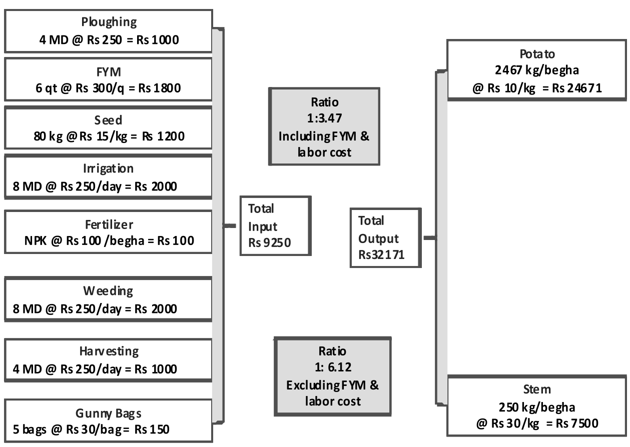


Figure 3: Economy involved in Pototo crop in agro ecosystem

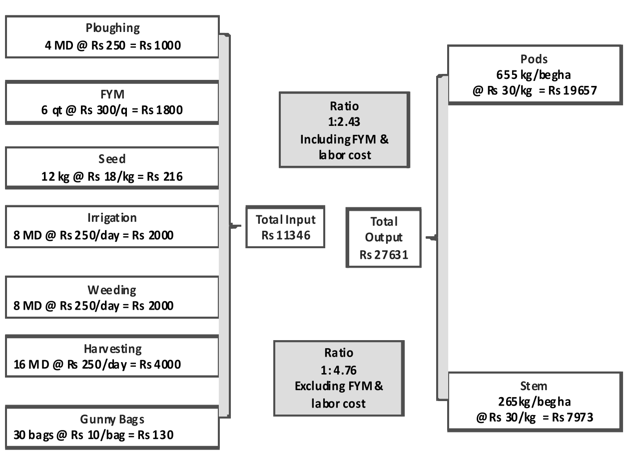


Figure4: Economy involved in Pea crop in agro ecosystem

ratio of Ratio1:1.29 (if labour and FYM cost is added), and if we do not add the labour and the FYM cost (as it is from the house only), then it works out to be 1:3.37 for barley (Figure 2).

Biomass production and economic values of Potato Crop

If we calculate the economy involved in case of potato crop total input was higher than barley through seed, ploughing, FYM, fertilisers, labour and gunny bags was Rs 9250 for biomass production of 2467 kg/begha of potato and 250 kg/begha of stem. Monitory output also comes out to be higher of Rs 32171 with input output ratio of Ratio1:3.47 with total inputs and 1:6.12 without labour and FYM cost. Hence, more profitable than barley (Figure 3).

Biomass production and economic values of Pea Crop

In case of pea crop, the total inputs were higher as compared to barley and potato of Rs 11346 including the cost of seed, ploughing, FYM, fertilisers, labour and gunny bags and biomass produced was 655 kg/begha of pods and 265 kg/begha of stem. Since the peas crop in these areas bear pods during the period when it is not available in the country, thus it is also termed as the offseason production of the crop, thus the farming community gets quite high price through its sale. The total monitory output comes out to be Rs 27631 with input output ratio of Ratio1:2.43 including all the inputs and it is 1:4.76 if labour and FYM cost is excluded (Figure 4). On the basis of the utilization of biomass and the economic values of the total material and energy inputs and the final produce along with residual waste utilization, depicts a drastic different picture for both the traditional crop and cash crops (peas and potatoes). Both the traditional as well as the cash crop systems are profitable, with more of inputs in the cash cropping system. Although there is higher inputs (Rs 9250 in case of potato and Rs 11346 in case of pea) in the cash crop system through different components such as seeds, fertilizers, chemicals, labour, *etc*., but their out put is drastically higher too (Rs 32171 in case of potato and Rs 27631 in case of pea with higher input output ratios of 1:3.47 and1:2.43, respectively. This is the basic reason why the farming community has shifted from the traditional crops to cash crops, as it brings in more of cash economy. Now presently, we can say that the farming community has shifted from the subsistence economy to market oriented economy with higher cash returns. Thus presently one finds a dramatic change in both the living standards as well as in foosd consumption habits, along with higher education of the younger generations. Hence we find major differences in the traditional crops (barley) and the cash crops (potatoes and peas), which is the basic reason for shifting of the farming community from traditional crops to the plantation of cash crops. Semwal *et al*. (2004) in their study found that changes in landuse and management have improved household income but at the cost of increase in intensity of biomass removal from forests and loss of forest cover. As farm productivity is dependent on forests, continued depletion of forest resources will result in poor economic returns from agriculture to local people together with loss of global benefits from forest biodiversity and ecosystem services. Policy support for sustainable income from forests to local people as well as technologies enhancing agricultural productivity through conservation of traditional crop diversity and efficient resource recycling within agro ecosystems is needed for sustainable livelihood of local communities together with global benefits from the Himalayan forests and ecosystem services. Maikhuri and Ramakrishnan (1990) evaluated the ecological and economic efficiencies of landuse systems, animal husbandry and domestic sub systems for three tribal (Garo, Khasi and Mikir) communities and one non tribal (Nepali) community living in the same area, at lower altitudes in Meghalaya. Jian (2006) found that economic output: input ratios under tea intercropping system were 64.29 per cent higher than that of the non tea intercropping system. They concluded that these two typical agro forestry intercropping systems have higher energy efficiency and also a better financial benefits to farmers. Kuusipalo *et al*. (1997) presented an approach for sustainable forest management planning in which economic, environmental and social sustainability are considered simultaneously in order to define an optimum management strategy from a set of available alternatives. Gay *et al*. (1996) revealed that converting marginal hardwood forests to grass may increase economic output from livestock production, but carries the risk of releasing excessive quantities of NO_3-N, with potential adverse effects on the environment. Misra and Kant (2004) proposed the framework for the production analysis of joint forest management (JFM) in the Gujarat state of India, by estimating the production functions of social, biological and economic outputs on the basis of data from fifty villages having JFM. Ainslie et al. (1998) presented a review of the ecological debates regarding production and degradation in communal rangelands. They focused on the issues involved in assessing the economic output from communal rangelands and issues of equity. Fodgaard *et al*. (1981) revealed as regards present landuse, there is little difference between agriculture and forestry in terms of economic output. At three per cent interest, forestry seems to be the better use on poor soils without irrigation and afforestation seems to be feasible in some regions, though the need for heavy investment and a negative net present value are deterrents. At five per cent, forestry no longer has a definite advantage. Ciubota *et al*. (2008) revealed that renewable energy resources from biomass could be of good solution for heating in rural zones. They presented in this paper the advantages of using biomass for energy purposes and the technological level achieved by conversion processes of biomass in energy producing products. Balsari and Airoldi (2002) carried out an economic evaluation of a short rotation forestry (SRF) poplar plantation in northern Italy. Poplar growth in a plantation for the production of two years whips in western Po Valley was observed considering SRF duration of eight years and a biomass (20 t/ha) harvest every two years. In this computing system, it was pointed out that the ratio between output and input energy of 13 and a cost of 77.5 Euro/t of dry matter. Singhal *et al*., 2015 while studying the effect of spraying of water soluble fertilizers on cowpea crop found the spray of fertilizer economical, profitable and proved highly remunerative. Venkatesh and Basu (2011) found the significant increase in number of branches and overall biomass production as a result of urea application. Our study is in line with the findings of Singh *et al.,* 2016, Upadhyay *et al.,* 2014, verma *et al*., 2015, Mukharjee 2016 and quing Xiong *et al.,* 2018.

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