Original Research

Draught Animal Power: Opportunities and Challenges in Mountain Agriculture

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Abstract

Climate change is a global phenomenon and agriculture is also drastically affected by the change with increasing fossil fuel consumption coupled with increased usage of agricultural machinery. Agriculture in the mountains is changing drastically; moreover, farm mechanization has also increased with introduction of power tillers. But with increasing climate change, there is need to maintain the existing animate eco-friendly power sources for agricultural operations i.e. draught animals. Hence, a study was conducted in the hilly state of northern India, Uttarakhand to know the opportunities and challenges associated with draught animals in mountain agriculture and data was collected from 240 draught animal rearing farmers through a semi-structured schedule. Analytical hierarchy process was used to see the weightage of different factors in four dimensions based on field observation. The study revealed that "means of agricultural workforce" (with a global priority score of 0.116); "insufficient fodder" (with a global priority score of 0.118); "animal friendly implements" (with a global priority score of 0.104) and "high demand of dairy animals" (with a global priority score of 0.116) were the most important strength, weakness, opportunity and threat identified respectively.

Key words: Climate Change, Draught Animals, Mountain Agriculture, Opportunities and Challenges

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Introduction

In the present context, climate change is omnipresent and has become a global phenomenon. Agriculture as a whole is also drastically affected by climate change and increased mechanization and usage of chemicals is again augmenting it. Indian agriculture is rapidly transforming in lieu of liberalisation, privatisation and globalisation especially with escalating growth of agricultural machinery. But with increased mechanization, the ecological balance is also being hindered and the agricultural system is becoming less sustainable. Mechanization in agriculture is associated with emission of greenhouse gases

like carbon dioxide and other trace gases due to burning of fossil fuels (Mishra and Dikshit, 2004) which is one of the reasons for causing environmental imbalance.

Moreover, in India, where 85% farmers fall under the category of small and marginal farmers (Agriculture Census, 2010-2011) that are not able to afford and have access to new machineries, we need to ponder over whether the use of tractors and tillers is economical or not. It is equally important to search out for ways to mitigate climate change that is advancing with increased mechanization. Mountain and coastal regions are the most affected by climate change and its aftereffects, hence it becomes more important to look for ways to sustain eco-friendly farm power sources. Livestock has been playing a crucial role in agriculture as an energy source in form of draught power. But due to mechanization in agriculture i.e. with the introduction of tractors and tillers, the role of animals in crop production became less relevant. Draught animal power (DAP) is relevant and useful being suitable for farmers with small land holding and the areas where mechanized implements cannot be put to use (Singh *et al.,* 2007). Akila and Chander (2009) have also reported that draught bullocks were better than tractors especially for small and marginal farmers when the farmers can meet out the feed cost by their own source of feed and the number of work days improved. Similar findings were reported by Mpanduji *et al.* (2007) in Tanzania that animal traction technology was more suitable both socially and economically viable for farmers with tradition in animal keeping. If we look upon the facts stated in the Livestock Census 2012, draught animal population is 49.69 million in our country that is mainly used for farm operations, transport and other purposes. They play a significant role in agriculture and livelihood with respect to small and marginal farmers that form the backbone of agriculture in developing nations. The energy for ploughing two–thirds of the cultivated area and two–thirds of rural transport are coming from animals in India (GOI 2008). The work bullocks not only contribute manure, conserve natural resources like fossil fuel, but also create employment opportunities and generate income particularly for the small scale farmers in India (Akila and Chander, 2011).

On the other hand, with climate change at hand, they form an important eco-friendly farm power source. This eco-friendly farm power in fact is an economically reliable and most readily available source of power in the mountains. As mechanized agriculture based on fossil fuels is not feasible in the mountains because of the topographic specificities; animals and manual tools are the most applicable and reliable source of power for agricultural operations. Even with transformation in agriculture, draught animal power and human muscle power are still the predominant feature of mountain agriculture for performing any agricultural operation (Singh, 2000). The social, cultural and economic contributions of draught animals help promote the sustainability of farming system in the mountains (Singh, 1998). Without draught animal power, mountain agriculture will lose its existence as they are the part and parcel of the farming system in the hills. But unfortunately, with increasing mechanization, migration and degrading natural resources, population of draught animals is also decreasing in the mountains. Hence, it becomes very important to

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know the various opportunities and challenges associated with them in the mountains at present to make their effective use in mountain agricultural system.

Materials and Methods

The study was conducted in the hilly state of India, Uttarakhand as it had the highest population of indigenous male cattle in the northern mountain states (Livestock Census, 2012) and information was sought from farmers who have been rearing draught animals for at least five years. Data was collected from 240 farmers spread across eight blocks, two from each district with a total of four districts namely Nainital and Almora from Kumaon division while Tehri and Uttarkashi from Garhwal division of Uttarakhand. Opportunities and challenges were analysed in form of Strengths, Weaknesses, Opportunities and Threats (SWOT) by using Analytical Hierarchy Process (AHP) for quantitative visualization. Paired comparison on four dimensions in a nine-point continuum to get the relative weightage of each dimension was done (Table 1).

Table 1: Priority weights of four dimensions of opportunities and challenges associated with draught animals in mountain agriculture

Factors	Priority Weights	λ_{max}	Consistency Index (CI)	Consistency Ratio (CR)	Rank
Strength	0.253	4.04	0.013	0.015	II
Weakness	0.234				III
Opportunity	0.219				IV
Threat	0.294				I

Afterwards, factors under each dimension were selected on the basis on experts' opinion and literature survey. Opinion of farmers interacted during pilot study was also taken into consideration before initial inclusion of factors. These factors were subjected to scrutiny and their subsequent screening for inclusion in the final schedule based on relevancy test. The relevancy weightage (RW) and mean relevancy score (MRS) were worked out for all the factors individually as well as overall mean relevancy score (OMRS) including all the factors was calculated. By these criteria the factors having relevancy weightage (RW) > 0.85 and mean relevancy score (MRS) greater than the overall mean relevancy score, were considered for inclusion in final analysis. Factors under each dimension were compared in a nine-point continuum (Satty, 2008). Aggregation of Individual Priorities (AIP) was done using geometric mean (Wu, 2008). By taking the derived value from AIP method, comparison matrix was developed for the group of individuals. Consistency of priorities was checked by using consistency index (CI) which is related to the eigenvalue method. The Eigen value (λmax) was obtained by summing of products of each element of eigen vector multiplied by the total of columns of reciprocal matrix. Consistency index was calculated by the following formula-

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$$CI = (\lambda_{max} - n)/ (n-1)$$ where, *n* = dimension of the matrix

λ_{max} = maximal eigenvalue

Consistency ratio (CI/Random index) of less than 0.1 is the assurance of consistency among choices made by individual as well as all respondents among factors under each dimension. The criteria had local priority (priority/ scaling factor within a particular factor) and global or overall priority (priority/ scaling factor in relation to overall goal). To get global priority of criteria to overall goal, priority vector of SWOT factors was multiplied with local priorities of respective criteria within the particular SWOT factor.

Result and Discussion

Opportunities and challenges with respect to draught animals were revealed in terms of four dimensions i.e. strengths, weaknesses, opportunities and threats based on field observation and the experiences of farmers rearing draught animals. The weightage of the respective factors is shown in the figure below-

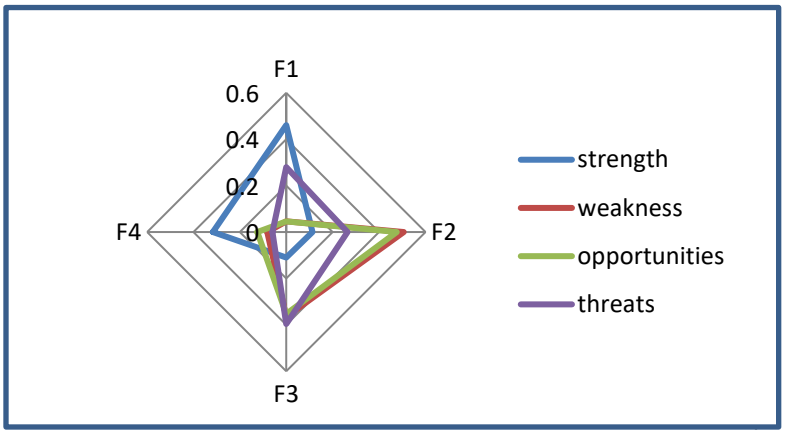

Fig. 1: Weightage of SWOT factors for opportunities and challenges related to draught animals

Strength Factors

Based on the analysis done, the most important strength associated with draught animals in mountain agriculture came as "Means of agricultural workforce" with a global priority index of 0.116. Even with transformation in agriculture, draught animal power and human muscle power are still the predominant feature of mountain agriculture for performing any agricultural operation (Singh, 2000). Draught animals are an inseparable part of mountain agriculture and form the backbone of farming in the hilly terrain. "Crop diversification" came as the second most important strength with the global priority index value of 0.080. Draught animals (predominantly bullocks) are essential for field operations in the uneven topography and marginal land holdings of the mountains with mixed farming system. Use of animals helps in field preparation for a variety of crops in small areas. "Farm sustainability" with a global priority index of 0.029 and "Income and employment generation" with global priority index of 0.028 came up as the third and

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fourth most important strengths respectively. Draught animals provide the farmer with organic manure and income gain through hiring out for agricultural operations thus helping in maintaining a sustainable farm.

Table 2: Strength factors in relation to draught animals in mountain agriculture

SWOT Group	Priority of the Group (Scaling Factor)	SWOT Factors	Consistency Ratio (CR)	Priority of SWOT Factors within SWOT Group	Global Priority of Factor
Strengths (S)	0.253	S1. Means of agricultural workforce	0.029	0.461	0.116
		S2. Farm sustainability		0.113	0.029
		S3. Income and employment generation		0.109	0.028
		S4. Crop diversification		0.317	0.08
$\lambda_{max= 4.08}$ CI= 0.026					

Weakness Factors

"Insufficient fodder" came up as the most serious weakness associated with draught animals in mountain agriculture with the global priority index of 0.118. Degrading forest and pasture land due to deforestation and increased construction activities is one of the main reasons for fodder deficit in the mountains. Maousami *et al.* (2017) in a study on Hill Korwa tribes also reported the unavailability of concentrate feeds for management of livestock. The second most important weakness that came up was "Uselessness in lean periods" with the global priority index value of 0.085.

Table 3: Weakness factors in relation to draught animals in mountain agriculture

SWOT Group	Priority of the Group (Scaling Factor)	SWOT Factors	Consistency Ratio (CR)	Priority of SWOT Factors within SWOT Group	Global Priority of Factor
Weaknesses (W)	0.234	W1. Scarcity of draught specific breeds	0.084	0.046	0.011
		W2. Insufficient fodder		0.506	0.118
		W3. Uselessness in lean periods		0.365	0.086
		W4. Much time and effort taking		0.083	0.019
$\lambda_{max= 4.22}$ CI= 0.075					

Since use of draught animals in agricultural operations is limited to certain operations like ploughing, levelling, puddling, etc.; they remain useless during the lean period and are only reared as an unproductive animal generally. The third most serious weakness associated with draught animals in mountain agriculture was "Much time and effort taking" with the global priority index value of 0.019. Field operations with draught animals requires a lot of physical strength and time to carry out the activities efficiently which is the reason farming is shifting towards mechanization. The last most serious weakness that came up was "Scarcity of draught specific breeds" with 0.0108 as the global priority index value. With increasing focus

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on improving milch breeds and negligence towards draught breeds, the population and efficiency of draught breeds is declining in India since many years. Maousami *et al.* (2017) also reported the lack of good breedable male among livestock as perceived by livestock owners of Hill Korwa tribe in Chhattisgarh.

Opportunity Factors

As per the analysis, the most important opportunity associated with draught animals in mountain agriculture was "Animal friendly implements" with global priority index value of 0.104. Working with animals in the field agricultural operations helps the farmers by drudgery reduction and availability of animal friendly implements can improve their field performance to a greater level. The second most important opportunity associated with draught animals was "Animal power generation" with global priority index of 0.077. Since draught animals generally remain unproductive and useless during lean period, they can be effectively utilized for power generation during this period. The third and fourth most important opportunity according to the analysis were "Alternative use in lean periods" and "Dairy cattle and buffalo for traction" with global priority index values of 0.027 and 0.01 respectively. In the mountains, dairy animals are not used for animal traction traditionally but taking inspiration from southern India and African nations, they can also be used as working animals through breed improvement though it would require much discussions and convincing on the cultural and religious aspects associated with cow as a scared animal in the mountains.

Table 3: Opportunity factors in relation to draught animals in mountain agriculture

SWOT Group	Priority of the Group (Scaling Factor)	SWOT Factors	Consistency Ratio (CR)	Priority of SWOT Factors within SWOT Group	Global Priority of Factor
Opportunities (O)	0.219	O1.Dairy cattle and buffalo for traction	0.09	0.046	0.01
		O2. Animal friendly implements		0.476	0.104
		O3. Animal power generation		0.352	0.078
		O4. Alternative sue in lean periods		0.126	0.027
$\lambda_{max= 4.25}$ CI= 0.086					

Threat Factors

The most important threat as perceived by the farmers regarding draught animals in mountain agriculture was "High demand of dairy animals" with a global priority index of 0.116. This holds true because since past many years the population of cross bred dairy cattle as well as milk production has increased and the population of indigenous breed especially the bullocks has decreased drastically (Livestock Census, 2012). The second most important threat that came up through the analysis was "Increasing agricultural mechanization" with global priority index of 0.082. With introduction of power tillers and tractors, the rearing and use of draught animals has decreased at an exponential rate within past many years. The third and fourth most serious threats that came up associated with draught animals in mountain agriculture were

"Decreasing draught animal population" and "Negligence in genetic improvement of draught breeds" with global priority index of 0.077 and 0.017 respectively. More focus on genetic improvement of milch breeds has led to negligence towards draught breeds and their population has also declined in past years with increased mechanization and migration in the hills.

Table 4: Threat factors in relation to draught animals in mountain agriculture

SWOT Group	Priority of the Group (Scaling Factor)	SWOT Factors	Consistency Ratio (CR)	Priority of SWOT Factors within SWOT Group	Global Priority of Factor
Threats (T)	0.294	T1. Increasing agricultural mechanization	0.009	0.28	0.083
		T2. Decreasing draught animal population		0.264	0.078
		T3. High demand of dairy animals		0.397	0.116
		T4. Negligence in genetic improvement of draught breeds		0.059	0.017
λmax= 4.02 CI= 0.008					

Conclusion

Draught animals play a very essential role in mountain agricultural system and their contribution is commendable as farm power source. With increased global warming leading to climate change the resources are depleting and there is need for non-renewable and eco-friendly energy sources. In this regard, draught animals are one of the most reliable, economic and best alternative as eco-friendly farm power source in the mountains and can play a better role in mitigating climate change. They provide organic manure as well as draught force to carry out farm operations and also provide income and employment to the owner and help in maintaining farm sustainability. But degrading forest land and animal's unproductivity in lean season has caused serious threats to population of draught animals. But opportunities can be grabbed by developing animal friendly implements and finding alternative uses in lean season. Policies and programmes should be made focusing on improvement of draught breeds and also on improving the field efficiency of draught animals. Mountain agriculture holds immense opportunities for effective utilisation of draught animal power and they must be addressed.

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