International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 11, Issue 17, 2019, pp.-9000-9003.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

EVALUATION OF FISHERIES BASED INTEGRATED FARMING SYSTEMS IN MID HILLS OF UTTARAKHAND

SINGH V.K.*[1], MEHTA K.S.[2] AND CHAUHAN R.S.[3]
[1]Associate Director, Krishi Vigyan Kendra, Lohaghat, 262524, G. B. Pant University of Agriculture and Technology, Pantnagar, 263143, Uttarakhand, India
[2]General Manager, Samak Aquaculture, Rudrapur, Uttarakhand, India
[3]Professor & Head, Department of Aquaculture, College of Fisheries, G. B. Pant University of Agriculture and Technology, Pantnagar, 263143, Uttarakhand, India
*Corresponding Author: Email - drvkskvk@gmail.com

Received: August 30, 2019; Revised: September 12, 2019; Accepted: September 13, 2019; Published: September 15, 2019

Abstract: Trials were conducted to evaluate different fisheries based integrated systems *viz*., fish-poultry, fish-vegetable, fish-crop farming and compared with composite fish farming at farmers' fields in mid hill conditions of Uttarakhand. In composite fish farming, fish seed (10-20 cm size) of silver carp, grass carp and common carp varieties were stocked in combination of 30:40:30, respectively at density of 300 no./100 m^2 in the month of February. In fish-poultry integration, along with fish farming, two crops of poultry chicks (*var*.- Cari Devendra), 25 number in each crop, in a year were reared. In fish-vegetable integration, two crops of vegetables namely Capsicum (variety- California wonder) followed by second crop of cauliflower (variety- Snow crown) were grown in 200 m^2 area plots adjacent to fish ponds. In fish-crop integration, two crops of cereal *viz*., soybean (*var*.- PS 1092) from June to October and wheat (*var*.- UP 2572) from October to May were cultivated in 200 m^2 area adjacent to fish ponds. Results showed that fish production was ranged between 59.80-65.49 kg/100 m^2 with maximum recorded in fish-poultry integration. Besides fish, additional food in the form of poultry meat (77.35 kg), vegetables (capsicum- 218 kg and cauliflower- 380 kg) and cereals (soybean- 17.6 kg and wheat- 32.5 kg) were also produced in different integrated systems. Economic analysis revealed maximum income in fish-poultry integrated farming (Rs 24164.20) followed by fish-vegetable (Rs 19006.40) as compared to fish-crop (Rs 11859.40) and composite fish farming (Rs 11041.20). Fish-poultry integrated farming also received maximum income over the investment cost with B:C ratio of 3.54 followed by fish-vegetable system (3.43) as compared to composite fish farming (2.76). It is concluded that fish-poultry followed by fish-vegetable integrated farming systems are found to be most suitable for mid hill conditions of Uttarakhand in terms of production as well as profit and also ensures nutritional security of rural people.

Keywords: *Fish-poultry, Fsh-vegetable, Fish-crop integration, Composite fish farming, Hill aquaculture*

Citation: Singh V.K., *et al*., (2019) Evaluation of Fisheries Based Integrated Farming Systems in Mid Hills of Uttarakhand. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 11, Issue 17, pp.- 9000-9003.

Academic Editor / Reviewer: Dr Raghvendra Singh, Dr Ajeet Singh

Introduction

Uttarakhand is primarily an agriculture state although its share in the country's total area and production is very small. The contribution of agriculture to the states domestic product is about 22.4% and population depends on agriculture for their livelihood is 75-78%. The average land holding in state is around 0.98 ha. Out of total cultivated area, about 50% land holdings (in number) are sub marginal and 21% land holdings measures between 0.5-1.0 ha. Only 10% of the cultivated land in hill region is irrigated and productivity of various crops is low hence subsistence farming is prevalent in this area [1,2]. Livelihood security of hill farmers from agriculture is very difficult since agriculture in hills is not very remunerative. Geographically difficult terrain, adverse climate, scattered and small land holdings, poor soil fertility are the factors which restricts expansion/commercialization of any single agricultural crop/enterprise. Considering the above facts, small and marginal farmers have great responsibility of producing more food to meet the required demand of nutritious food for the community. However, their inability to invest more capital restricts them to adopt intensive farming practices [3]. In order to provide a sustainable source of production and income, farmers have to follow different approach of farming in hills. Integrated farming systems which essentially ensure production of diversified produce at low cost through recycling of different farm waste [4] would be best option for these small and marginal land holders. Integrated farming system approach works on the principle that waste of one enterprise is input for other [5] offer profuse employment, regular production and income besides reducing production risks, cost of cultivation through optimal use of natural resources and internal resources recycling [6,7].

Many workers have emphasized the importance of various Integrated farming system for increasing the production and profit in different agro-climates [8-12]. Majority of people residing in hill areas of Uttarakhand prefer non-vegetarian food in their diet and fish catches from natural water bodies such as lakes, reservoirs and rivers forms one of the important sources of animal protein for them. However, availability of fish from these water bodies has been drastically reduced in recent years due to sharp decline of fish catches owing to multiple reasons such as silting, landslides, poisoning, over exploitation, destruction of breeding ground etc [13]. The demand, farmers are attracting towards pond-based rearing of exotic carps namely silver carp, grass carp and common carp varieties in suitable areas depending on availability of water resources. Although, carp farming technology for mid hill areas have now been very well standardized [14], in spite of that, its adoption rate is very slow largely due to high cost of fish feed. Therefore, there is need to introduce appropriate integrated farming system comprising suitable components such as poultry, vegetable production and fisheries within the bio-physical and socio-economic environment of farmers to make farming more profitable and dependable [15]. In integrated farming of fish-poultry-vegetable, waste from poultry is used to fertilize fish pond substituting feed supplement for fish and nutrients rich water from fish pond is used to irrigate vegetable crops during water exchange for fish substituting fertilizer use in crops [16]. Vegetable waste acts as excellent food for grass carp fish. Fisheries based integrated farming system incorporating poultry and vegetable components has been proved to be technically feasible, economically viable, ecologically sustainable and widely adopted practice in different agroclimatic conditions [17-20].

However, it is yet to be introduced systematically in hilly areas of Uttarakhand. Therefore, present trials were planned to evaluate performance of integrated farming system comprising fish, poultry, vegetable components in mid hill conditions in order to optimize production of different components with benefits.

Materials and Methods

Characteristics of trial area

The trials were conducted at farmers ponds situated in mid hills (altitude: 1400-1800 m msl) in Champawat district of Uttarakhand. This area experiences great climatic variations but mostly has temperate climate. The valleys are warm in summer, while upper reaches of hills suffer from extremely cold wind, hails and high rainfall with occasional snowfall. The temperature fluctuates between 4°C in winters and 32°C in summers. Average rainfall has been recorded to be 1000mm.

Composite fish farming (T1)

Trial on composite fish farming was conducted at five farmers ponds each having 100 m^2 area. Ponds were prepared in the month of January by draining and drying the pond, applying lime @ 200 kg/ha;cowdung @ 10,000kg/ha initially and filling the ponds with water. After 20-25 days of filling water in ponds, fish seed (10-20 cm size) of silver carp, grass carp and common carp varieties were stocked in combination of 30:40:30, respectively at density of 300 no./100 m^2 in the month of February. Lime @ 100 kg/ha and cowdung @ 5000 kg/ha were applied at monthly intervals for sustained production of fish food organism. Pond water quality was monitored regularly. Fishes were fed daily with pelleted fish feed (25% protein) @ 2-3% of their body weight. Vegetable leaves waste was fed to grass carp as per availability. Fishes were harvested during October-December months.

Fish-poultry integration (T2)

Fish ponds were prepared and stocked with fish seed as per procedure followed in T1. Lime was applied @ 100 kg/ha at monthly intervals. Pond water quality was monitored regularly. Fishes were fed daily with pelleted fish feed (25% Protein) @ 1-2% of their body weight. Vegetable leave waste was fed to grass carp as per availability. Fishes were harvested during October-December months. For rearing poultry, 10x6x5 feet size poultry houses were constructed with brick-cement walls and tin-shed roof on the pond embankments. One week old chicks (Cari Devendra variety) were procured from Instructional Poultry Farm, Pantnagar and kept in poultry houses in 25 numbers each unit. Two crops of poultry birds (25 numbers in each crop) were reared in a year, first crop from March to July and second crop from August to December. Recommended management practices were followed for rearing poultry chicks. Birds were kept opened during day time and closed in poultry houses during night hours. Poultry excreta mixed with spilled poultry feed was washed in to the ponds daily.

Fish-vegetable integration (T3)

Fishes were reared as per procedure followed in T1. Two crops of vegetables, first crop of Capsicum (variety- California wonder) followed by second crop of cauliflower (variety- Snow crown) were grown in 200 m^2 area plots adjacent to fish ponds. Nursery of capsicum was grown during March- April and was transplanted in mid-April at 60x45 cm distance. Picking of fruits were started from June onwards and final harvesting was done in the month of September. Cauliflower was grown as second crop in the same plots, for which, nursery was grown in September and plants were transplanted during September end at 45x45 cm distance. Cauliflower crop was harvested during December-January. All recommended management practices were followed for growing both the vegetable crops. Crops were irrigated with nutrient rich pond water as per their requirement. Vegetable leaves waste was fed to grass carp regularly.

Fish-crop integration (T4)

Fishes were reared as per procedure followed in T1. Two crops of cereals *viz*., soybean (*var*.- PS 1092) from June to October and wheat (*var*.- UP 2572) from October to May were cultivated in 200 m^2 area adjacent to fish ponds. All recommended crop management practices were followed for growing soybean and wheat crops. Nutrient rich fish pond water was used to irrigated crops as per their requirements.

Results and discussion

Fish production ranges between 59.80-65.49 kg/100m^2 with maximum (65.49 kg/100m^2) recorded in Treatment T2 where fish farming was integrated with poultry rearing [Table-1]. Highest production in ponds T2 would be due to continuous dropping of poultry excreta in these ponds which contains high amount (15-20%) of undigested/partly digested and spilled poultry feed owing to very short digestive tract of poultry birds [21]. This of undigested/partly digested and spilled poultry feed is directly consumed by fishes [22]. In addition, poultry excreta act as good source of fertilizer as it contains major inorganic nutrients which helps in sustained production of fish food organisms *i.e*. phyto and zooplankton. Higher fish production in fish-poultry integrated farming have also been reported by [23,24]. Species wise, grass carp attained maximum average weight (415g) in fish-vegetable integrated farming (ponds T3). Regular availability of vegetable waste throughout year for feeding fishes would have resulted higher growth of grass carp in these ponds. Highest growth of grass carp in hill conditions when fed with vegetable waste regularly have also been recorded by [14]. Integrated farming increases the efficiency of resource utilization and produces additional food [25]. In present trials too, besides fish, additional food in the form of poultry meat (77.35 kg), vegetables (capsicum- 218 kg and cauliflower- 380 kg) and cereals (soybean- 17.6 kg and wheat- 32.5 kg) were also produced in different integrated systems. Higher productivity (26.3%) in Integrated farming systems compared to conventional systems have been reported by [26]. Fish feed is major input in fish farming which accounts up to 60% of total production cost [27]. In present trials also, expenditure on fish feed was 50.06% of total cost of fish production [Table-2] in fish farming alone (T1) followed by fish-crop (43.53%) and fish-vegetable farming (36.07%). In fish-vegetable integrated farming, large amount of food requirement of grass carp was fulfilled by waste from vegetable crop hence reduces the expenditure on fish feed. Integration of livestock with fish culture increases the production of animal protein per unit area at reduced cost by saving expenditure on fish feed [19] which is also evident in fish-poultry integrated farming (T2) where expenditure on fish feeding was only 14.66% of total cost with 6.77% greater fish production. Integrated farming systems provide more opportunities of employment also in rural areas by engaging farm families in different farm operations [28]. Vegetable and crop cultivation are labour intensive, hence, expenditure on labour charges in these systems were 36.07 and 28.29 %, respectively which is equal to or next to fish feeding. However, family labour was used for undertaking all farming activities, therefore, cost on labour charges is also saving for these farmers. Majority population of Uttarakhand hills are non-vegetarian in their food preference, hence, animal food always remains in high demand, as a result, provides higher prize to the farmers. Economic analysis of various integrated farming systems presented in [Table-3] also showed maximum income in fish-poultry integrated farming (Rs 24164.20) followed by fish-vegetable (Rs 19006.40) as compared to fish-crop (Rs 11859.40) and composite fish farming (Rs 11041.20). Fish is an important constituent of fisheries based integrated farming systems. In present trials also contribution of fish component was quite higher (59.36%) in gross income of fish-vegetable integrated system and was almost equal (48.78%) to poultry (51.22%) in fish-poultry integrated farming. Maximum contribution of fish (68.53%) was also recorded by [29] among integration of seven different enterprises. However, only 9.24% contribution of cereal crops in fish-crop integrated farming shows its least suitability for the farmers. Among the integrated farming systems, maximum profit (Rs 17344.20) was earned in fish-poultry integrated system which is 146.15% greater as compared to composite fish farming with involving 100.88% additional investment cost. While in fish-vegetable integrated farming, net profit was 91.04% greater than fish farming with application of 63.33% more investment. [Obtained 111.63% greater net income in fish-vegetable integrated farming and found 65% higher net profit in fish-poultry-horticulture (papaya) as compared to composite fish farming. However, in fish-crop integrated system, in spite of investing 35.35% more cost on inputs, net profit was only 3.10% greater over composite fish farming. Integrated farming systems provide more income over the investment cost [30]. This is also evident from present trials as fish-poultry integrated farming received maximum

Table-1 *Production details of different integrated farming systems*

Crop details		T1 (Fish)	T2 (Fish-poultry)	T3 (Fish-vegetable)	T4 (Fish-crop)
Fish production					
Species wise fish growth (g)	Silver carp	236	245	230	235
	Grass carp	390	398	415	386
	Common carp	286	319	284	285
Average fish growth (g)		328	354	337	325
Survival rate (%)		62.33	61.67	62	61.33
Fish production		61.34	65.49	62.68	59.8
Change over T1 (%)		-	6.77	2.18	2.51
Poultry production					
Number of bird		-	35	-	-
Average weight (kg)		-	2.21	-	-
Total weight (kg)		-	77.35	-	-
Vegetable production					
Capsicum (kg)		-	-	218	-
Cauliflower (kg)		-	-	380	-
Crop production					
Soybean (kg)		-	-	-	17.6
Wheat (kg)		-	-	-	32.5

Abbreviations: T1- Trial 1; T2- Trial 2; T3- Trial 3 and T4- Trial 4.

Table-2 Details of expenditure on various inputs in different integrated farming systems

Inputs	T1 (Fish)	T2 (Fish-poultry)	T3 (Fish-vegetable)	T4 (Fish-crop)
Lime	70.0 (1.75)	70.0 (1.03)	70.0 (1.26)	70.0 (1.52)
Cowdung	125.0 (3.15)	-	175.0 (3.16)	175.0 (3.81)
Medicines	-	200.0 (2.93)	-	-
Chemicals	-	-	100.0 (1.80)	50.0 (1.09)
Fish seed	600.0 (15.02)	600.0 (8.80)	600.0 (10.82)	600.0 (13.06)
Poultry chicks	-	1250.0 (18.33)	-	-
Vegetable seedlings	-	-	200.0 (3.61)	-
Crop seed	-	-	-	100.0 (2.18)
Fish feed	2000.0 (50.06)	1000.0 (14.66)	2000.0 (36.07)	2000.0 (43.53)
Poultry feed	-	1800.0 (26.29)	-	-
Labour charge	1000.0 (25.06)	1500.0 (21.99)	2000.0 (36.07)	1300.0 (28.29)
miscellaneous	200.0 (5.01)	400.0 (5.87)	400.0 (7.21)	300.0 (6.53)
Total	3995.00	6820.00	5545.00	4595.00
Additional expenditure over T1 (%)	-	100.88	63.33	35.35

Figures in the parentheses are percentage in relation to total expenditure of respective integrated farming system

Table-3 *Economic analysis of different integrated farming systems*

Treatments	Crops	Quantity (kg)	Rate (Rs/kg)	Amount (Rs)	%age of gross income	Gross Income (Rs)	Expenditure (Rs)	Net Income (Rs)	Change over Net Income (%)	B:C ratio
T1	Fish	61.34	180	11041.2	100	11041.2	3995	7046.2	-	2.76
T2	Fish	65.49	180	11788.2	48.78	24164.2	6820	17344.2	146.15	3.54
	Poultry	77.35	160	12376	51.22					
	Fish	62.68	180	11282.4	59.36					
T3	Capsicum	218	18	3924	20.65	19006.4	5545	13461.4	91.04	3.43
	Cauliflower	380	10	3800	19.99					
	Fish	59.8	180	10764	90.76					
T4	Soybean	17.6	29	510.4	4.3	11859.4	4595	7264.4	3.1	2.58
	wheat	32.5	18	585	4.93					

income over the investment cost with B:C ratio of 3.54 followed by fish-vegetable system (3.43) as compared to composite fish farming (2.76). Similar results have also been reported by other workers in different integrated farming systems. Reported B:C ratio of 4.61 in fish-vegetable farming as compared to 2.89 in composite fish farming. Calculated B:C ratio 4.52 in fish-poultry-horticulture (papaya) cultivation compared with 2.9 in composite fish farming [13,22].

Conclusion

From the present trials, it could be concluded that Fish-Poultry followed by Fish-Vegetable Integrated Farming systems are most suitable for mid hill conditions of Uttarakhand in terms of production as well as profit and also ensures nutritional security of rural people.

Application of research: Fish-poultry followed by fish-vegetable integrated farming systems are found to be most suitable for mid hill conditions of Uttarakhand

Research Category: Integrated Farming Systems

Acknowledgement / Funding: Authors are thankful to Department of Biotechnology, Govt of India, New Delhi for funding the project No. BT/PR12777/SPD/24/385/2009. Authors are also thankful to Krishi Vigyan Kendra, Lohaghat, 262524, G. B. Pant University of Agriculture and Technology, Pantnagar, 263143, Uttarakhand, India

***Principal Investigator or Chairperson of research: Dr V K Singh**
University: G. B. Pant University of Agriculture and Technology, Pantnagar, 263143, Uttarakhand, India
Research project name or number: BT/PR12777/SPD/24/385/2009

Study area / Sample Collection: Champawat district of Uttarakhand

Cultivar / Variety / Breed name: Capsicum- California wonder, Soybean-PS1092

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

References

[1] Kandpal K. (2013) *Agropedia.iitk.ac.in*, 21.05.2013, 15.15.
[2] Taneja U. (2013) *Agricultural profile of Uttarakhand. Agricultural Economics Research Centre, University of Delhi, January* 2013, 32.
[3] Sasikala V., Tiwari R. and Saravanan M. (2015) *J. Int. Acad. Res. for Multidisciplinary*, 3(2), 319-328.
[4] Panke S.K., Kadam R.P. and Nakhate C.S. (2010) *In: 22nd Nat. Sem. "Role of Extension in Integrated Farming Systems for sustainable rural livelihood", 9-10th Dec., Maharashtra*, 33-35.
[5] Tomar S.P., Sairam R.K., Harika A.S. and Ganguly T.K. (1982) *Forage Research*, 8, 93-98.
[6] Singh K.P., Singh S.N., Kumar H., Kadian V.S. and Saxena, K.K. (1993) *Haryana J. Agronomy*, 9, 122-125.
[7] Singh S.N., Saxena K.K., Singh K.P. Kumar H. and Kadian V.S. (1997) *Annals of Agricul. Res*., 18(3), 340-43.
[8] Jayanthi C., Rangaswamy A., Chinnusammy C., Purushothaman S and Planiappam S.P. (1994) *Indian J. Agronomy*, 39, 1-7.
[9] Laxmi, Gupta N., Singh M. and Sharma R.P. (2015) *Current World Environment*, 10(2), 667-671.
[10] Nageswaran M., Selvaganapathy E., Subbiah V.R. and Nair S. (2009) *In: Report of M.S. Swaminathan Research Foundation, Chennai*, 16-53.
[11] Radhamani S., Balasubramanian A., Ramamoorthy K. and Geethalakshmi V. (2003) *Agricultural Reviews*, 24, 204-210.
[12] Sharma S.K., Nainwal G.C., Kumar P and Ujjania N.C. (2016) *Progressive Research- An International Journal*,11 (Special-I),411-414.
[13] Vass K.K. (2002) *In: Proc. Nat. Sem. Aquatic Resource Management in hills, NRCCWF, Bhimtal*, 198-216.
[14] Singh V.K., Mehta, K.S., Singh Ajay K. and Singh Awani K. (2014) Int. *J. Basic and Applied Agric. Research*, 12(3), 425-430.
[15] Bahera U.K., Jha K.P. and Mahapatra I.C. (2004) *Crop Research*, 27(1), 83-89.
[16] Tugie D. Abebe A. and Endebu M. (2017) *Int. J. Fish. Aquatic Studies*, 5(4), 377-382.
[17] Getu D., Amare F., Barhanu T., Kinfo H. and Tefere T. (2017) Advance *Research Journal of Multidisciplinary Discoveries*, 170.0, c-5, 20-27.
[18] Kalita G., Ahmad F.A., Bora I., Buragohain R., Sarma K., Rahman, Kalita A. and Nongthombam J. (2016) *CAU Farm Magazine*, 6, 4-11.
[19] Kochewad S.A., Meena L.K., Singh S.P. and Singh K. (2017) *South Asian J. Food Technol. Environ*., 3(1), 526-532.
[20] Prinsloo J.F., Schoonbee H.J. and Theron J. (1999) *Water SA*, 25(2), 231-238
[21] Chen Y. (1981) *Chicken farming, In: Integrated farming, Vol. II, Regional Aquaculture Lead Centre, Wuxi, China.*
[22] Devaraj K.V. and Keshavappa G.Y. (1980) *In: Proc. Sem. some aspects of Inland Aquaculture in Karnataka*, 1-7.
[23] Njoku D.C. and Ejiogu C.O. (1999) *Aquaculture Research*, 30, 399-408.
[24] Sahoo U.K. and Singh S.L. (2015) *Int. J. Agric. and Forestry*, 5, 281-286.
[25] Bezbaruah P. (2012) *In: Book of extended summaries, The National seminar on livelihood options for small and marginal farmers in fragile ecosystems, ICAR Research Complex for NEG region, Umaim, Meghalaya.*
[26] Jagadeeshwara K., Nagaraju Y., Bhagyavathi and Nagaraju K. (2011) *Livelihood improvement of vulnerable farmers through integrated farming systems of southern Karnataka*, 145-146.
[27] Pillay T.V.R. (1990) *Aquaculture principles and practices, Fishing News Book, London*, 526-542.
[28] Gangwar L.S., Saran S. and Sarvesh K. (2013) *Agricultural Economics Research Review*, 26, 181-188.
[29] Tripathi H., Tomar, S.S., Pandey R., Solanki V.S., Singh R., Meena K.L., Tomar M. and Adhikari D.S. (2010) *In: 22nd Nat. Sem. "Role of Extension in Integrated Farming Systems for sustainable rural livelihood", 9-10th Dec., Maharashtra*, 42-43.
[30] Chinnabasavanna A.S., Biradar D.P., Prabhudev K.N. and Mahabhaleswar H. (2009) *Karnataka J. Agric. Sci*., 22(1),25-27.