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Livelihood improvement through integrated farming system interventions to resource poor farmers

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ABSTRACT

The field experiment was conducted to study the integrated farming approach over conventional method of agriculture farming. An area of 5.6 ha of land was selected for the experimental trial involving twelve small and marginal farmers at village Chakramdas of Vaishali district in Bihar. The initial survey conducted to assess the farming practice and the economics of conventional farming over developed integrated farming systems (IFS). The crop equivalent yield (q/ha), net returns (Rs/ha) and the Benefit: Cost ratio was calculated both as per farmers practice and as per integrated farming approach. Crop + fish +duck +goat integration supersedes over all other integrations in terms of monetary returns (Rs. 1,07, 828/annum) with a sustainability index of 83.9 while in terms of RGEY, Crop + fish + cattle integration supersedes among other integrations (18.76t/ha) but due to more labour requirement it couldn't supersedes over crop + fish + duck + goat integration in economic terms. Under individual component goat rearing again supersedes over other enterprises with a B: C ratio of 2.7. Additional nutrient gain in terms of NPK was found highest with poultry upon nutrient recycling within the system.

Keywords: Integrated farming system, system productivity, yield, nutrient recycling, economics, sustainability index, employment

INTRODUCTION

Indian economy is mainly agriculture oriented where small and marginal farmers are the core of the Indian rural economy constituting 85% of the total farming community but possessing only 44% of the total operational land (GOI, 2014). In Bihar and Kerala, the average size of holding fell by more than three times during the last four decades, whereas in Andhra Pradesh, Karnataka, Madhya Pradesh and Maharashtra, it has reduced by more than two times. This is reflective of the immense population pressure on the limited land resource available for cultivation. The declining trend of per capita land availability poses a serious challenge to the sustainability and profitability of farming (Siddeswaran *et al.,* 2012). Due to ever increasing population and shrinking land resources in the country, practically there is hardly any scope for horizontal expansion of land for food production. Only vertical expansion is possible by integrating appropriate farming components that require lesser space and time to ensure reasonable periodic income to farm families (Gill *et al.,* 2009). A system approach is the need of the hour for fulfilling the demand of ever increasing population without disturbing the ecological balance. Integrated farming system seems to be the possible solution to the continuous increase of demand for food production, stability of income and nutritional security particularly for the small and marginal farmers with limited resources.

Integrated farming system is the system invariably having combination of crop and animal components where the product and byproduct of one component can be used as input for another component. Integrated farming and mixed farming benefits more in terms of economic returns than the mono crop. The demand for food is increasing day by day due to decreased food production; there is continuous conversion of agricultural lands to residential lands and also the number of farmers working in the field is drastically reduced. The primary objective of the IFS is to maintain production of food and other goods and services that contribute to food security and income generation to the rural poor (Kumar *et al.,* 2016). Other functions that are just as important are achieving environmental sustainability and contributing to agriculture sustainability and ecosystem services. This would imply that these systems have components that incorporate the concepts of multifunctionality. Multifunctionality is interpreted in terms of multiple roles assigned to agriculture (Groenfeldt, 2005). In the framework of multifunctionality agriculture as an activity is entrusted with performing four main functions in society, namely, food security and environmental, economic and social functions. In general, increasing the number of functions tends to increase the stability of agriculture and land use (Price, 2000). Added to this, the use of diverse plants and animals broadens possible sources of income generation.

Many attempts have been made to integrate the desirable features of farming system research into the mainstream agricultural research so that the technologies developed are relevant, client-oriented and location specific. Integrated farming system is a reliable way of obtaining high productivity with substantial nutrient economy in combination with maximum compatibility and replenishment of organic matter by way of effective recycling

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of organic residues/wastes etc. obtained through integration of various land- based enterprises (Solaniappan *et al,* 2007). The 80 % of operational farm holdings in India as well as in the eastern India is less than one ha. The poor farmers with small land holdings concentrate only on crop production, mainly cereals only with high risks of flood and drought. Historical records indicate that extreme excess/deficit occurs in any form of severity in one or other part of the region in every year. Climate model simulations (Hennessey *et al.,* 1997) and empirical evidences confirm that warmer climates, owing to increased water vapor, lead to more intense precipitation events and therefore increase risks of floods (IPCC, 2007) and similarly, larger breaks within the monsoon season may cause severe drought conditions across the region. The recent extreme rainfall deficit occurred over Bihar during June and July of 2009 incurred a loss of Rs. 1839 crores to state exchequer (Khan *et al.,* 2009). Thus, small and marginal farmers can take a suitable crop along with horticulture, animals, fisheries and other components that would minimize risks and provide additional income and employment from the same piece of land per unit time, apart from improving soil fertility over a period of time. Integrating different components with crop will increase the profitability through recycling of wastes of one component into another (Kumar *et al.,* 2012a). Therefore, an attempt was made to conduct a trial at field level to improve the agricultural farming with the following objectives: to make aware the farmers regarding functioning of integrated farming systems, to increase land and water productivity with minor and major interventions and making alteration in the existing system, to enhance employment to farm families and to ensure better economic returns and enhancing livelihood of the poor farmers.

MATERIALS AND METHODS

The experiment was conducted at Chakramdas village, Vaishali district, Bihar, India during the year 2011-14. Twelve farmers were selected for a total land holding of 5.6 hectare. In the model, crop, horticulture, livestock, fishery and mushroom was integrated as main enterprise while mushroom and vermicomposting were taken as allied enterprise. It comprised of main crops like rice, wheat, green gram, mustard and maize. Initial baseline data was collected upon through survey by adopting PRA technique. Based on PRA survey, seven integrated farming systems were developed in an area of 0.8 ha each. The intervention on necessary critical inputs (Improved crop seeds and seedlings, Vegetable seeds, spawn for mushroom raising, animals like goat, poultry, fodder) provided based on integrated farming approach without affecting the main crops. Training and demonstrations were also organized (on seed treatment) to create awareness among the farmers for integrated farming. Exposure visits to different IFS models in Bihar and Jharkhand states were organized to motivate the farmers for creating interest and to know the functioning of integrated farming systems. Apart from this, several field visits and exposure visits were also organized to enhance the knowledge regarding the latest technologies and to clear any doubt regarding the developed technology. The technical knowledge of farmers was also enriched by carrying out different training programmes on horticultural crops, livestock production and management, fishery, mushroom raising, vermicomposting, poultry raising, goat rearing, duck rearing etc. Several interventions were also demonstrated in the farmers' fields to produce creeping vegetables like ridge gourd, cucumber, bitter gourd, sponge gourds and other vegetables like tomato, cauliflower, beans on the field bunds and on the fencings. Backyard poultry with Gram Priya/Vanraja and broiler rearing were also promoted. Farmers were trained regarding the integrated farming and also mixed farming to achieve better returns. The field experiments/demonstrations were monitored regularly. Yield from different enterprises, net returns and B:C ratio were calculated and calculated data with initial survey data were statistically analyzed by using paired students 't' test for further interpretation.

RESULTS AND DISCUSSION

Productivity from different crops

Crop yields were recorded and the crop equivalent yield was calculated and analyzed statistically using paired student's t test. The average crop equivalent yield (q/ha) varied significantly from 10.3 (Farmers' practice) to 13.8 (improved

Table 1: Average Productivity (RGEY) t/ha and economics of different farming systems (mean value of 3 years, 2011-2014)

Farming Systems	RGEY (t/ha)	Capital cost	Deprecia-tion value/year	Production cost (INR/ha)	Total Producti on cost (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	Net return /day (Rs.)	Sustain ab-ility Index
Crop alone	10.03	---	---	60,337	60,587	1,20,400	59,813	164	39.4
Crop + fish + poultry	17.02	1,00,000	9,600	91,002	1,00,852	2,04,240	1,03,388	283	79.8
Crop + fish + Duck	13.82	1,02,625	10,308	77,477	88,035	1,65,880	77,845	213	56.1
Crop + Fish + goat	16.55	1,15,500	11,050	85,044	96,344	1,98,600	1,02,256	280	78.7
Crop+fish+duck+goat	18.11	1,33,125	13,158	96,044	1,09,452	2,17,280	1,07,828	295	83.9
Crop + fish + cattle	18.76	1,50,000	14,500	1,26,213	1,40,963	2,25,160	84,197	231	62.0
Crop+fish +mushroom	13.45	1,05,000	10,100	70,799	81,149	1,61,360	80,211	220	58.3
Mean	15.39	1,17,708	11,453	86,702	96,769	1,84,703	87,934	241	65
SD	3.10	19,939	1,946	21,224	25,034	37,209	17,349	48	
CV (%)	20.1	16.9	17.0	24.5	25.9	20.1	19.7	19.7	

Note: Total Production cost includes depreciation value, land revenue and interest on working and fixed capitals.

technology)and upto 18.76 through IFS model (Table 1). The increase in the crop production may be due to intervention on seed treatment, growing of improved varieties, application of bio- fertilizers like *Trichoderma spp.,* green and farm yard manure, timely application of nutrient sprays and pesticides to control pest and by adoption of suitable cropping systems for the better returns. The effectiveness of the use of microorganisms as biofertilizers and biocontrol however, is determined by a myriad of factors including virulence of the isolate, environmental factors, time of application, ability to survive in the environments other than their origin and colonize plants roots during certain period of time to control plant pathogens. Application of Trichoderma along with green manure and FYM improved germination of seeds and soil fertility (Sheila *et al.,* 2011). Growing new varieties of different crops also contributed more than 16 percent in yield increase of particular crop.

Productivity from livestock

India has emerged as the fourth and fifth largest producer of eggs and poultry meat, respectively in the world even though per capita availability is just 40 eggs and 1.2 kg poultry meat as against the ICMR recommendations of 180 eggs and 11 kg of poultry meat. Backyard poultry production system is one of the best profitable component of farming system as it involves very little expenditures for rearing of chicks and backyard rearing is within the reach of an ordinary farmer who with minimal input can manage independently, skillfully and successfully. Vanaraja, Gramapriya in poultry (Jaishankar *et al.,* 2014)gave encouraging results under traditional backyard and semi-intensive system of poultry production with an improved productivity, adaptability and disease resistance. Birds are let out into the field for scavenging during the day time and balanced supplementary feed of about 25-30g/bird/day is provided during night hours. The body weight was increased from 1.5 kg to 2.5-3.0kg over a period of six months in case of backyard poultry while body weight achieved with broilers were 1.5-1.8kg in a time span of 35 days which fetches an annual income (Rs. 29,400/100 birds in seven cycles) to the farmers and motivated the farmers for rearing of broiler chicks under integrated farming system (Kumar *et al.,* 2012b).

50 nos. of Black Bengal goats were also reared in the system which fetches an additional income of Rs. 65000/year due to sale of live goats for meat purpose. Black Bengal is a very popular local breed of eastern India and its kidding capacity is twice a year in form of triplets or quadruplets. This component is considered as ATM (Any time money) to the resource poor farmers. The goats were stall fed and for feeding the goats 200m^{2}area was allocated for fodder production and, Berseem- maize- cowpea and Oat- cowpea-napier grass rotations were followed. Results on these combinations for three years over the study sites revealed that integration of crop +fish +duck + goat resulted higher average sustainability index (83.9 percent). Cropping alone has resulted in lower sustainability index value of 39.4 percent only.

The highest yield from different cropping sequences was obtained with vermicompost (12.43t/ha) and was followed by poultry recycled droppings with pond silt (12.32t/ha). While, considering the individual animal component, average productivity of 5.56 t was obtained with 20 + 1 goat unit. The goat unit also produced 2.3 t of goat manure, which was used in crops within the system. While, assessing the feasibility of rearing fish by using poultry and duck droppings as feed, the fishes fed with poultry droppings resulted in higher average fish yield of 170 kg/0.06 ha over duck fed droppings (140kg/0.06 ha) during the experimental period (Table 2). A higher level of fish productivity through recycling of poultry manure was reported by Singh *et al.*(2004) owing to better plankton development as well as direct feed to fishes.

Table 2: Average Productivity (RGEY) and economics of individual components under developed IFS model (mean value of 3 years, 2011-2014)

Components	RGEY (t)	Production cost	Gross returns	Net return	B: C ratio
Crop alone	8.02	48270	96840	97970	2.0
Crop + poultry manure	9.84	52173	118080	65907	2.3
Crop + Duck manure	9.60	52408	115240	62832	2.2
Crop + goat manure	9.78	52022	117360	65380	2.3
Crop + FYM	9.68	51853	116160	64307	2.2
Crop + vermicompost	9.94	52290	119280	66990	2.3
Poultry (100 no./batch)	4.50	24,600	54,000	29,400	2.2
Duckery (30 + 5)	1.56	10,988	18,668	7,680	1.7
Goat (20 +1)	5.56	24,496	66,748	42,252	2.7
Cattle (3+3)	7.99	66,342	95,872	29,530	1.4
Mushroom (100 bags)	1.06 (155 kg)	5706	12720	7014	2.2
Fish fed with poultry dropping (0. 06 ha)	0.99 (170 kg)	4,861	11,991	7,130	2.5
Fish fed with duckry dropping (0. 06 ha)	0.82(140 kg)	4,836	9,849	5,013	2.0
S.E.M. ±	-	254.6	576.1	351.6	0.013
C.D. (0.05)	-	746.7	1543.05	1031.2	0.039

Note: Figures in parenthesis denotes actual yield, RGEY: Rice grain equivalent yield

Productivity from individual components

For efficient utilization of ponds' water composite fish culture with Rohu, silver carp, Common carp were undertaken in an area of 1200m^2. A duck shed was also constructed in the pond (for 35 ducks of Khakhi Cambell breed) and their feces were fed to the fish as feed. On and around the bund small fruit plants like guava, papaya, lemon and banana were raised which had added an additional income of Rs. 6,890/year. 310 kg (RGEY 1.8t) of fish yield and 5625 nos. of duck egg were also produced from the system which enhanced the system productivity, water productivity and net returns of the system by Rs. 7680/annum (Kumar *et al.*, 2012b). Further, 100 bags of oyster mushroom was also cultivated in the developed IFS model, which has added 155 kg of fresh wt. (RGEY 1.06t) of mushroom with a net return of Rs. 7014/year (Table 2).

Nutrient recycling

Samples of raw animal and bird manures, recycled products like FYM, goat manure, vermicompost and silted silt in the ponds were collected and analyzed for their NPK contents. The average quantity of nutrients received through poultry, duck, goatry, cattle as droppings and plant wastes in form of vermicompost for the study sites had been presented in Table 3. Residue recycling revealed that integration of crop with fish and poultry resulted in higher fish productivity over duck dropping fed fishes which resulted in higher net return of INR 7130/year from 0.06 ha of pond. Poultry unit had produced 2857 kg of raw droppings and out of total raw droppings produced, 25 per cent was fed to fishes and from the rest 75 percent poultry manure were prepared and applied to the crops while, in case of duck unit, 1508 kg raw dropping were produced per year and total droppings were allowed to fed to fishes. Poultry and duck unit had generated an average of 51.7, 31.4, 24.6 and 27.0, 9.9, 15.2 kg N, P_2O_5 and K_2O/year, respectively. Recycling of droppings through fish ponds, enhanced the nutrient content by 2folds (76.0, 42.5, 35.0 and 45.5, 18.2, 32.0 kg of N, P_2O_5, K_2O) for 25 percent of poultry and whole duck droppings, respectively. Apart from this, poultry unit had also provided 79.7, 57.3 and 26.5 kg of N, P_2O_5, K_2O in form of poultry manure. From raw goat droppings (2300kg), goat manure was prepared, through which 14.2:8.1:4.5kg additional NPK was gained (Table 3). In case of FYM and vermicompost also additional nutrients were gained through recycling. Applications of these nutrients as organic sources not only increased the yield but also reduce the application of inorganic fertilizer and thereby increased

Table 3: Average nutrient recycling within integrated farming systems (mean value of 3 years, 2011-14)

Nutrient	Raw poultry dropping		Poultry manure (75 %)		Pond manure (25 %)		Additional nutrient gained by recycling
	%	kg/2857 kg	%	kg/2143 kg	%	kg/5000 kg	kg
N	2.81	80.2	3.72	79.7	1.92	95.8	95.4
P_2O_5	1.82	51.9	2.67	57.3	0.99	49.8	55.23
K_2O	0.86	24.6	1.23	26.5	0.74	36.8	38.67
	Raw duck droppings				Pond manure		Additional nutrient gained by recycling
	%	kg/1508 kg			%	kg/5000 kg	kg
N	1.79	27.0			0.91	45.5	18.5
P_2O_5	0.65	9.9			0.36	18.2	8.3
K_2O	1.01	15.2			0.62	32.0	16.8
	Raw goat droppings		Goat manure				Additional nutrient gained by recycling
	%	kg/2300 kg	%	kg/1840 kg			kg
N	1.48	34.1	2.62	48.3			14.2
P_2O_5	0.92	21.1	1.59	29.2			8.1
K_2O	0.66	15.2	1.08	19.9			4.5
	Raw cow dung		Farm Yard Manure				Additional nutrient gained by recycling
	%	kg/13,333 kg	%	kg/10,667 kg			kg
N	1.19	158.2	1.96	209.3			51.2
P_2O_5	0.71	94.3	1.61	171.6			77.5
K_2O	1.11	143.5	1.89	201.2			57.7
	Plant waste		Vermicompost				Additional nutrient gained by recycling
	%	kg/1087 kg	%	kg/761 kg			kg
N	1.12	10.9	2.47	17.5			5.83
P_2O_5	0.83	8.1	2.12	14.3			5.63
K_2O	1.03	9.9	2.22	15.8			5.13

net return. Manure prepared through recycling of poultry droppings, duck droppings, pond silt, FYM, goat manure and vermicompost (crop residues+mushroom wastes) within the farm acted as an efficient and valuable input for crop production. Acharya and Mondal (2010) also reported similar benefits due to recycling of different animals' droppings and plant wastes from their findings. If we analyze all animal and plant wastes, then it can be interpreted that cattle recycled droppings had generated highest P_2O_5 (31.4 kg) and K_2O (24.6 kg) while poultry had generated highest N (51.7 kg) into the system. Kumar *et al.* (2012) also reported that due to nutrient recycling of different wastes an ample amount of N, P205 and K20 was added into the field soil. The additional nutrients gained by recycling of waste/byproducts over raw wastes were also confirmed by Rangasamy and Jayanthi (1994) and Baishya *et al.* (2004) in lowland situation.

Employment generation

Total employment generated through different farming systems varied due to labor requirement of different enterprises. The labor requirement was increased by100,110, 110,170,210 and 240 man-days in crop + fish + poultry, crop + fish + mushroom, crop + fish + duck, crop + fish + goat, crop + fish + cattle and crop + fish + duck + goat, respectively. Thus crop + fish + duck + goat combination required maximum number of man days/labour *i.e.* 622 man-days and was followed in respect of labor requirement by crop + fish + duck + goat combinations (412 man-days). However, crops grown in conventional system required least man-days (286 man-days) whereas crops grown in farming system required 96 additional man-days (372 man-days) due to inclusion of one more crop in the sequence and for carrying out other improved practices. The results are in conformity with the findings of Vittal *et al.*, 2002.

CONCLUSION

On the basis of above results, we can conclude that resource poor farmers couldn't thrive healthy with traditional farming (rice- wheat) rather than farming with system mode. It is also demand of time to adopt integrated farming system practices on larger scale as it not only ensures economic net returns but also provides employment and nutritional security to farm families and others. Here, Crop + fish + duck + goat combination had resulted as most appropriate integration and provided maximum net return and employment followed by crop + fish + poultry and crop + fish + goat combination in the eastern part of the country.

To sustain food and nutritional security the approaches of IFS is highly recommendable which will conserve the resource base through efficient recycling of farm wastes within the system. The dissemination of such integrated farming system models will help in anchoring sustainability in agriculture and its allied sectors with robust economy. There is need to formulate suitable policies by the government to promote integrated farming system models on a massive scale.

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REFERENCES

Acharya D and Mondal SS 2010.Effect of integrated nutrient management on the growth, productivity and quality of crops in rice (*Oryza sativa*) - cabbage (*Brassica oleracea*) – green gram (*Vignaradiata*) cropping system. *Indian Journal of Agronomy* **55** (1):1-5.

Baishya A, Pathak AK, Bhowmick BC and Ahmed S. 2004. Predominant farming system and alternatives in Assam. In Altenate farming systems: Enhanced income and employment generation options for small and marginal farmers (editors). Singh AK, Gangwar B and Sharma SK, PDFSR, Modipuram (U.P.) India.

Gill MS, Singh JP and Gangwar KS. 2009. Integrated Farming System and agriculture sustainability. *Indian Journal of Agronomy* **54** (2): 128-39.

GOI 2014.Agricultural statistics at a glance, Directorate of economics and statistics, Govt. of India, New Delhi.

Groenfeldt D. 2005. Multi functionality of agricultural water: Looking beyond food production and ecosystem service. Paper prepared for the FAO/Netherlands international conference on water for food and ecosystems. The Hague, January 31 – February 5, 2005

Hennessey KJ, Gregory JM and Mitchell JFB. 1997. Changes in daily precipitation under enhanced greenhouse conditions. *Climate Dynamics* 13:667–680.

Intergovernmental Panel on Climate Change (IPCC) (2007). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, edited by S. Solomon *et al.,* Cambridge Univ. Press, Cambridge, U. K.

Jaishankar N, Janagoudar BS, Kalmath Basavaraj, Naik VP and Siddayya S. 2014. Integrated Farming for Sustainable Agriculture and Livelihood Security to Rural Poor. Int'l Conference on Chemical, Biological, and Environmental Sciences (ICCBES'14) May 12-13, 2014 Kuala Lumpur (Malaysia), pp: 22-24.

Khan MA, Singh KM, Singh SS, Upadhyaya A, Srivastava AK, Dey A, Kumar U and Subash N. 2009.Bihar Agricultural Contingency Plan – Mimeograph M01/PAT-01/2009, ICAR-RCER, Patna, Bihar, India.

Kumar Sanjeev, Shivani, Singh KM and Singh AK. 2016. Integrated farming systems in changing agricultural scenario. *In* souvenir: National conference on rural livelihood security through innovative agri- entrepreneurship (12-13 March, 2016) at ICAR- CPRS, Patna (Bihar), pp. 36-46.

Kumar Sanjeev, Singh SS, Meena MK, Shivani and Dey A. 2012a. Resource recycling and their management under integrated farming system for lowlands of Bihar. *Indian Journal of Agricultural Science* **82**(6):504-10.

Kumar Sanjeev, Subhash N, Singh SS, Shivani and Dey A. 2012b.Evaluation of different components under Integrated farming system (IFS) for small and marginal farmers under semi- humid climatic environment. *Experimental Agriculture* **48**(3):399-413.

Price T. 2000. Cultivation our futures. Final Paper. OECD Publications No. 2.Organization for Economic Co-operation and Development.

Rangasamy A and Jayanthi C. 1994.Recycling of organic wastes in integrated systems. In: Proceedings of national Training on Organic Farming, Government of India; TNAU, Coimbatore, 1-8 September, 1994.

Sheila a Okoth, jane a Otadoh and James o Ochanda. 2011. Improved seedling emergence and growth of maize and beans by trichoderma harziunum. *Tropical and subtropical agroeco systems*, 13:65-71

Siddeswaran K, Sangetha SP and Shanmugam PM. 2012. Integrated farming system for the small irrigated upland farmers of Tamil Nadu. (in) Extended Summaries Vol 3: 3rd International Agronomy Congress, pp.992-93, held during 26-30 November 2012 at New Delhi.

Singh K, Singh AK, Singh KK and Singh CS. 2004.Analysis of farming systems in north eastern plain zone of Uttar Pradesh. *Journal of Farming Systems Research and Development* **10** (1-2):1-6.

Solaniappan U, Subramanian V and Maruthi Sankar G R. 2007.Selection of suitable integrated farming system model for rainfed semi-arid verticinceptisols in Tamilnadu. *Indian Journal of Agronomy* **52** (3): 194-197.

Vittal KPR, Mauthi Sankar G R, Singh H P and Sharma J S. (2002). Sustainability index. In: Sustainability of practices of Dryland Agriculture: Methodology and Assessment, Central Research Institute for Dryland Agriculture, Hyderabad.

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