

41 9.06 million ton of residue burnt every year in Haryana. The residue of crop can play an
42 important role in the cycling of nutrients as rice straw at harvest contains typical amounts of
43 nutrients are 5-8 kg N, 0.7-1.2 kg P, 12-17 kg K, 0.5-1 kg S, 3-4 kg Ca, 1-3 kg Mg, and 40-70 kg
44 Si per ton of straw on a dry weight basis (Dobermann and Witt, 2000). According to Singh
45 (2000), in Haryana 3 percent soils during 1980 had low P content and by 1995, the earlier figure
46 jumps to 73 percent, while low N content area increased to non-significant extent (from 89 to 91
47 percent). Soils with higher K values had come down from 91 percent (in 1980) to 61 percent (in
48 1995). The reason is clear that residue burning is deteriorating the soil health and to maintain the
49 crop yield in the region we have to put more chemical fertilizers, which will increase the cost of
50 cultivation. Mulching with rice straw along with sowing of wheat in no-till conditions emerged
51 as one of the important system (Sidhu *et al.* 2007) known as In-situ crop residue management. In
52 Punjab the wheat yield in plots sown with happy seeder was significantly more (3.24%) than the
53 conventionally sown wheat (Sidhu *et. al* 2011). Chakraborty *et al.* (2008, 2010) also reported that
54 mulching with rice straw increased wheat grain yield, reduced crop water use by 3-11% and
55 improved WUE by 25% compared with no mulch. Therefore we need to adopt the newer
56 technology for sustainability of the rice-wheat cropping system.

57
58 Extension services in India have traditionally been funded and delivered by government.
59 Till the 1960s, agricultural extension was purely a function performed under the guidance of the
60 State Departments of Agriculture. ICAR also initiated some programmes as the Lab-to-Land
61 Programme in 1979 and the Operational Research Programme in 1976 that were merged with the
62 KVKs in the 1990s. (Birner *et. al*, 2007). Likewise to cater the problem of residue burning, the
63 government of India initiated Central Sector Scheme on “Promotion of Agricultural
64 Mechanization for In-Situ Management of Crop Residue” in the states of Punjab, Haryana, Uttar
65 Pradesh and NCT of Delhi during the year 2018 with an outlay of 1152 crores for this scheme.
66 Information, Education and Communication (IEC) were the important component of this scheme
67 and state agri. departments/ KVKs, ICAR Institutes and SAUs are the important partners in this
68 endeavor. The main emphasis of this project was on **capacity building, environment building**
69 **and stimulating young minds for making awareness** among all stakeholders for the in-situ
70 crop residue management (Anonymous, 2018).

71 72 **Material and methods**

73 Ambala is an intensively rice-wheat growing district in Haryana (Fig. 1). Conventional rice-
74 wheat rotation was being followed on the field from last 15 years. The climate of the area is
75 semiarid, with an average annual rainfall of 1100 mm (75–80% of which is received during July
76 to September), minimum temperature of 0 to 4°C in January, maximum temperature of 38-42°C
77 in June, and relative humidity of 67 to 83 per cent throughout the year. It has six blocks i.e.
78 Ambala-I, Ambala-II, Saha, Barara, Naraingarh and Shahjadpur shown in the map (Fig 1).

79 In view of above and in pursuance to the Budget 2018 announcement regarding a special
80 Scheme to support the efforts of the governments of Haryana, Punjab, Uttar Pradesh and the
81 NCT of Delhi to address air pollution and to subsidize machinery required for in-situ
82 management of crop residue, a new Central Sector Scheme on ‘Promotion of Agricultural
83 Mechanization for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar
84 Pradesh and NCT of Delhi’ for the period from 2018-19 to 2019-20 has been approved.

85 The scheme was having following objectives:-

- 86 • Protecting environment from air pollution and preventing loss of nutrients and soil micro-
87 organisms caused by burning of crop residue;
- 88 • Promoting in-situ management of crop residue by retention and incorporation into the soil
89 through the use of appropriate mechanization inputs;
- 90 • Promoting Farm Machinery Banks for custom hiring of in-situ crop residue management
91 machinery to offset the adverse economies of scale arising due to small landholding and
92 high cost of individual ownership.
- 93 • Creating awareness among stakeholders through demonstration, capacity building
94 activities and differentiated Information, Education and Communication strategies for
95 effective utilization and management of crop residue.

96 For the final implementation of the scheme in the Ambala district, a district level executive
97 committee (DLEC) was constituted in which Deputy Commissioner allotted as the Chairman,
98 Deputy Director Agriculture (DDA) as Member Secretary and Assistant Agricultural Engineer
99 (AAE) as Co-Member Secretary of the committee. DLEC was responsible for carrying forward
100 the objectives of the scheme for project formulation, implementation and monitoring. In this
101 notification the individual farmers, Co-operative Societies of farmers, FPOs, Self-Help Groups,
102 registered Farmers Societies/farmers groups, Private Entrepreneurs, Group of women farmers or
103 self-help groups were invited to avail the benefits of scheme.

104

105 Anju and satbir, 2017 found that newspaper, public agriculture sector, television, radio
106 are the major source of accessing latest information by the farmers in Haryana. Therefore, for
107 wider coverage of the scheme both the agencies i.e. department of agriculture and Krishi Vigyan
108 Kendra-Ambala were also utilized these tools. These were broadcasting of the information about
109 the scheme through newspapers, radio jingles on FM radio and television programmes via DD-
110 Kisan channel. Department of agriculture published the notification in various newspapers and
111 on the official website of department of Agriculture and by using kisan message portal the KVK
112 broadcasted the message about the scheme. Placing of hoardings which address the benefit of
113 using CRM machinery, slogan writing at prominent places in the Ambala district. The leaflets
114 were also distributed among the framers by which they can know about the ill effects of burning,
115 benefits to civil society, improvement in soil health and recent development in crop management
116 related machinery and equipment.

117

118 **Results and discussion**

119 In Ambala district for establishment of custom hiring centers and for individual farmers
120 two kinds of schemes were launched i.e. in the first case for CHC, the targeted group have to
121 purchase the machinery from the 8 listed machineries and their cost should be of 35 percent of
122 the total cost of the CHC. The CHC should have minimum of Rs. 10 lac and maximum of Rs. 75
123 lac. The assistance in the form of subsidy was given as 80% of the project cost of the in-situ crop
124 residue management implements. The remaining other 65% project cost may include other
125 machinery and equipment for crop production for which financial assistance was given as 40%
126 of the project cost. In the other scheme, in which the targeted beneficiary was the individual
127 farmer have to purchase the 1-3 among the 9 listed crop residue management related machinery.
128 The 9 listed machinery were Super straw management system for combine harvester, Happy
129 Seeder, Paddy straw chopper/Mulcher, Shrub master/Cutter cum spreader, Hydraulic reversible
130 mould board plough, Rotary slasher, Zero tillage seed drill and Rotavator. For the purchasing of

131 quality machinery for efficient operation, the government also empaneled the approved
132 manufacturers from the testing agencies.

133 To curb the residue burning in Ambala, the department has set up the 75 custom hiring
134 centers. Out of 75 CHCs, 17 centers were related to kisan club or societies and 58 related to the
135 farmers. The Ambala district categorized into 6 blocks i.e. Ambala-I, Ambala-II, Saha, Barara,
136 Shahjadpur and Naraingarh. These blocks consists the number of CHCs as Ambala-I (23),
137 Ambala-II (6), Saha (14), Barara (20), Shahjadpur (8) and Naraingarh (4) respectively. The
138 number of implements and their kinds under both the 80 and 40 percent schemes are given in the
139 tables (Table 1 and 2). Approximated Rs. 3.50 crore and Rs. 2.71 crore as subsidy under both the
140 CRM and SMAM schemes were disbursed as DBT to the CHCs owner bank accounts. In which
141 326 and 176 implements were purchased by the CHCs owners under both the schemes
142 respectively (Anonymous, 2019). Block wise spatial distribution of the CHCs in Ambala district
143 has been shown in the maps (Map 2 to 7). For widespread coverage of the area under CRM, we
144 send the details of CHCs to the Farmers of nearby villages via social group network of
145 whatsApp.

146 For maximum utilization of the budget provided to the department of agriculture and to
147 reach tail end farmers, the individual farmers were also called for the purchasing of limited
148 number of implements under the scheme. In which total 183 individual farmers were purchased
149 the machinery. Out of 183 farmers from whole district, block wise number of farmers i.e. 82, 10,
150 31, 19, 17 and 24 from Ambala-I, Ambala-II, Saha, Barara, Shahjadpur and Naraingarh
151 respectively purchased the different crop residue related machinery. In terms of type of
152 implement, 22 Happy Seeder, 1 mulcher, 4 reversible mould board plough, 11 rotavator, 20
153 Straw management system for combine harvester, 7 straw chopper and 16 zero till drill were
154 purchased in the Ambala-I block. In Ambala-II block 3 Happy Seeder, 1 Mulcher, 3 Rotavator
155 and 4 Zero till drill were purchased by farmers. In Barara block 3 Happy Seeder, 4 Mulcher, 4
156 Rotavator, 3 Reversible M.B. plough, 2 Zero till drill, 2 S.M.S. and 1 Straw chopper were
157 purchased by farmers Total subsidy of Rs. 1,07,38,788.00 was disbursed into the bank accounts
158 of farmers.

159 After the purchasing of all machinery purchased by farmers under both the schemes, the
160 Krishi Vigyan Kendra-Tepla, Ambala conducted the hands on training from 11-14, September,
161 2018. The training programme was organized for the farmers and machine operators on the
162 management of crop residue in general and operating machines in particular. Major emphasis
163 was given to harvest the crop with combine harvester fitted with Super Straw Management
164 System (SMS), which initially cuts the crop into small pieces and other operations can be
165 performed easily in the field with particular references to Happy Seeder and other optional
166 machines for in-situ crop residue management. The trainings helped the participants in getting
167 acquainted to the improved machines and knowing various aspects of machine operation and
168 maintenance. Hands-on-training was an integral part of the trainings as the farmers were to use
169 residue management machines practically in the field and covered the topics such as basic
170 information about the machines, their efficient operation in the field, their maintenance and
171 storage, do's and don'ts etc. The farmers were exclusively selected, which have purchased the
172 residue management related machinery i.e. from blocks Ambala-I, Ambala-II, Saha, Barara,
173 Shahjadpur and Naraingarh. Total 497 farmers participated in the training programme from all
174 the blocks.

175
176 **Conclusions**

177 Rice-wheat cropping system has contributed immensely to fulfill the food security in India. But
178 has consequently led to many sustainability issues such as degrading soil health, environmental
179 degradation and declining water resources and further responsible for the stagnating or declining
180 crop productivity in Haryana. In-situ crop residue management is the demand of today by
181 adopting the same, we will be able to sustain the natural resources i.e. soil and water. After a
182 long time period, a mega scheme has been launched by the government in which mass farmers
183 were took part to establish custom hiring centers (CHCs) and owing the new generation
184 agricultural machinery at subsidized rates. In the monitoring study of paddy residue burning in
185 North India using satellite remote sensing by Indian Agricultural Research Institute, New Delhi,
186 it was concluded that total burning events detected were 537, 502 and 332 respectively during
187 the years 2016, 2017 and 2018. It means that number of firing events were reduced by 62 and 51
188 percent in 2018 as compared to firing events in year 2016 and 2017. On the other hand by
189 adopting the technology of in-situ crop residue management we have found reduced cost of
190 cultivation (Wheat) i.e. Rs 28500 ha⁻¹ in Happy Seeder as compared to Rs. 36000 ha⁻¹ in
191 conventional sowing, 25-30 percent water saving, less weed emergence due to mulching and its
192 cost effective management, qualitative grain yield by suppressing terminal heat effect.
193 Consequently, the farmers will be benefited by having higher net return i.e. Rs. 69065 ha⁻¹ in
194 Happy Seeder and Rs. 58500 ha⁻¹ in conventional sowing. Thereby the benefit cost ratio was also
195 higher 3.40 and 2.70 respectively in Happy Seeder and conventional sowing. It is suggested that
196 the full potential of the distributed CRM machinery and equipment's can only be utilized if the
197 district authorities make sure that combine harvester owners will operate the combine after
198 fitment of the super S.M.S. on to their combine harvester for wider adoption of crop residue
199 management.

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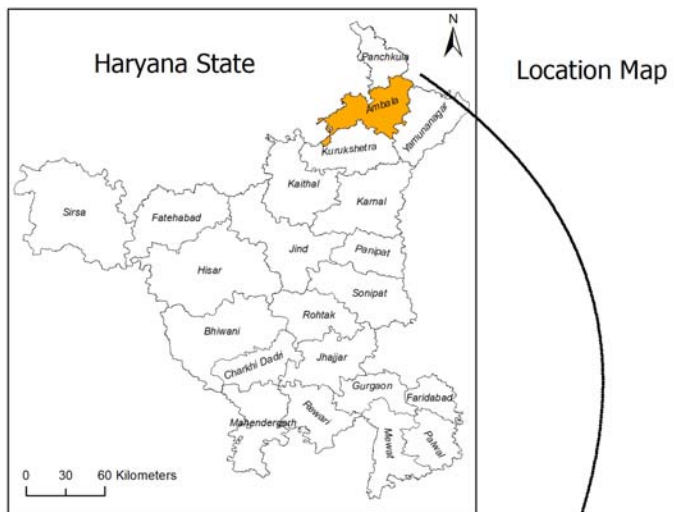
Sr. No	Name of Implement	No of Implements	Subsidy Disbursed (In Lac.)
1	Happy Seeder	78	35,065,766.00
2	Mulcher and Paddy Straw Chopper	60	
3	Reversible MB Plough	47	
4	Rotatory Slasher	7	
5	Rotavator	71	
6	Shrub Master	9	
7	Super straw Management System (S.M.S)	11	
8	Zero Till Seed Drill	43	
	Total	326	

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270
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Sr. No	Name of Implement	No of Implements	Subsidy Disbursed (In Lac.)
1	Combine	1	27,138,108.00
2	Cultivator	17	
3	Disc Harrow	21	
4	Hey Rake	1	

5	Laser Land Leveller	27	
6	Potato Digger	6	
7	Potato Planter	7	
8	Power Harrow	6	
9	Power Tiller	4	
10	Reaper Binder	0	
11	Straw Baller	2	
12	Straw Reaper	8	
13	Tractor mounted spray pump	6	
14	Tractor	70	
	Total	176	
	Grand Total	502	62,203,874.00

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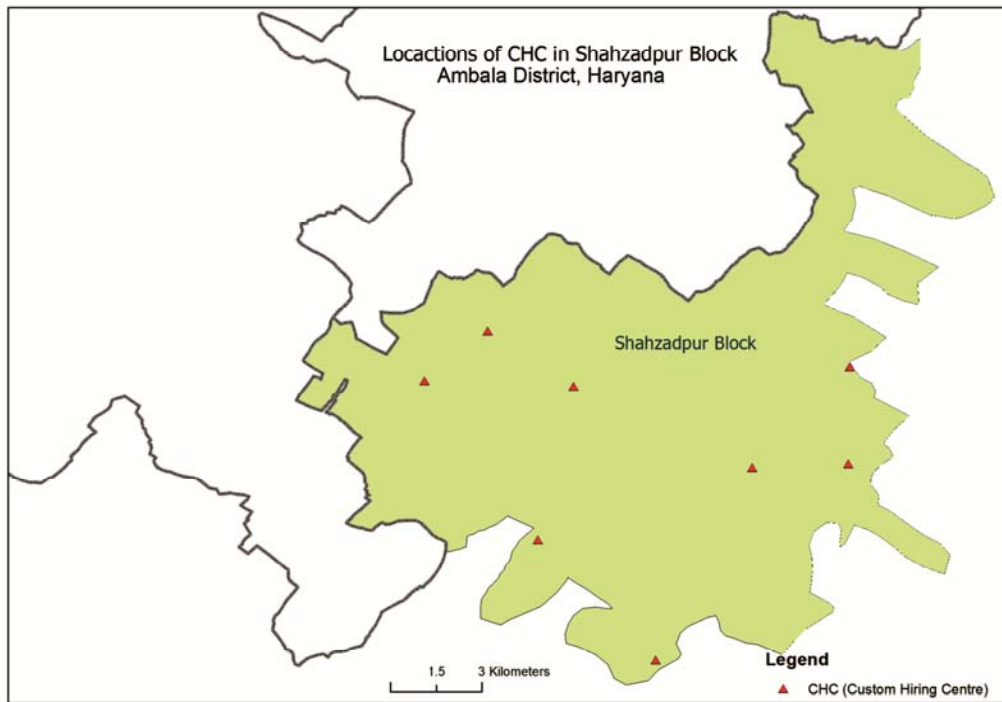


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274 **Fig. 1. Location map of Ambala District, Haryana, India**

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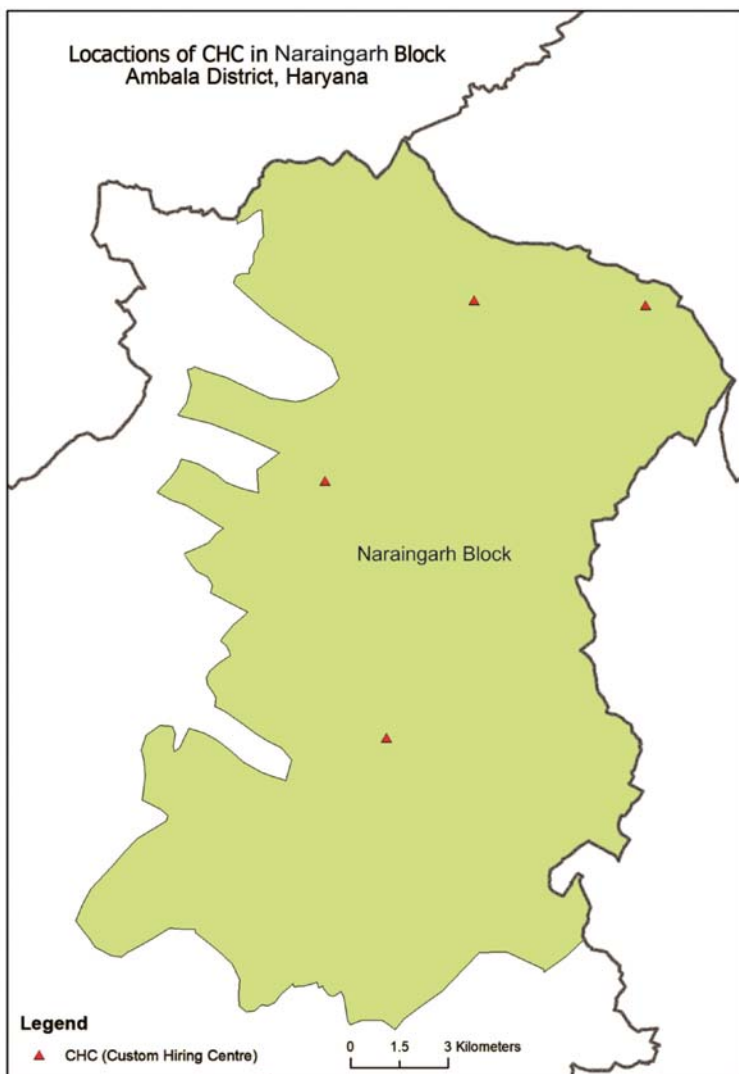
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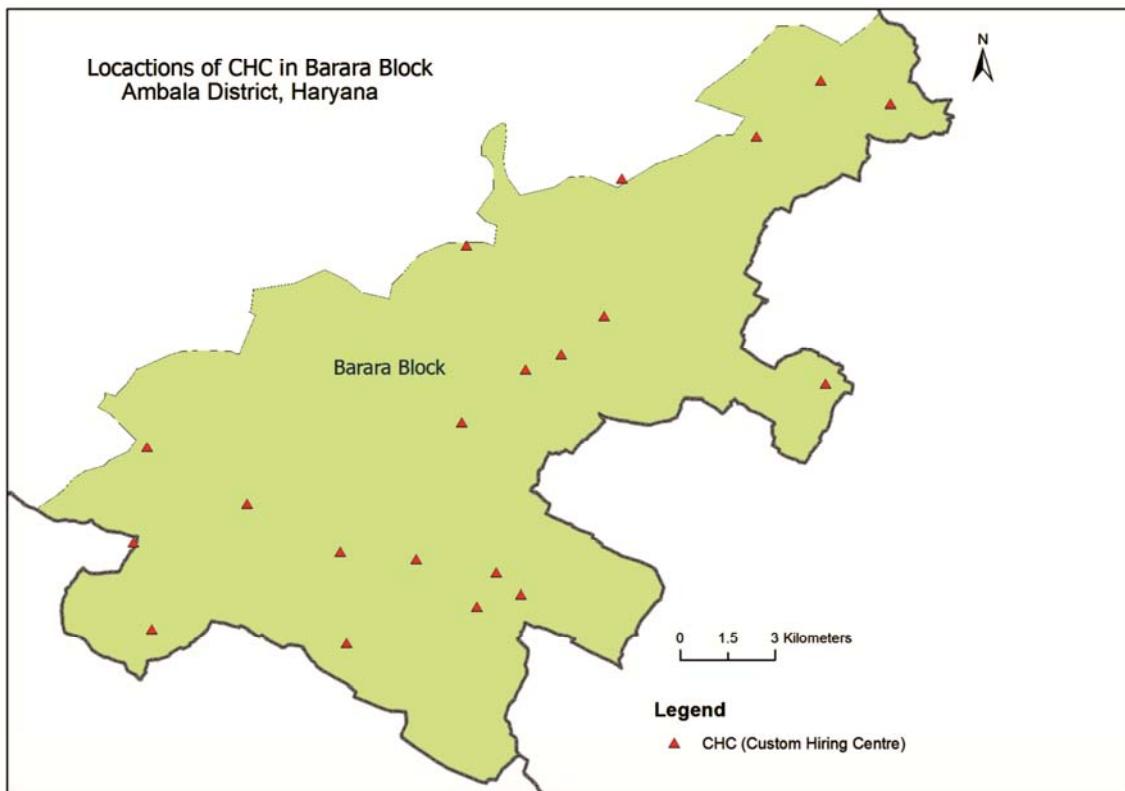
279 **Fig. 2. Location of CHC in Shazadpur Block, Ambala, Haryana,**



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282 **Fig. 3. Location of CHC in Naraingarh Block, Ambala, Haryana**

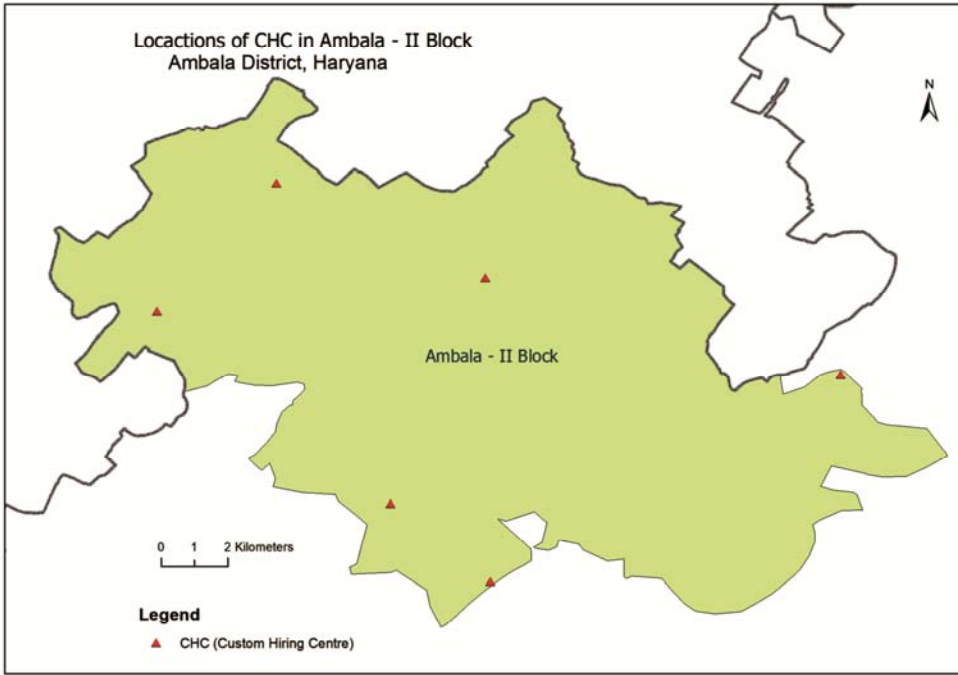


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285 **Fig. 4. Location of CHC in Barara Block, Ambala, Haryana**

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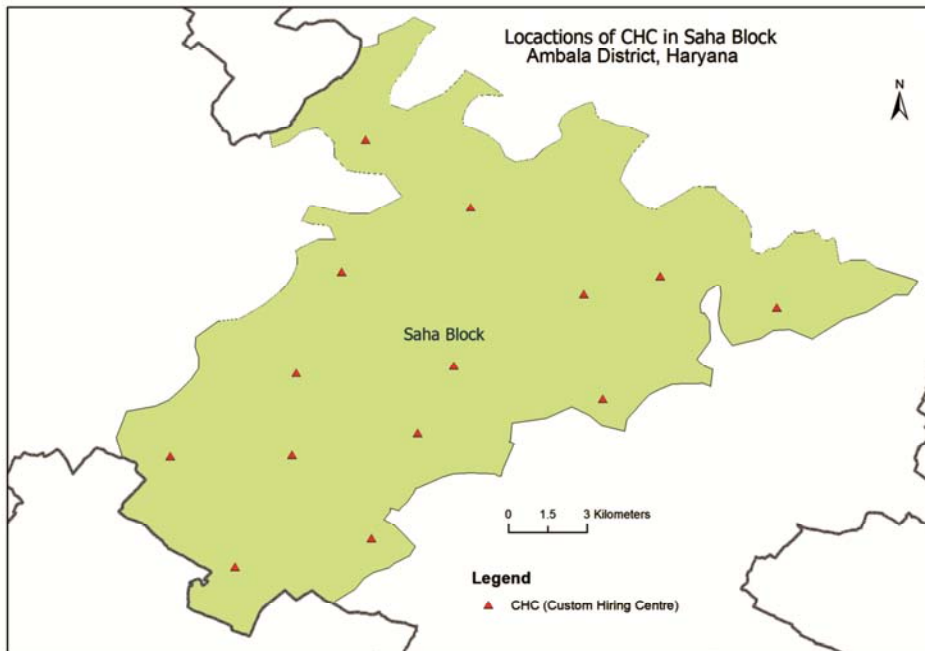
288 **Fig. 5. Location of CHC in Ambala-II Block, Ambala, Haryana**

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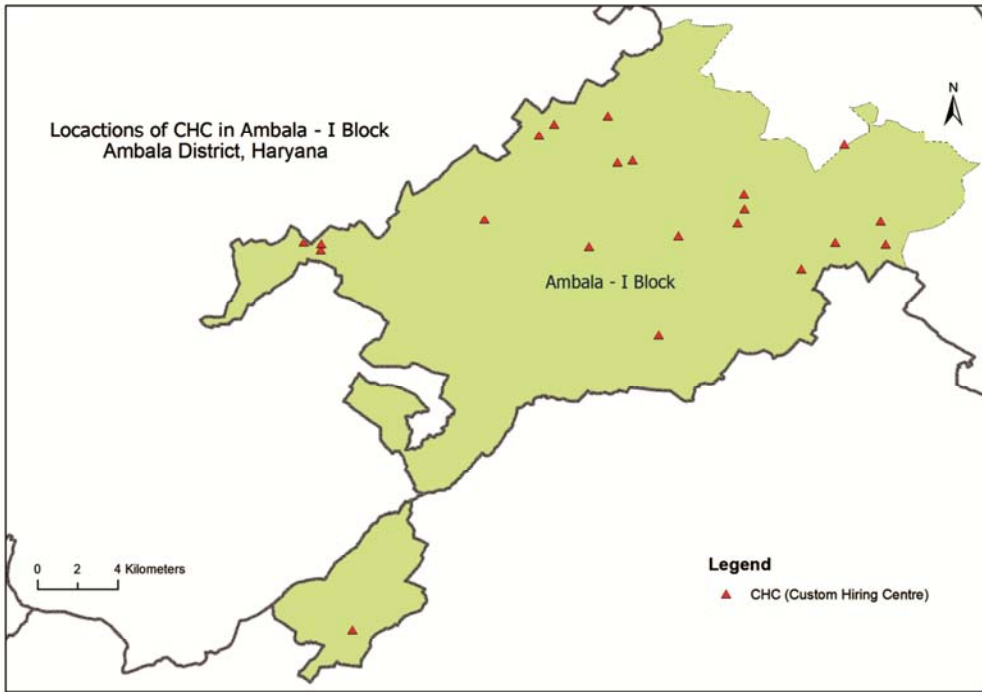
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294 **Fig. 6. Location of CHC in Saha Block, Ambala, Haryana**

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299 **Fig. 7. Location of CHC in Ambala- I Block, Ambala, Haryana**