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Participatory Weed Assessment for Promoting Precision and Sustainability

DEBABRATA BASU, SUDIPTA BANERJEE, RUPAK GOSWAMI, DURBA BISWAS

Agricultural Extension, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia. Pin - 741235

ABSTRACT

Participatory Weed Assessment (PWA) is a relatively new approach in weed management that is based on the stakeholders' experience and wisdom over years in a particular agro-ecological environment and it promotes development through more reliable and updated database of weed infestations and management quickly. Though there has been works on weed mapping, especially in combination with Geographic Information System (GIS) or Global Positioning System (GPS), little research has been carried out on participatory weed mapping alone. The current weakness of precision weed management is that of poor capability to create reliable weed maps rapidly and cost effectively. Many research projects have used a grid map (i.e. discrete points), and a few have mapped continuously from a specialised vehicle or combine harvester to create weed maps. However, these methods are time consuming and there is still a need to develop an accurate and cost effective weed mapping system. Airborne remote sensing has been identified as a promising technique for mapping weeds in crops and pastures. The combination of these two has also been tried in some cases (Rew, et al. 1999). A community-university GIS partnership for weed mapping is reported recently from the Blackwood community of Victoria, Australia. This is primarily an action research to integrate weed map by local people with the GIS image (Baral, et al. 2004). However, even without meant to combine with GPS/GIS, the participatory weed mapping can be proved as a quick, authentic and cost-effective method useful for precise weed management with multiple concerns of precision, sustainability, livelihoods and policy.

Key words : Participatory weed assessment, provision and sustainability.

Relative Advantages of Participatory Weed Assessment

The conventional weed mapping exercise encompasses only the spatial dimension of weed occurrence and forwarded for management related action at different levels. But PWA mingles the temporal dimension with it to make it more comprehensive within a spatio-temporal frame. It also takes into account the seasonality and mobility of weeds, their overall prioritization on the basis of people's criteria, alternative uses and the relative strength, weakness, opportunity and threat of existing modes of weed management, which is often typical for a given agro-ecological-social-cultural system. In this sense it is more holistic and worthwhile enough to be used in combination with GIS. The functional aspects of its advantages are –

i Its ability to strengthens the decision support system in weed management with more precision and rapidity;

ii Its potential to empower the farmers and the community to optimize the resource utilization in this regard in a sustainable manner.

iii. Its capacity to generate valuable qualitative and quantitative information regarding existing weed fauna, their infestation pattern, crop-weed interaction, priority of weed management, relative efficacy of different control measures, alternative uses of weed, future threats etc.

iv. The information generated by PWA has wider implication in weed management from the micro and macro perspectives if properly fed into research, extension and sale promotion agenda of different organizations.

MATERIALS AND METHODS

Locale of study

The study was conducted in village Basantapur of Chakdah Block, District Nadia, West Bengal, India, on the ground that it has a very high intensity of cropping, shows a trend of quick shift in cropping pattern, has a wide variety of weed species, farmers practice both mechanical and chemical weed control measures and having certain groups of people who depend on weeds for food security of human and animal.

Methods

The exercise was carried out by a team of four multidisciplinary researchers having knowledge in weed science and skill in applying Participatory Appraisal tools (PLA). They spent six active hours in the field. Another two hours were spent for the analysis of the findings.

The following Participatory Appraisal techniques were employed for PWA:

RESULTS AND DISCUSSION

From the seasonal diagram of weeds (Fig 1) it is seen that occurrence of *Echinochloa colona, Cynodon dactylon, Elusine indica, Parthenium hysterophorus* are found throughout the year with high and almost equal intensity; while *Amaranthus viridis, Amaranthus spinisus* and *Brachiara vamosa* are observed throughout the year with moderate intensity. *Chenopodium album, Oxalis corniculata, Raphanus raphanistrum, Gnaphalium luteoalbum and Phalaris minor* are seasonal weeds and found in winter season (from Oct-Nov to Jan-Feb) with high intensity. *Cyperus rotundus, Portulaca oleracea, Enhydra sp., Commelina bengalensis* and *Portulaca sp.* are also seasonal in nature and found in the rainy season with high intensity (among these *Cyperus rotundus, Portulaca oleracea* and *Enhydra sp.* are found in other seasons also, but in moderate to low intensity).

This tool helps to identify the critical months of the year in respect of weed management; it also indicates the severity of weed occurrence over time (while the dotted lines indicating moderate weed occurrence, the solid lines represents severe weed infestation). Along with other tools it also gives hint to weed control with special consideration of time, space, livelihoods consideration etc.

BOX 1: Which are the most obnoxious/dangerous weeds? The farmers' criteria

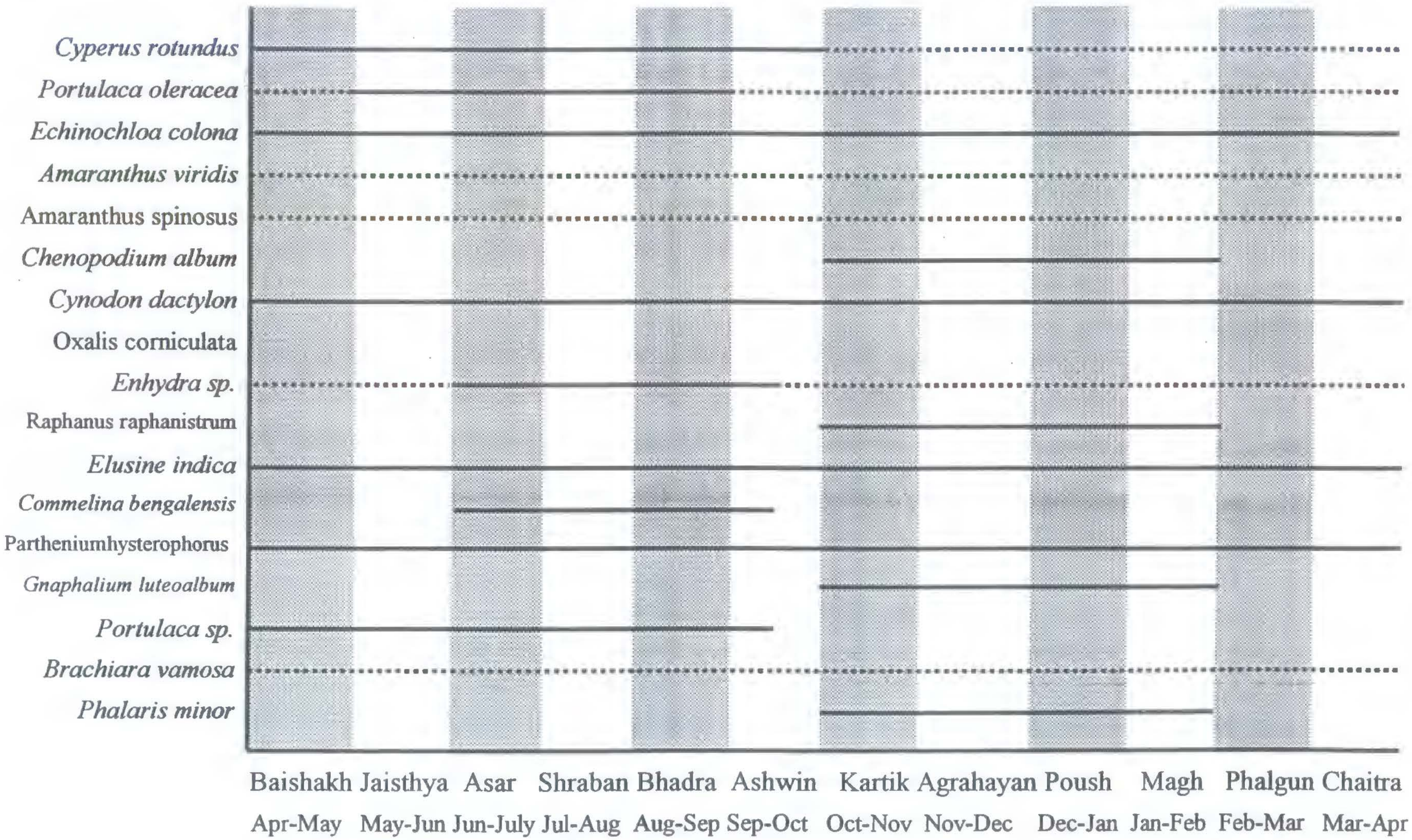
Scientists'/researchers' criteria for assessing the obnoxiousness of weed are often dissimilar to that of the farmers'. This is due to their difference in knowledge system, agricultural performance, livelihood activities, attachment of importance to specific crops etc. The criteria identified by the farmers are –

- ✓ Hard to eliminate completely (*Cyperus sp.)*
- ✓ Wide range of associated crops (Cyperus *sp., Cynodon dactylon*)
- ✓ Depth of root (crop injury during weeding)
- ✓ Regenerating mode of propagation (bulb in *Cyperus sp.*)
- ✓ Labour requirement
- ✓ Number of seed (*Phalaris minor, Amaranthus sp.*)
- ✓ Quick growing habit (*Cynodon dactylon*)
- ✓ Suppression of crop growth (*Echinochloa colona*)

Injury from weed (prickle of *Amaranthus spinosus*; breathing problem by *Parthenium hysterophorus*)

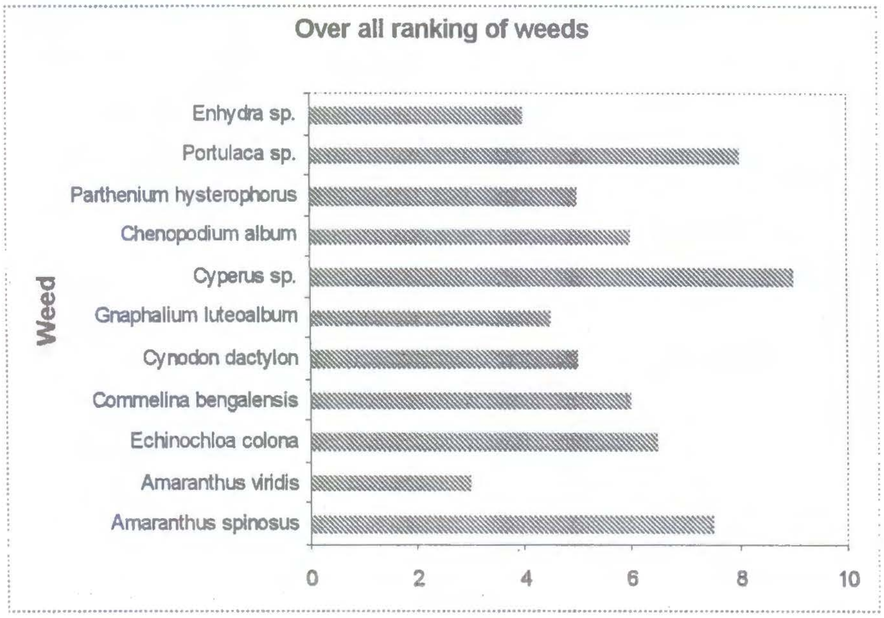
Tools		Objective
Seasonal diagram of weed	:	To understand the seasonality of weed occurrence
Crop- weed matrix	:	To explore the typical crop-weed association with their extent of obnoxiousness as perceived by the farmers
Weed ranking	:	To find out the overall importance of weeds according to the farmers' perception
Weed mobility	:	To trace the movement of specific weeds over space
Weed mapping	:	To depict the spatial distribution of weeds over different micro-farming situation (see Box 3)
Trend analysis of weeds	:	To understand the changes of weed occurrence over time and space
SWOT analysis	:	To show the strength, weakness, opportunity and threat associated with the different weed management practices done by the farmers

Figure 1: Seasonal Diagram of Weeds in Village Basantapur



The overall ranking of the weeds shows the higher severity of *Cyperous sp., Amaranthus spinosus* and *Portulaca sp.* over *Enhydra sp., Gnaphalium luteoalbum* and *Amaranthus viridis. Chenopodium album, Commelina bengalensis* and *Echinochloa colona* comes in between them. When triangulated with the farmers' criteria of weed obnoxiousness the overall ranking could be understood better.

Figure 2: Overall Ranking of Weeds on the Basis of their Degree of Obnoxiousness



From the crop-weed matrix (Fig. 3) it is evident that some weeds occur in most of the crops whereas few are associated with some specific crops. *Cyperus sp.* are creating problems in most of the crops and occupying first or second position as problematic weed based on the farmers' perceptions. But *Echinochloa colona* (paddy), *Commelina bengalensis* (tomato and brinjal) and *Cynodon dactylon* (jute and pointed gourd) are very specific in crop-weed association.

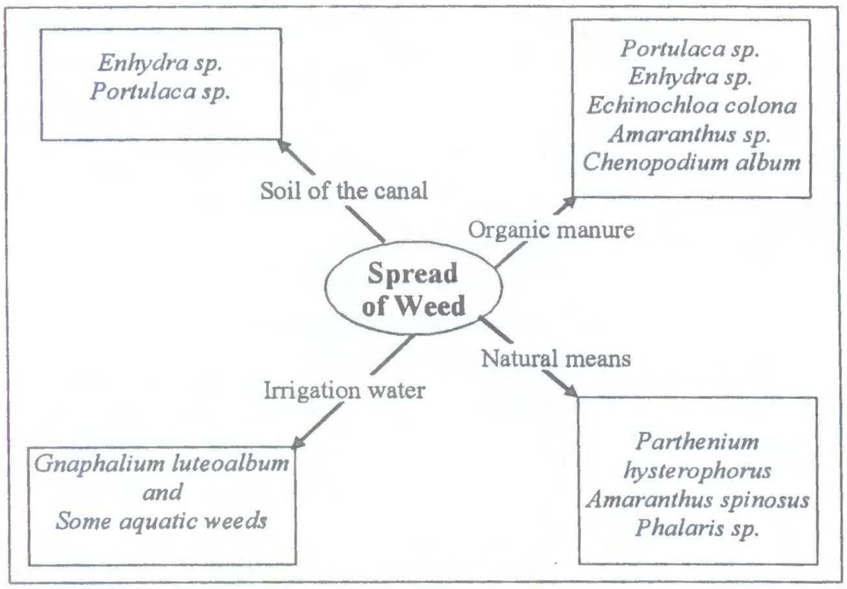
This tool helps to understand the crop-weed association along with their extent of severity. When triangulated with time and space related tools, the crop-weed matrix reveals the severity of weeds in different micro-farming situations in different seasons.

Figure 3: Crop-Weed Matrix and their Degree of Occurrence

Weeds / Crops	*Cyperus sp.*	*Amaranthus spinosus*	*Portulaca sp.*	*Echinochloa colona*	*Commelina bengalensis*	*Parthenium hysterophorus*	*Cynodon dactylon*	*Gnaphalium luteoalbum*
Paddy	2		3	1				
Jute	1		2				3	
Tomato	2	3			3	2		1
Pointed Gourd	2		1				3	
Coriander	1		2			3		1
Brinjal	1	2			3			
Cole Crops	1	3				2		2
Banana	1	2				1		3

Fig. 4 shows the means of weed mobility over space and time (to some extent). The most important means apart from the natural processes (wind, insect etc.) are the organic manure (the excess of cattle feed, which is mostly the chopped weeds collected from the field, and the FYM containing seeds of the weeds), soil of the canal (the Yamuna canal; shown in figure) and irrigation water.

Figure 4: Means of Mobility of Weeds



Box 2: The villagers use the organic matter rich soil of the Yamuna canal which is fed by the untreated organic waste of nearby Haringhata Farm. Some specific weeds like *Portulaca sp., Enhydra sp.* etc. have grown vigorously in those lands treated by Yamuna soil. The weeds spread by irrigation water have increased with the evergrowing use of irrigation water in the village and have caused some misunderstanding among farmers regarding micro-level management of weed.

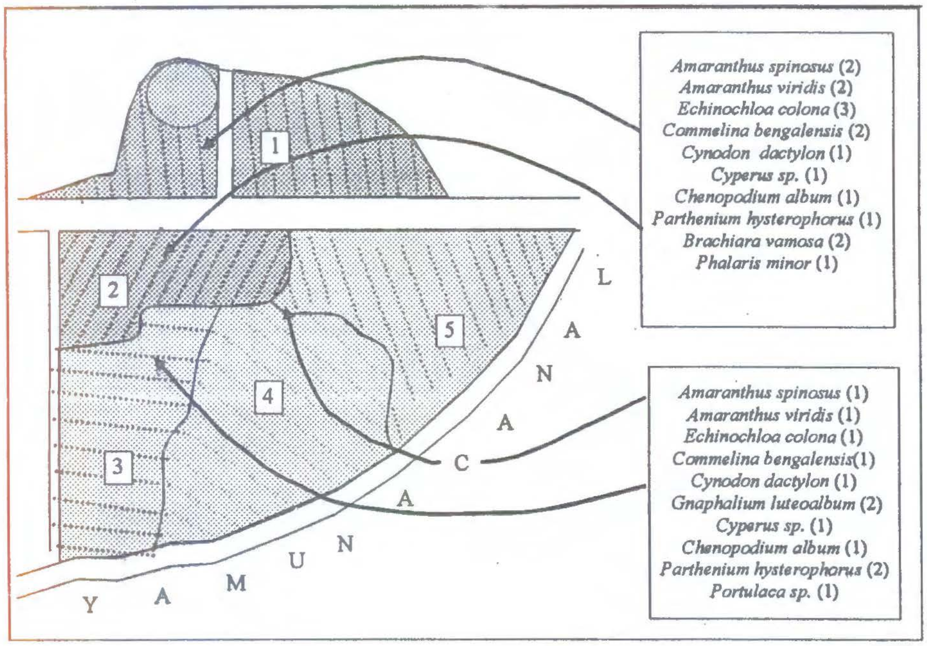
The changing trend of crop cultivation and weed occurrence (Table 1) helps to understand the changing pattern of crop raising, the consequential crop-weed association, the emergence and extinction of certain weeds from the village. In addition to this temporal observation adds the spatial dimension - micro farming situation. In combination we come to know the changes over decades and different fields (micro farming situation). *Solanum nigrum* and *Argemone mexicana* are no more observed in both the micro-farming situations now. On the other hand, *Portulaca sp.*, *Gnaphalium luteoalbum* and *Parthenium hysterophorus* have emerged heavily in the last decade. When observed in combination with the weed map, the pattern of spread over time and space can be more comprehensively understood.

Table 1: Changing Trend of Crop Cultivation and Associated Weed Occurrence

Micro farming situations	1970		1980		1990		2000	
	Crops	Weeds	Crops	Weeds	Crops	Weeds	Crops	Weeds
Beler Math	Aus paddy, jute, black gram, red gram, lentil, Bengal gram, tomato	*Argemone mexicana, Amaranthus spinosus, Solanum nigrum, Echinochloa colona, Commelina bengalensis, Cynodon dactylon, Cyperus sp., Raphanus raphanistrum,*	Aus paddy, wheat, jute, red gram, black gram, lentil, Bengal gram, pea, cucumber, tomato	*Argemone mexicana, Amaranthus spinosus, Solanum nigrum, Echinochloa colona, Commelina bengalensis, Cynodon dactylon, Cyperus sp., Raphanus raphanistrum,, Chenopodium album*	Aus paddy, wheat, jute, pointed gourd, potato, cabbage, cauliflower, mustard, radish, banana, coriander, brinjal, pea, cucumber	*Amaranthus spinosus, Echinochloa colona, Commelina bengalensis, Cynodon dactylon, Gnaphalium luteoalbum Cyperus sp., Chenopodium album ,*	Aus paddy, jute, pointed gourd, potato, mustard, banana, guava, coriander, brinjal, pea, cucumber	*Amaranthus spinosus, Amaranthus viridis, Echinochloa colona, Commelina bengalensis, Cynodon dactylon, Gnaphalium luteoalbum Cyperus sp., Chenopodium album , Parthenium hysterophorus*
Kandar Math	Aus paddy, jute, radish, tomato, cabbage, cauliflower, cucumber, sugarcane	*Argemone mexicana, Amaranthus spinosus, Echinochloa colona, Commelina bengalensis, Cynodon dactylon, Cyperus sp., Enhydra sp., Chenopodium album*	Aus paddy, jute, radish, tomato, cabbage, cauliflower, cucumber	*Argemone mexicana, Amaranthus spinosus, Echinochloa colona, Commelina bengalensis, Cynodon dactylon, Cyperus sp., Chenopodium album, Enhydra sp., Oxalis corniculata*	Aus paddy, wheat, jute, pointed gourd, potato, cabbage, cauliflower, mustard, radish, banana, coriander, brinjal, pea, cucumber	*Amaranthus spinosus, Echinochloa colona, Commelina bengalensis, Cynodon dactylon, Gnaphalium luteoalbum Cyperus sp., Chenopodium album , Oxalis corniculata, Enhydra sp.*	Aus paddy, jute, pointed gourd, potato, mustard, banana, guava, coriander, brinjal, pea, cucumber	*Amaranthus spinosus, Amaranthus viridis, Echinochloa colona, Commelina bengalensis, Cynodon dactylon, Gnaphalium luteoalbum Cyperus sp., Chenopodium album , Parthenium hysterophorus*

Box 3: For the present study, we have modified the spatial dimension in a more comprehensive way. Though the method of identification of micro farming situations is beyond the scope of the present study, it is, in short, identification of relatively homogeneous environment of crop growing on the basis of certain criteria of farmers which represents the whole gamut of physical, bio-physical, social and economic realities. For convenience, we have taken only two distinct of those micro farming situations representing difference in weed occurrence. However, for a short time exercise this step can be avoided and simple spatial classification like land situation can be used.

Figure 5: Weed Map of the Village Basantapur



The weed map shows the distribution of different weeds over space within the village. Though not very thorough and comprehensive, it gives an overall idea of weed distribution over different micro farming situations (numbers within the parentheses indicate the severity of occurrence of that particular weed species). The different shades of background indicate five micro farming situations of the village. Though, for the present purpose micro farming situation 1, 2 and 3, 4, 5 constitute two general homogeneous situations for delineating weed distribution. This map could be improved by using different legends for different weeds; but it will require more time and labour (the purpose of study will also have to be considered).

Alternative use of weeds

- *Amaranthus spinosus* : Vegetables at early stage, fodder
- *Amaranthus viridis* : Vegetables, fodder
- *Echinochloa colona* : Fodder
- *Commelina bengalensis* : Fodder
- *Cynodon dactylon* : Used for religious purpose
- *Cyperus sp.* : Fodder (esp. goat)
- *Chenopodium album* : Vegetables
- *Enhydra sp* : Fodder
- *Raphanus raphanistrum* : Used to control against ectoparacites of fowl
- *Oxalis corniculata* : Preparation of *chatni*
- *Portulaca sp.* : Vegetable, fodder

Understanding the alternative use of weeds is very important for sustainable management of weed with definite concern for livelihood security of the poor. It shows the use of the weeds that occupies an important part of people's livelihood options. The combined observation of weed map, seasonality, control measures and alternative use of weeds point out the strong and weak points of weed management as far as the food and livelihood security of rural people is concerned. In Basantapur village, where small livestock animal is an important stay for people's livelihoods, *Amaranthus spinosus*, *Amaranthus viridis* (throughout the year), *Chenopodium album* (in winter) etc. has definite importance for the poorest people irrespective of their occupation.

SWOT Analysis of Different Modes of Weed Management

The SWOT analysis of different means of weed management shows the farmers' perception of relative advantages of their management practices, their weaknesses, and potential opportunity and threats on the basis of their existing realities. The typical weaknesses of hand weeding obvious from the Table 2 are – difficulty to complete weeding at a time (same weed in different fields/different weeds in same field), physically taxing activity, fear of weeds being grown beyond critical level if operation is delayed (e.g. due to lack of cash in hand) and less availability of space in broadcasted crops. Whereas, the concern of proper management while applied in addition to other pesticides is identified as the weakness of chemical measure of weed control. The opportunity for hand weeding has been found to be managing time for proper ploughing operations within the tight schedule due to high cropping intensity. Acquaintance with selective herbicides can be a good opportunity for chemical weed control. The deterioration of soil fertility is identified as a threat for both modes of weed control.

Table 2: SWOT Analysis of Different Modes of Weed Management

	Strength	Weakness	Opportunity	Threat
Hand /mechanical	• Can almost avoid ill-effect if done before flowering • Increase soil aeration • Only means of weeding when the crop is established	• Higher labour cost • Cause root injury of crops during weeding • Difficult to complete weeding at a time (same weed in different fields/different weeds in same field) • Physically taxing/laborious • Weeds grow beyond critical level if operation is delayed (e.g. Due to lack of cash in hand) • Less space available in broadcasted crops	• Proper ploughing • Combined use of manual/mechanical and chemical means of weeding	• Repeated operation renders the field less fertile (by deteriorating the physical property of soil)
Chemical	• Less labour cost • More effective against *Cyperous sp.*	• Can not be applied after germination Can cause harm to crops during pesticide application if the sprayer is not cleaned properly	• Use of selective herbicides	• Round-up affects the soil fertility

Conclusion and areas of interventions

From the present study it is evident that PWA is and can be a very useful tool for precise and sustainable weed management which can both be fed to research related to GIS (for complementation) and as an authentic tool for community use itself (for dialogue of policy intervention by public and private agencies). The points of intervention are given in tabular form below.

Organizational	Technological	Policy and extension
• Researchers and marketers both have to reorient their organizational programmes based on the results of PWA.	• Participatory technology development with focus to weed management and stakeholders' preference • Validation and refinement of indigenous knowledge about weed management • Participatory GIS development	• Linkage with Government, agro-industries, traders, growers and labourers as stakeholders of wee management • Capacity building at different lev stakeholders for promoting sustai weed management considering stakeholders' wisdom and knowl as input.

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