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Farmers' knowledge and perception of late blight of potato and its management strategies in Kailali and Banke districts of Nepal

Tiwari S[1*] and Srivastava A[2]

[1] *Department of Plant Pathology, Agriculture and Forestry University, Chitwan, Nepal*
[2] *Department of Horticulture, Agriculture and Forestry University, Chitwan, Nepal*

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Abstract

Late blight of potato (*Phytophthora infestans*) is one of the major diseases of potato in Nepal, causing a significant yield loss. Late blight has continued to be a dominant potato disease for many decades in the hill, midhills, and terai regions of Nepal. A survey of 60 randomly selected farmers was carried out in two major potato-growing districts (Kailali and Banke) in the western Terai region of Nepal to examine farmers' knowledge and management practices of the late blight of potato and to analyze the role of relevant knowledge in their practices. According to the study, farmers ranked disease as the major constraint in potato cultivation, followed by a lack of inputs and market problems. The majority of farmers were able to identify disease symptoms on contaminated leaves and stems. On the other hand, they knew relatively little about the diseases, their causes, and practical ways to treat them. The majority of farmers relied on chemical management techniques and did not adhere to traditional methods for controlling late blight. Based on the severity of the illness and the availability of fungicides, the majority of farmers reported applying them three to four times per season, separated by 10 to 14 days. Therefore, in order to manage the disease effectively, farmers must become knowledgeable about the disease, choose the right fungicides, apply them on time, and control the diseases in their local context by implementing a workable combination of management choices.

Keywords – Cardinal – Fungicides – Indigenous – Krinoxyl Gold – *Phytophthora infestans*

Introduction

Potato (*Solanum tuberosum* L.) is a significant food crop cultivated in 198,788 hectares, with a reported production and productivity of 3,325,231 metric tons and 16.73 metric tons per hectare in the 2020/21 period. It is the second most important cash crop in Nepal after oilseed, which covers 287,038 hectares. Additionally, the production of potato in Banke and Kailali is 48,965 metric tons and 62,390 metric tons, respectively. Furthermore, it is the fourth most important staple crop in Nepal after rice, maize, and wheat (MoALD 2021).

Phytophthora infestans (Mont.) de Bary is a major disease of potatoes in Nepal, causing a significant yield loss. In hilly and plain areas of Nepal, late blight infestations in potatoes have resulted in yield losses up to 75% and 90%, respectively (Shrestha 2000). In Nepal, when the overall yield loss due to late blight is estimated at a minimum level of 20%, the economic loss is

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Corresponding Author: Srijan Tiwari – e-mail – srijantiwari03@gmail.com
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approximately equal to 1.8 billion Nepalese rupees annually (Sharma & KC 2004). To control LB in the Kathmandu valley, most potato farmers spray fungicides 10-15 times on the crop planted between September and October (Dhital et al. 2007). The level of resistance in existing potato varieties is intermediate, and farmers have limited access to resistant varieties. 'Kufri Jyoti', 'Kufri Sinduri', 'Desiree', 'Khumal Seto-1', 'Khumal Rato-2', 'Janakdev', 'Cardinal', and 'NPI-106' are the major commercially grown potato varieties in Nepal (Khatri et al. 2004). Most of these varieties are now susceptible to late blight.

The potato yield and quality are affected by numerous insect pests and pathogens. The late blight of potato is particularly problematic, causing significant anuual losses worth billions of dollars (Chakrabarti et al. 2022). Effectively managing potato diseases such as bacterial wilt and late blight relies heavily on farmers' understanding of the diseases and their integration of recommended management methods into their daily practices (Tafesse et al. 2018).

The purpose of this study was to evaluate the prevalence of potato late blight and the methods used to manage it in the Kailali and Banke districts of Nepal, which are major potato-growing areas. The goal was to identify the difficulties faced in potato production in these regions, as well as to gain insight into the knowledge and attitudes of farmers towards late blight and their strategies for managing the disease.

Materials & Methods

The surveys were conducted during the month of January and February 2021 in the major potato-growing areas of Banke and Kailali districts (Table 1, Fig. 1). Lists of producers were obtained from the respective Agriculture Knowledge Centers (AKCs) of each district. Careful attention was paid to include producers from various wealth categories, farm size and ethnic groups. Focus Group Discussion (FGD) and field observation was used to verify or add new information. A total of 60 households were selected using the simple random sampling method (SRS) to draw a representative sample, with the household (HH) survey serving the basic sampling unit for collecting the necessary information. Of the samples, 30 were chosen from 2 municipalities in each district.

A semi-structured questionnaire was prepared, pre-tested, and improved to cover general household information, economic status, types of farming, average potato cultivation, average yield, major varieties grown, varietal preference, general cultivation practices, major constraints in potato production, pest status, and major fungicide application, including interval and rate. Field survey data were coded, tabulated, and analyzed using statistical packages of social science such as SPSS, and Microsoft Excel. Variables such as family size, occupational pattern, educational level, and size of landholding were analyzed using simple descriptive statistics such as frequencies, percentages, and mean, as well as indexing (ranking).

Results

General characteristics of the respondents

The majority of the farmers interviewed were male, making up 63.5% of the total, while females accounted for 36.5%. A quarter of the farmers were 20-30 years old, 65% were between 31-50 years old, and 15% were 51 years old. The majority of the farmers had between 14.06 to 16.02 years of experience in potato farming.

The majority of the respondents (68%) had formal education, including primary school (grades 1–5), secondary school (grades 6-10), or completion of SLC and +2. Only 31.67% of the farmers were illiterate. Approximately 71.66% of potato-growing farmers were engaged in commercial farming, while 28.33% were involved in subsistence farming. The average area of potato cultivation was approximately 14.625 kattha (0.482ha) (Table 2).

Potato varieties and farmers' preference

In the different regions surveyed, a total of 6 potato varieties were grown. 45% of the farmers grew only one variety, while the remaining farmers grew more than one variety. The most preferred variety in both districts was cardinal. In Kailali district, the local varieties Tharu local and Lal Gulab were preferred more than in Banke district (Fig. 2).

The primary reasons for chosing cultivar was yield, with 91.25% of respondents mentioning it. Other factors included market price (84%), taste (75%), availability of seed (63%), tuber size (52%), tuber color (40%), early maturity (22%) and late blight resistance (18%) as shown in Table 3.

Table 1 Surveyed districts, municipalities and their respective ward.

District	Municipality	Ward No.
Kailali	Tikapur	2,3
	Janaki	3,8
Banke	Duduwa	6,9
	Nepalgunj	16,22

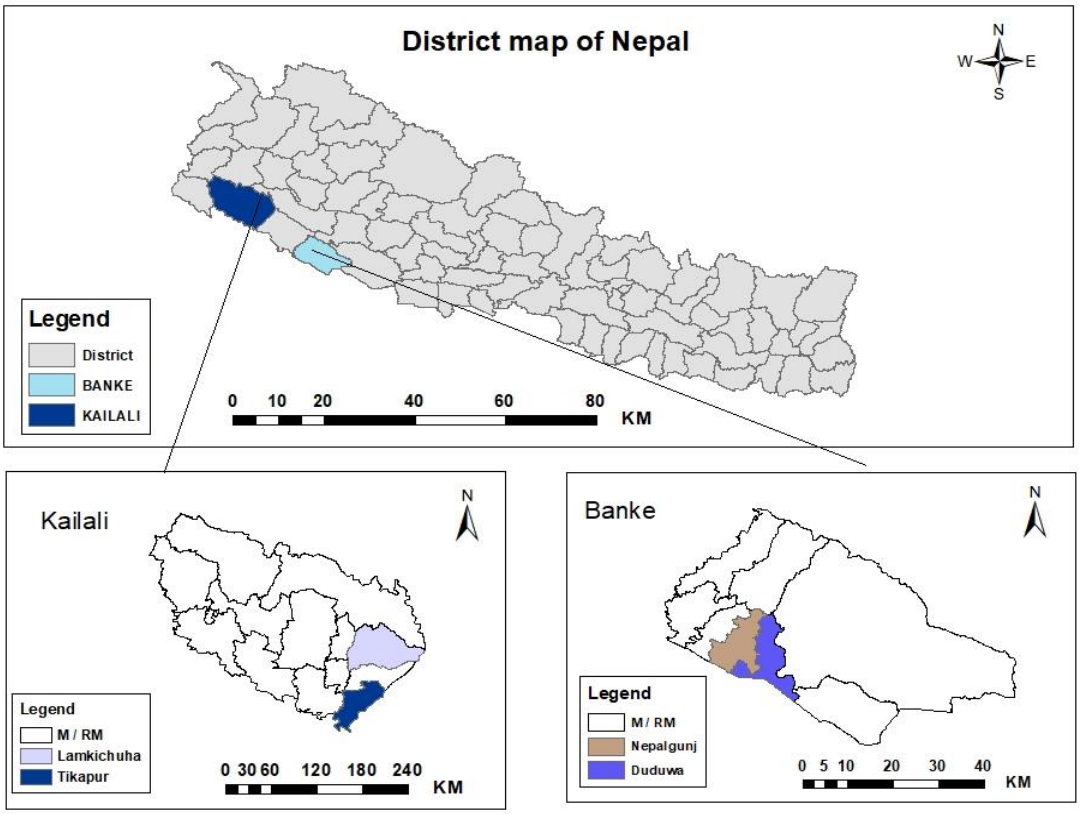

Fig. 1 – Map of Nepal showing the study area.

Potato production constraints

In both districts, the majority of farmers identified disease as their top concern in potato production, followed by lack of inputs (79.9%), lack of market access (37.6%), lack of quality seed (56.8%), poor storage facilities (43.5%), pests (31.1%), and drought (25.8%), as shown in Table 4. However, the significance of these challenges varied between the two districts. The results indicated that diseases are the primary obstacles faced by potato producers in Kailali and Banke. There may be various reasons behind the prevalence of disease, such as climate change and

inadequate disease management due to farmers' limited technical knowledge and understanding of the disease.

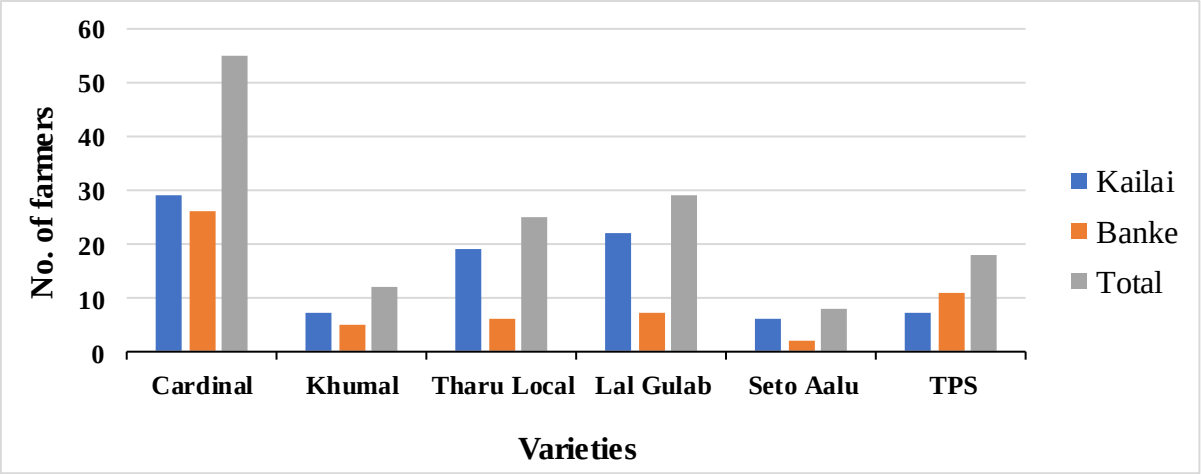

Fig. 2 – Potato varieties cultivated by farmers in Kailali and Banke.

Table 2 General socio-demographic characteristics.

District		**Kailali (n = 30)**	**Banke (n = 30)**	**Overall (n = 60)**
Gender	**Male**	13 (20.66)	27 (42.8)	40 (63.5)
	Female	14 (26.98)	6 (9.00)	20 (36.5)
Age of respondents	**20-30**	6 (10.0)	6 (10.00)	12 (20.00)
	31-40	11 (18.33)	5 (8.3)	16 (26.63)
	41-50	9 (15.00)	14 (23.33)	23 (38.33)
	51 and above	4 (6.00)	5 (8.33)	9 (14.33)
Education level	**Illiterate**	9 (15.00)	10 (16.67)	19 (31.67)
	Primary (1-5)	2 (3.00)	3 (5.00)	5 (8.00)
	Secondary (6-10)	7 (11.66)	10 (16.67)	17 (28.33)
	SLC/SEE	3 (5.00)	3 (5.00)	6 (10.00)
	+2	9 (15.00)	4 (6.67)	13 (21.67)
Types of farming	**Commercial**	22 (36.67)	21 (35.0)	43 (71.66)
	Subsistence	8 (13.33)	9 (15.00)	17 (28.33)
Age of household head		45.75	47.59	46.67
Average area on potato cultivation (Kattha)		11.05	17.48	14.265
Experience in potato cultivation (years)		14.06	16.02	15,03

Farmer's knowledge and perception of late blight of potato

Farmers were surveyed to determine their familiarity with the symptoms and causes of late blight of potato. The results showed that 74.60% of farmers in major potato growing areas were able to accurately describe the symptom of late blight as burning of leaves, while 14.28% identified whitish lesions at the bottom of leaves, 3.17% noted wilting of plants, and 7.93% described the symptom as yellowing of the plant (Fig. 3). Additionally, 75% of respondents believed that fog is the primary cause of late blight of potatoes, while 10.93% attributed it to fungi and 9.37% to rain (Fig. 4).

Table 3 Factors influencing farmers' choice of varieties.

Variety Preference	Score								Weightage score	Index	Rank
	1	0.875	0.75	0.625	0.5	0.375	0.25	0.125			
Yield	31	20	5	4	0	0	0	0	54.75	0.91	I
Market price	29	15	3	10	0	0	0	0	50.625	0.84	II
Taste	0	25	11	24	0	0	0	0	45.125	0.75	III
Availability of seed	0	0	24	19	17	0	0	0	38.375	0.63	IV
Tuber size	0	0	17	3	16	21	3	0	31.25	0.52	V
Tuber color	0	0	0	0	21	36	0	3	24.375	0.40	VI
Early maturity	0	0	0	0	3	4	33	20	13.75	0.22	VII
Late blight resistance	0	0	0	0	0	3	24	33	11.25	0.18	VIII

Table 4 Major constraints of potato production.

Major constraints	Score							Weightage score	Index	Rank
	1	0.857	0.714	0.571	0.428	0.285	0.142			
Disease	51	9	0	0	0	0	0	58.713	0.978	I
Lack of inputs	5	36	8	7	0	4	0	47.979	0.799	II
Lack of market	0	9	45	12	3	0	0	46.701	0.778	III
Lack of quality seed	4	4	0	39	9	0	4	34.117	0.568	IV
Poor storage	0	0	3	9	40	4	4	26.109	0.435	V
Pests	0	4	0	0	6	39	11	18.673	0.311	VI
Drought	0	0	0	4	14	9	33	15.527	0.258	VIII

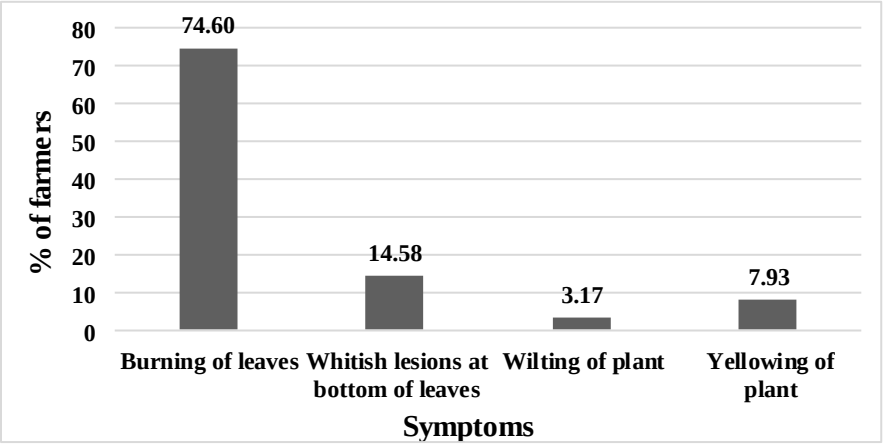

Fig. 3 – Farmers' knowledge of symptoms of late blight of potato.

Use of different fungicides by farmers

Farmers' preference for fungicide products varied significantly across the study sites. The most commonly used trade names were Averblite (56.75%), DM 45 (48.64%), Acrobat (32.42%), Farmthor (29.62%), Antracol (13.51%), Dimetho (13.5%) and Krinoxyl Gold (5.4%). Averblite and DM 45 were the most commonly used fungicides in the study sites as shown in Table 5. Many farmers were unable to differentiate between the two types of fungicides and were unaware of the timing for their application.

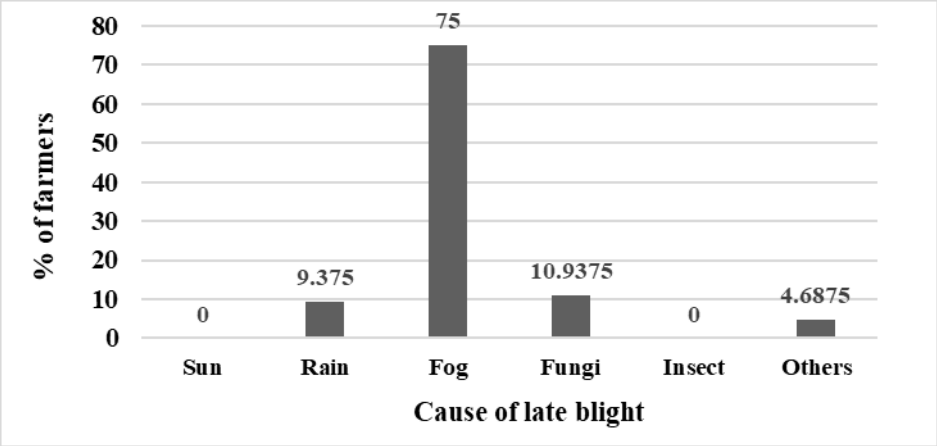

Fig. 4 – Farmers' perception on cause of late blight.

Table 5 Fungicides used by farmers to control late blight of potato.

Trade Name	Kailali	Banke	Overall
Antracol	0 (0)	8 (13.51)	8 (13.51)
DM 45	16 (27.02)	13 (21.62)	29 (48.64)
Farmthor	8 (13.51)	10 (16.21)	18 (29.62)
Krinoxyl Gold	0 (0)	3 (5.4)	3 (5.4)
Dimetho	5 (8.1)	3 (5.4)	8 (13.5)
Acrobat	11 (18.91)	8 (13.51)	19 (32.42)
Averblite	20 (32.43)	14 (24.32)	34 (56.75)

Fungicide doses and spray interval

The majority of farmers (65%) did not follow the recommended fungicide dosage and spray intervals from manufacturers and Agrovet. Many applied higher than recommended doses, especially with low-cost fungicides, in an attempt to improve effectiveness. On the other hand, the average dosage for more expensive fungicides like Krinoxyl Gold was lower than recommended. Additionally, the spray intervals for cheaper fungicides were shorter compared to the intervals for more expensive ones. The most commonly used fungicides contained Dimethomorph, a systemic fungicide. Farmers reported applying these fungicides three to five times per season, with intervals of 10-14 days depending on disease severity and fungicide availability as shown in Table 6.

Starting of fungicide application

In the majority of fields, (41.11%) farmers begin applying fungicide after the first symptoms appear, while 27.77% wait until the plants are 20cm tall. In the majority of fields, (41.11%) farmers begin applying fungicide after the first symptoms appear, while 27.77% wait until the plants are 20cm tall. 16.66% start after the onset of fog, 11.11% after seeing symptoms in a neighboring field, and 3.33% after the onset of rain. A large majority of farmers (92%) practice the application of fungicides (Table 7). However, many farmers do not know which type of fungicide (contact or systemic) to use or when to apply them.

Farmers practice of handling infected/ damaged potatoes

Farmers typically attempted to separate infected or damaged potato tubers and ware potatoes from healthy-looking ones through visual inspection. When asked about their handling of infected or damaged potato tubers, approximately 80.3% of farmers said they would leave them in the field, while nearly 9% reported throwing them on the farm side, and only 6% used damaged potatoes as livestock feed (Table 8). Similarly, around 4.54% of farmers reported collecting and burying infected potato plants and tubers, while none of the surveyed farmers practiced collecting and burning damaged potatoes.

Table 6 Farmers' application rates of different fungicides and their time interval.

S. N.	Fungicides (Trade Name)	Composition	Concentration (g/l)	No. of sprays	Interval (Days)
1.	Acrobat	Dimethomorph 80% WDG	2-3 g/l	3-4	10-14
2.	Averblite	Dimethomorph 50% WDG	2-3 g/l	4-5	10-14
3.	Dimetho	Dimethomorph 50% WDG	2-3 g/l	4-5	10-14
4.	DM 45	Mancozeb 75%WP	3-4 g/l	6-7	7
5.	Farmthor	Chlorothalonil 75% WG	3-4 g/l	4-5	10-14
6.	Antracol	Propineb 70%WP	2.5-3 g/l	4-5	7
7.	Krinoxyl Gold	Metalaxyl 8%+ Mancozeb 64% WP	2.5 g/l	4-5	10-14

Table 7 Starting of fungicide application.

Fungicide Application	Frequency	Percentage (%)
Appearance of first symptoms	25	41.11
When plants are 20 cm tall	16	27.77
Onset of fog	10	16.66
Onset of rain	2	3.33
After hilling	0	0
Before hilling	0	0
Symptoms in a neighboring field	7	11.11

Table 8 What farmers do with the damaged or infested potato with late blight.

Infected or Damaged Potato	Frequency	Percentage (%)
Leave on field	47	80.3
Collect and burn	0	0
Collect and bury	3	4.54
Throw away at the farm side	6	9.09
Use as livestock feed	4	6.06

Discussion

A survey of potato-growing farmers in Banke and Kailali revealed that most farmers were engaged in commercial potato cultivation, with the average cultivation area of 14.63 kattha. Cardinal variety was the most preferred by famers in both districts. The survey also found that diseases were the major challenges faced by potato producers in Kailali and Banke. Possible reasons for the disease problem include climate change and poor disease management due to farmers' lack of technical knowledge in disease identification and management. Subedi et al. (2019) also found similar results, stating the lack of improved and quality seeds wass the most important problem, followed by disease and pest incidence in potato production in various Terai districts. A survey by Musebe et al. (2017) in Rwanda showed that insect pests and diseases, along with a lack of high-quality seeds and high input costs, were the main challenges leading to low and unstable vegetable yields.

Most farmers are able to recognize the symptoms of late blight on leaves and stems, unlike the causal agents of the diseases. This aligns with the findings of Nyankanga et al. (2004), who found that most potato farmers in the Kenyan highlands associated late blight with weather conditions. However, without a good understanding of its various spreading mechanisms, effectively controlling the disease is difficult.

The majority of farmers did not apply fungicides until they observed the first symptoms of late blight on the potato plant, which is ineffective in controlling the disease due to the pathogen's rapid spread. Despite the availability of various Agriculture Knowledge Centres (AKCs) in Nepal that can help farmers optimize the use and timing of fungicide applications, none of them have been effectively functioning.

The majority of farmers lack knowledge about the proper timing for applying systemic and contact fungicides, as well as the difference between the two types of fungicides. They are unsure whether to use them before or after the appearance of symptoms. Additionally, the cost of fungicides is high, leading to irregular application due to the expense. Growers often use these fungicides at a higher frequency and rate than recommended (Sharma & KC 2004). For example, growers in Katmandu Valley apply fungicides 10–15 times in a season to control late blight, depending on the weather conditions and potato varieties (Sharma et al. 2011).

The farmers still spray fungicides in a conventional way, often with limited success in controlling the disease. Similar results were also observed by Tafesse et al. (2018), who reported that only a few farmers properly disposed of diseased or damaged seed potatoes. Some farmers even thought that leaving infected/damaged potato tubers on the field would improve soil fertility with little regard for possible contamination of the soil.

Conclusion

The study has provided new insights into farmers' knowledge of late blight in potato production systems in the Kailali and Banke districts of Nepal. It has revealed that farmers have limited knowledge and perception of the disease. While most farmers can identify the symptoms of late blight, they have limited understanding of its causes and integrated management, relying mainly on chemical management. The study also found that farmers' practices contribute to the spread of diseases due to a lack of relevant knowledge. To address this, a learning approach that integrates both generic and local knowledge is needed to enhance farmers' understanding of the disease and improve their management practices. Additionally, farmers should work collectively and integrate multiple management practices to effectively deal with the disease. It is important to raise awareness among farmers about the selection and application of fungicides, as well as the integrated management of the disease. They should also be educated about fungicide resistance and be equipped with the capacity to implement effective mitigation measures.

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