

## Supplementary material

Table S1 Rice crop spray used in Pakistan (© 2021 Syngenta PAKISTAN - Rice, 2021)

Product Name	Chemical composition	Type/Use	Application (1 acre = 4046.86 sq.m)
Ricer	500 g/L Cyhalofop Butyl (C <sub>20</sub> H <sub>20</sub> FNO <sub>4</sub> )	Herbicide	1 L/acre
Enrich	50 g Penosulam (C <sub>16</sub> H <sub>14</sub> F <sub>5</sub> N <sub>5</sub> O <sub>5</sub> S) 400 g/kg Humic Acid	Crop enhancement	8 kg/acre
Apron max	70 g/kg Potash 25 g/L Fludioxonil (C <sub>12</sub> H <sub>6</sub> F <sub>2</sub> N <sub>2</sub> O <sub>2</sub> )	Seed care	400 ml/100 kg seed
Rifit	37.5 g/L Metalaxyl-M (C <sub>15</sub> H <sub>21</sub> NO <sub>4</sub> ) 500 g/L Pretilachlor (C <sub>17</sub> H <sub>26</sub> ClNO <sub>2</sub> )	Herbicide	400-500 ml/acre
Apiro Forte	366.0 g/L Pyrifthalid (C <sub>15</sub> H <sub>14</sub> N <sub>2</sub> O <sub>4</sub> S)	Herbicide	160 ml/acre
ZINC PLUS 27%	270 g/kg Zinc Sulphate (ZnSO <sub>4</sub> )	Crop enhancement	7.5 kg/acre
Virtako 40 WG	200 g/kg Thiamethoxam (C <sub>8</sub> H <sub>10</sub> ClN <sub>5</sub> O <sub>3</sub> S)	Insecticide	40 g/acre
Amistar Top	200 g/kg Chlorantraniliprole (C <sub>18</sub> H <sub>14</sub> BrCl <sub>2</sub> N <sub>5</sub> O <sub>2</sub> ) 200 g/L Azoxystrobin (C <sub>22</sub> H <sub>17</sub> N <sub>3</sub> O <sub>5</sub> )	Fungicide	200-300 ml/acre
Score	125 g/L Difenoconazole (C <sub>19</sub> H <sub>17</sub> Cl <sub>2</sub> N <sub>3</sub> O <sub>3</sub> ) 250 g/L Difenoconazole (C <sub>19</sub> H <sub>17</sub> Cl <sub>2</sub> N <sub>3</sub> O <sub>3</sub> )	Fungicide	125 ml/acre
Isabion	100 g/L Amino Acids	Crop enhancement	400-500 ml/100 L water
Karate	25 g/L Lambda Cyhalothrin (C <sub>23</sub> H <sub>19</sub> ClF <sub>3</sub> NO <sub>3</sub> )	Insecticide	200 ml/g/acre

Plenum	500 g/kg Pymetrozine (C <sub>10</sub> H <sub>11</sub> N <sub>5</sub> O)	Insecticide	120 g/acre
Actara WG	250 g/kg Thiamethoxam (C <sub>8</sub> H <sub>10</sub> ClN <sub>5</sub> O <sub>3</sub> S)	Insecticide	24 g/acre
Imidacloprid 20% SL	200 g/L Imidachloprid (C <sub>9</sub> H <sub>10</sub> ClN <sub>5</sub> O <sub>2</sub> )	Insecticide	100 ml/acre
Cartap	40 g/kg Hydrochloride (C <sub>7</sub> H <sub>16</sub> ClN <sub>3</sub> O <sub>2</sub> S <sub>2</sub> )	Insecticide	09 kg/acre
Copper oxychloride	Cu <sub>2</sub> (OH) <sub>3</sub> Cl	Fungicide	
Cuporous oxide	CuO	Fungicide	
Streptomycin	C <sub>21</sub> H <sub>39</sub> N <sub>7</sub> O <sub>12</sub>	Fungicide	
Bordeux mixture	Copper Sulphate (CuSO <sub>4</sub> ) Quicke Lime (CaO)	Fungicide	
Kumulus	Sulphur	Fungicide	800 g/kg
Moltovin	Tribasic copper sulphate (Cu <sub>3</sub> H <sub>2</sub> O <sub>10</sub> S <sub>2</sub> )	Fungicide	250-500 ml/acre
	Cymoxanil (C <sub>7</sub> H <sub>10</sub> N <sub>4</sub> O <sub>3</sub> )		

Table S2 Wheat crop spray used in Pakistan (© 2021 Syngenta PAKISTAN - Wheat, 2021)

Product name	Composition	Type	Dosage
Logran	750 g/kg Triasulfuron C <sub>14</sub> H <sub>16</sub> ClN <sub>5</sub> O <sub>5</sub> S	Herbicide	16 g/acre
Enrich	400 g/kg Humic acid 70 g/kg Potash	Crop enhancement	8 kg/acre
Vibrance duo	25 g/L Sedaxane (C <sub>18</sub> H <sub>19</sub> F <sub>2</sub> N <sub>3</sub> O) 25 g/L Fludioxonil (C <sub>12</sub> H <sub>6</sub> F <sub>2</sub> N <sub>2</sub> O <sub>2</sub> )	Seedcare	200 ml/100 kg wheat seed
Ally max	14.3 % Metsulfuron methyl (C <sub>14</sub> H <sub>15</sub> N <sub>5</sub> O <sub>6</sub> S) 14.3 % Tribenuron methyl (C <sub>15</sub> H <sub>17</sub> N <sub>5</sub> O <sub>6</sub> S)	Herbicide	14 g/acre
Axial	50 g/L Pinoxaden (C <sub>23</sub> H <sub>32</sub> N <sub>2</sub> O <sub>4</sub> )	Herbicide	330 ml/acre
Bromoxinil	200 g/L Bromoxynil (C <sub>7</sub> H <sub>3</sub> Br <sub>2</sub> NO)	Herbicide	500 ml/acre

	200 g/L Mcpa (C <sub>9</sub> H <sub>9</sub> ClO <sub>3</sub> )		
Metribuzin	70 g/kg Metribuzin (C <sub>8</sub> H <sub>14</sub> N <sub>4</sub> OS)	Herbicide	80 g/acre
Pendimethalin	330 g/L Pendimethalin (C <sub>13</sub> H <sub>19</sub> N <sub>3</sub> O <sub>4</sub> )	Herbicide	1-1.5 L/acre
Sulfosulfuron	75 % Sulfosulfuron (C <sub>16</sub> H <sub>18</sub> N <sub>6</sub> O <sub>7</sub> S <sub>2</sub> )	Herbicide	13.5 g/acre adjuent
Topik	150 g/kg Clodinafop (C <sub>17</sub> H <sub>13</sub> ClFNO <sub>4</sub> )	Herbicide	120 g/acre
	150 g/kg Cloquintocet mexyl (C <sub>18</sub> H <sub>22</sub> ClNO <sub>3</sub> )		
Naya npk	15:15:15 Npk	Crop enhancement	1 kg/acre
Naya potash	300 g/L Liquid potash	Crop enhancement	0.3 L/acre
Naya zinc plus 27%	270 g/kg Zinc sulphate	Crop enhancement	7.5 kg/acre
Promix	8:8:6 Npk	Crop enhancement	500 – 1000 ml/acre in (100 - 120 L water)
Tilt	250 g/L Propiconazole (C <sub>15</sub> H <sub>17</sub> Cl <sub>2</sub> N <sub>3</sub> O <sub>2</sub> )	Fungicide	200 ml/acre

Table S3 Statistics of total area of Rice cultivation, Rice crop production and yield from past 5 years in Pakistan (Pakistan Bureau of Statistics (Government of Pakistan). Pakistan Economy Survey 2019-2020, 2020).

Year	Area	Production	Yield (kg/Hec.)	Consumption of
	'000'	'000'		fertilizer '000' nutrient
	hectares	tonnes		tonnes
2016-17	2724.0	6849.3	2514	302.39
2017-18	2900.6	7449.8	2568	285.75

<b>2018-19</b>	2810.0	7202.0	2563	276.83
<b>2019-20</b>	3034.0	7413.7	2442	272.9
<b>2020-21</b>	3335.1	8419.7	-	-

Table S4 Details of Metals and POPs (PCDD/fs, PCBs and PAHs) samplings. T<sub>av</sub> Stack: Average temperature in the stack (°C); Biomass feeding: kg of biomass burned per hour (kg/h).

<b>Sampilg</b>	<b>Time Start</b>	<b>T<sub>av</sub> Stack °C</b>	<b>Biomass feeding</b>
<b>Punjab</b>			
Dioxin-PAH-PCB	12:28	102.83	6.56 kg/hour
Heavy Metal	16:03	107.20	
<b>AJK</b>			
Dioxin-PAH-PCB	14:54	111.32	6.64 kg/hour
Heavy Metal	16:22	118.22	
<b>Sindh</b>			
Dioxin-PAH-PCB	12:18	108.09	7.67 kg/hour
Heavy Metal	16:36	104.19	

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Pakistan Bureau of Statistics (Government of Pakistan). Pakistan Economy Survey 2019-2020, 2020. Chapter 2.