

An investment plan for low-emission rice production in the Mekong River Delta region in support of Vietnam's Nationally Determined Contribution to the Paris Agreement

Working Paper No. 263

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Tran Van The
Mai Van Trinh
Nguyen Thi Dieu Trinh
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Leo Sebastian
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RESEARCH PROGRAM ON
**Climate Change,
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Contact:

CCAFS Program Management Unit, Wageningen University & Research, Lumen building, Droevendaalsesteeg 3a, 6708 PB Wageningen, the Netherlands. Email: ccaafs@cgiar.org

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Abstract

Rice production is integral to agriculture and food security in Vietnam, but it also contributes greenhouse gas emissions. In 2010, paddy rice production emitted 44.61 million tons carbon dioxide equivalents (MtCO₂e), 18% of total national GHG emissions. A variety of options to mitigate GHG emissions from paddy rice show promise and will contribute to implementing Vietnam's Nationally Determined Contribution (NDC) and green growth strategies. One of the most promising options is alternate wetting and drying (AWD), a technique in which fields are allowed to dry out to a certain point before irrigation instances. This paper focuses on the Mekong River Delta region, which produces more than 50% of total rice production and 95% of rice exported from Vietnam. This study employs a literature review, a study of promising GHG mitigation options, and an analysis of cost and benefits of AWD to develop an investment plan for AWD in the Mekong River Delta. In our field survey, we found AWD contributed to increasing farmers' net incomes primarily by decreasing production costs. The study proposes an investment plan with four outputs and 15 investment activities with a goal of practicing AWD on 900,000 hectares in the Mekong River Delta and mitigating 10.97 M.tCO₂e. A co-benefit is additional net income for farmers of 8,540 billion VND (USD 371.36 million) per year compared to conventional rice cultivation. The budget is USD 721.78 million (81.32% for hard infrastructure, 18.19% for MRV operation, research, performance and planning), of which 36.9% is provided by the state, 29.92% from local provinces, 21.77% from international support and 11.42% from the private sector. Mobilization of financial resources from public and private sectors and the integration into government plans and programs are recommended.

Keywords

Low emissions development; Nationally Determined Contribution; Rice; Alternate wetting and drying; Greenhouse gas; Agriculture; Climate change mitigation

About the authors

Following are the authors and their affiliations:

- Tran Van The (tranvanthe.iae@gmail.com) - Institute for Agricultural Environment (IAE)
– lead author
- Mai Van Trinh - Institute for Agricultural Environment (IAE)
- Nguyen Thi Dieu - Trinh National Economics University (NEU)
- Le Hoang Anh - Ministry of Agriculture and Rural Development (MARD)
- Meryl Breton Richards - CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) and the Rubenstein School of Environment and Natural Resources at the University of Vermont
- Leo Sebastian - CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)
- Eva Wollenberg - CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) and the Rubenstein School of Environment and Natural Resources & Gund Institute for Environment at the University of Vermont
- Vu Duong Quynh - Institute for Agricultural Environment (IAE)
- Bjoern Ole Sander - International Rice Research Institute (IRRI)

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Acronyms

1M5R	One must (used certificated seed), five reductions (sowing seed, pesticide, N-fertilizer, irrigated water and post-harvested losses)
3G3R	Three gains (yield, quality and income), three reductions (sowing seed, pesticide and N-fertilizer),
AWD	Alternate wetting and drying
CC	Climate change
CTF	Clean Technology Fund
GCF	Green Climate Fund
GEF	Global Environmental Fund
GHG	Greenhouse gas
IKI	International Climate Initiative (German development fund)
LED	Low emission development
LULUCF	Land use, land-use change, and forestry
MARD	Minister of Agriculture and Rural Development
MONRE	Ministry of Natural Resources and Environment
MRD	Mekong River Delta
MtCO ₂ e	Million tons of carbon dioxide equivalents
NDC	Nationally Determined Contribution
PAF	Pilot Auction Facility
SCCF	Special Climate Change Fund
VND	Vietnamese Dong

1. Introduction

Rice production is integral to agriculture and food security in Vietnam and is being negatively affected by the effects of climate change (CC). However, paddy rice production is also responsible for high levels of greenhouse gas (GHG) emissions. In 2010, paddy rice production was directly responsible for 44.61 million tons carbon dioxide equivalents (MtCO₂e), or 18% of total national GHG emissions (MONRE 2014). A variety of options to mitigate GHG emissions from paddy rice show promise and could contribute to implementing Vietnam's Nationally Determined Contribution (NDC) and green growth strategies. One of these options is alternate wetting and drying (AWD), a technique in which irrigation water is applied to rice after the field is allowed to dry out to a certain point.

In 2016, the Ministry of Agriculture and Rural Development (MARD 2016) reviewed and established means to implement the NDC in agriculture (Document No 7028/BNN-KHCN on 25/8/2016). In MARD's plan, AWD is utilized on 200,000 hectares nationwide to reduce emissions by 0.94 MtCO₂e as part of its unconditional mitigation (to be achieved with domestic resources). The NDC states that AWD will be utilized on an additional 500,000 hectares nationwide (an additional reduction of 2.34 MtCO₂e), conditional upon international support for NDC implementation.

The Mekong River Delta (MRD) region contains 12% of the country's natural area and 19% of its population. It produces 50% of the rice, 65% of the aquaculture, and 70% of the fruits grown in Vietnam. About 95% of rice exported from Vietnam is grown in the MRD (GoVN, 2017). In addition to nationwide goals for AWD, mitigation options specific to rice production in the MRD have been established. They are: a) AWD; b) three gains (yield, quality and income), three reductions (sowing seed, pesticide and N-fertilizer), called 3G3R; and c) one must (used certificated seed), five reductions (sowing seed, pesticide, N-fertilizer, irrigated water and post-harvested losses), called 1M5R. All three are regarded as high-priority options to implement the NDC in the MRD region according to Decision 7028/BNN-KHCN on 26 August 2016 by MARD.

The purpose of this study was to develop an investment plan for AWD in the MRD region of Vietnam. We reviewed literature on GHG emissions from rice production and studied promising GHG mitigation options for the NDC. We then analyzed the cost and benefits of AWD to inform investment needs. With this information and identification of financial sources, we developed investment plans for AWD as a low emission development (LED) practice for rice production in the MRD region.

2. Methodology

The components of the methodology for this study are shown in Figure 1. Data were collected through rapid rural appraisal (RRA), standardized questionnaires and individual interviews. A strength, weakness, opportunities and threats analysis (SWOT), bottleneck analysis, cost-benefit analysis (CBA) and marginal abatement cost (MAC) analysis were used to process data and report on AWD in rice production in the MRD region.

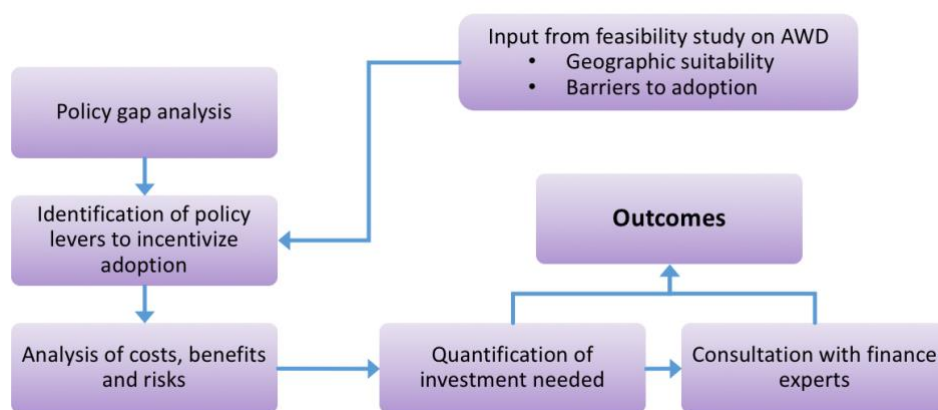


Figure 1. Components of investment plan methodology

In the field survey, 180 farm households were sampled, of which 120 households utilized AWD practices and 60 others used conventional, continuously flooded production practices (Table 1). The study was also informed by interviews and group discussions with local stakeholders, experts, policymakers and scientists. Three independent domestic reviewers reviewed the final draft of this study. Experts from various management units and scientists under MARD and Ministry of Natural Resources and Environment (MONRE) were consulted for final approval of the study.

Table 1. Sample selection for field survey

Province	Sample size (households)	
	AWD	Conventional
An Giang (Chau Thanh)	40	20
Kien Giang (Go Quao, Tan Hiep)	40	20
Soc Trang (Nga Nam, Chau Thanh)	40	20
Total	120	60

3. Results

3.1 GHG emissions and reductions from rice production

According to MONRE (2017), in 2010 agricultural production in Vietnam emitted 89.41 MtCO_{2e}, which represented 34.51% of total national GHG emissions, including land use, land-use change, and forestry (LULUCF). Rice production emitted 44.61MtCO_{2e}, which accounted for 50.5% of total agricultural GHG emissions in 2010 (MONRE, 2014).

Potential reductions are described in Table 2. The proportion of emissions from rice is projected to reduce from 44.61 MtCO_{2e} (50.5%) in 2010 to 39.95 MtCO_{2e} (36.5%) by 2030 because the areas of rice cultivation is expected to reduce from 7.48 million hectares in 2020 to 7.01 million hectares in 2030 (MONRE 2014). Although rice production has high GHG emissions, it is also thought to hold great promise for GHG mitigation through integrated crop management (ICM), AWD and system of rice intensification (SRI), the introduction of biochar, and replacement of nitrogen fertilizer with ammonium sulfate. According to a technical report on the NDC by MONRE (2015), **AWD/SRI could**

achieve 14.06% of Vietnam’s unconditional mitigation goal for the agriculture sector (0.9 MtCO_{2e} of a total of 6.4 MtCO_{2e}) and 28.13% of the goal for crop production (0.9 MtCO_{2e} of a total of 3.2 MtCO_{2e}). For Vietnam’s conditional GHG mitigation goal, AWD/SRI contributes 17.59% of the total goal for the agriculture sector (7.0 MtCO_{2e} of a total of 39.8 MtCO_{2e}) and 19.23% of the goal for crop production only (7.0 MtCO_{2e} of a total of 36.4 MtCO_{2e}).

Table 2. GHG reduction options for the agriculture sector from Vietnam’s NDC (unconditional mitigation goals)

Options	Potential GHG reduction	
	MtCO _{2e}	%
I. Unconditional mitigation options	6.40	100.00
<i>I.I. Crop production</i>	<i>3.20</i>	<i>50.00</i>
A2. Reuse of agro-residues	0.40	12.50
A3. AWD/SRI	0.90	28.13
A4. Introduction of biochar	1.10	34.38
A5. Integrated crop management in rice cultivation	0.50	15.63
A6. Integrated crop management in annual upland crops	0.30	9.38
<i>I.II. Remaining agriculture (livestock, fishery)</i>	<i>3.20</i>	<i>50.00</i>
II. Conditional mitigation options	39.80	100.00
<i>I.I. Crop production</i>	<i>36.4</i>	<i>91.46</i>
A7. Substitution of urea with ammonium sulfate	3.20	8.79
A8. Reuse of upland crop residues	0.30	0.82
A9. AWD/SRI	7.00	19.23
A10. Introduction of biochar	18.80	51.65
A14. Improved technology for waste treatments from crops	3.40	9.34
A15. Improved irrigation for coffee	3.40	9.34
A16. ICM in upland crops	0.30	0.82
<i>I.II. Remaining agriculture (livestock, fishery)</i>	<i>3.40</i>	<i>8.54</i>

Source: Ministry of Natural Resources and Environment, 2015.

3.2 Policy levers for AWD

A field survey in three provinces (An Giang, Kien Giang and Soc Trang) found that AWD uses fewer inputs than conventional rice cultivation: 21.67% less seed, 18.82% fewer pesticides and 33.34% less irrigated water. Because of these efficiencies, AWD has been given high priority in a variety of supportive policies: a green growth strategy effective until 2030 (Decision No 403/QD-TTg on 20 March 2014); a restructured project of crop production development (Decision No 1006/QD-BNN-TT on 13 May 2014); and the restructured rice production project up to 2020 and envisioned to 2030 (Decision No 1898/QD-BNN-TT on 23 May 2016). Policy levers for AWD focus principally on application and transfer of supporting technology, improving yields, improving the value chain of rice, improving efficiency in input use (especially chemical fertilizers and pesticides), and saving irrigation water.

AWD is also a priority in Vietnam's plan for Paris Agreement implementation (Decision No 2053/QD-TTg on 28 October 2016), as well as in the technical aspects of Vietnam's sectoral action plan of climate change response for the period 2016-20, its Vision 2050 (Decision 819/QD-BNN-KHCN on 24 March 2016) and in other projects and programs (VnSAT, the extension project for rice and the sustainable development plan for the MRD region).

In addition, for the MRD region in particular, AWD is considered an important practice in the strategy and plan for rice development in the sectoral crop restructured project (Decision No 1006/QD-BNN-TTr on 13 May 2014 by MARD); the rice production restructured project (Decision 1898/QD-BNN-TT on 23 May 2016 by MARD), strategy of MRD development to response climate change (Resolution 120/NQ-CP on 17 November 2017 by Government of Vietnam).

These strategies, plans, policies, projects and programs are important policy levers to supporting investment in low-emissions rice production. Amongst these, AWD is an essential climate change mitigation and climate change adaptation option for rice cultivation in the MRD region.

3.3 Cost-benefit analysis for AWD in An Giang, Kien Giang and Soc Trang provinces

Farm household survey results in An Giang, Kien Giang and Soc Trang provinces found that average costs for AWD are an estimated 14.98 million VND ha⁻¹ (USD 651.31 ha⁻¹), a savings of 1.01 million VND ha⁻¹ (USD 47.82 ha⁻¹) over conventional rice production (Table 3). On average in An Giang, Soc Trang and Kien Giang provinces, total revenues from AWD are estimated to be 42.51 million VND ha⁻¹ (USD 1848.26 ha⁻¹), about 3.44 million VND ha⁻¹ (USD 149.56 ha⁻¹) more than returns from conventional rice production because AWD provided higher yields than conventional rice (significance at $\alpha=0.01$). The average net benefit realized from AWD is therefore 27.52 million VND ha⁻¹, a difference of 4.43 million VND ha⁻¹ (USD 193.04 ha⁻¹) more than conventional rice cultivation (cognizance at $\alpha=0.01$).

In An Giang, rice grown with AWD produced 40.54 million VND ha⁻¹ (USD 1762.61 ha⁻¹) in revenue, the lowest among surveyed provinces, although this was greater than conventional rice cultivation by 7.61%. Net income from AWD was estimated at 25.65 million VND ha⁻¹, 16.48% greater than conventional rice, because farmers in An Giang province saved on costs related to sowing seed, irrigation and labor (at α was less 10%) and farmers benefitted from a significant increase in total revenue of 2.87 million VND ha⁻¹ at $\alpha=10\%$). Farmers earned 2.72 times of the total of their costs and investments when employing AWD; this exceeded the 2.41 return on conventional rice. Costs benefit ratio amounted to 36.73% and a rate of return of 63.27%, much higher than conventional rice (Table 3).

In Kien Giang, on average, farmers practicing AWD earned 29.72 million VND ha⁻¹ (USD 1292.17 ha⁻¹) in net income, which was 25.59% greater than farmers producing rice conventionally. This was the highest net income among surveyed provinces. Related, the average costs of rice production for farmers using AWD in Kien Giang were also the lowest, 13.04 million VND ha⁻¹ (USD 566.95 ha⁻¹), which was 13% lower than the other provinces. According to field survey, AWD generated savings on land preparation costs because of active water control (at $\alpha=1\%$), sowing seeds because of more

flat and thinner sowing density (at $\alpha=1\%$), weed control in use because of stronger rice growth (at $\alpha=5\%$), and harvesting and labor because of more mechanization (at $\alpha=1\%$).

In Soc Trang Province, net income for farmers practicing AWD reached 27.22 million VND ha⁻¹, which is 13.42% greater than conventional rice cultivation. Income was increased (at $\alpha=1\%$) partially due to lower land preparation cost (at $\alpha=1\%$), pest and disease management because stronger plans and thinner density (at $\alpha=5\%$ and labor cost (at $\alpha=5\%$). AWD yielded 2.6 VND revenue for each VND of cost, while conventional rice cultivation generated only 2.37 VND. Costs amounted to 38.45% of revenues (the highest among provinces surveyed), giving a rate of return of 61.55%, which is higher than conventional rice cultivation.

Table 3. Cost and benefit analysis from AWD in the Mekong River Delta region

No	Item	An Giang		Kiên Giang		Soc Trang	
		AWD	-/+	AWD	-/+	AWD	-/+
	Sample size		60		60		60
I.	Cost (1000 VND ha⁻¹)	14,892.50	-763.11^{ns}	13,045.77	-2,106.54^{***}	17,004.22	-135.69^{ns}
1	Land preparation	1,952.13	127.59 ^{ns}	1,510.16	418.12 ^{***}	1,771.41	379.41 ^{***}
2	Seed	1,500.60	-414.71 ^{***}	1,422.41	-497.13 ^{***}	1,531.48	-19.21 ^{ns}
3	Fertilizer application	4,272.36	300.78 ^{ns}	3,241.75	-375.51 ^{ns}	4,061.18	-292.52 ^{ns}
4	Weed management	327.72	59.69 ^{ns}	247.68	-125.64 ^{**}	494.62	59.01 ^{ns}
5	Pests and diseases management	2,069.14	-25.73 ^{ns}	1,805.62	-187.84 ^{ns}	2,561.84	-826.10 ^{**}
6	Rodent management	103.86	-14.80 ^{ns}	86.50	-22.02 ^{ns}	84.65	28.89 ^{ns}
7	Snail management	273.38	-30.54 ^{ns}	227.62	-182.13 ^{**}	712.36	228.14 [*]
8	Harvesting	1,889.71	26.11 ^{ns}	1,787.60	-530.02 ^{***}	2,088.72	-12.91 ^{ns}
9	Irrigation water	442.55	-417.39 ^{**}	615.04	-77.34 ^{ns}	351.50	-227.19 [*]
10	Labor	2,061.05	-374.12 ^{**}	2,101.39	-527.03 ^{**}	3,346.46	546.79 ^{**}
II.	Revenue (M.VND ha⁻¹)	40,541.98	2,866.72[*]	42,769.56	3,931.43[*]	44,220.83	3,515.91^{***}
III.	Net benefit (M.VND ha⁻¹)	25,649.48	3,629.84^{**}	29,723.79	6,037.97^{***}	27,216.61	3,651.60^{**}
1	BCR (times)	2.72	0.32	3.28	0.72	2.60	0.23
2	CBR (%)	36.73	-4.82	30.50	-8.51	38.45	-3.65
3	NI/R (%)	63.27	4.82	69.50	8.51	61.55	3.65

Notes: ^{ns} no significant difference between conventional and AWD ; * difference significant at $\alpha=0.05$

difference significant at $\alpha=0.01$; *difference significant at $\alpha=0.001$

Sources: Estimated from a field survey in Kien Giang, An Giang and Soc Trang provinces, 2016.

However, cost components of AWD vs. conventional production varied among the provinces. Examples include costs for seed (significant differences in An Giang and Kien Giang but not in Soc Trang), pests and diseases management (significant in Soc Trang, but not in An Giang and Kien Giang), irrigated water (significant in An Giang and Soc Trang but not in Kien Giang). The differences may be due to the small sample size of the survey (limited due to time and scope of this study). Also, the technical analysis shows that AWD may face more risk from climate change (due to anticipated more irregular seasonal rain and extreme climate events and tides) which may lead to

difficulties controlling alternating dry and wet periods and more stress on irrigation management capacity due to the importance of irrigated water in the MRD.

4. Developing investment plans for AWD in the MRD region

4.1 Determining potential cultivated areas for AWD

The field survey results in An Giang, Kien Giang and Soc Trang indicated that AWD is adapted to alluvial, low- and medium-saline soil in the MRD region. According to MONRE (2016), total arable land for rice in the MRD was 1.91 million hectares, while rice was cultivated on 4.29 million hectares (Table 4), meaning that farmers are cropping 2.22 rice seasons per year.

Table 4. Estimated potential AWD development from rice production in MRD region

Province	Rice cultivated area (1000 ha)			Arable areas for AWD-rice (1000 ha)			Cultivated areas per year for AWD rice (1000 ha)
	2005	2010	2015	Alluvial soil area (1000 ha)	Low & medium saline soil area (1000 ha)	Total (1000 ha)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)=(5)+(6*30%)	(8)=(7)*2 rice seasons/yr ⁻¹
Long An	254.30	258.60	263.50	40.40	9.30	43.19	86.38
Tien Giang	95.00	86.80	83.10	84.50	22.90	91.37	182.74
Ben Tre	37.90	38.10	38.30	34.70	24.20	41.96	83.92
Tra Vinh	102.90	97.70	97.30	65.00	30.20	74.06	148.12
Vinh Long	72.90	70.20	71.10	44.50	-	44.50	89.00
Dong Thap	226.80	225.20	226.40	123.50	-	123.50	247.00
An Giang	264.30	257.70	257.40	158.60	-	158.60	317.20
Kien Giang	253.20	377.40	381.50	52.80	51.10	68.13	136.26
Can Tho	92.80	91.60	91.20	82.70	-	82.70	165.40
Hau Giang	84.20	82.50	82.40	44.30	1.20	44.66	89.32
Soc Trang	160.90	146.60	147.70	75.70	180.10	129.73	259.46
Bac Lieu	82.50	77.60	77.60	-	88.60	26.58	53.16
Ca Mau	80.80	116.90	95.40	-	109.70	32.91	65.82
Arable area for AWD rice	1,808.50	1,926.90	1,912.90	806.70	517.30	961.89	-
Cultivated area for AWD rice (2 rice seasons/yr⁻¹)	3,945.90	4,304.10	4,295.20	1,790.87	1,148.41	-	1,923.78

Sources: Land inventory report by Ministry of Natural Resources and Environment (2005, 2010, 2015)

According to evaluations undertaken by MARD (2012) in the MRD region, alluvial soils cover about 806.7 thousand hectares, and low- and medium-saline soils cover about 517.3 thousand hectares. The

results of the field survey in An Giang, Kien Giang and Soc Trang provinces indicate that AWD could be practiced on all alluvial soil areas and in 30-50% of low- and medium-saline soil areas. Hence, AWD can expand to 961.89 thousand hectares of arable land areas in the survey area and can expand to 1.92 million hectares including An Giang, Soc Trang, Dong Thap, Tien Giang, Tra Vinh and Kien Giang provinces, which are the largest AWD-rice potential areas in the MRD region.

Thus, both the unconditional NDC implementation target to develop 200,000 hectares and the conditional NDC implementation target of an additional 500,000 hectares under conditional mitigation options can be met. Additional mitigation in the MRD region is possible by 2030 with investments.

4.2 Proposed investment plan for AWD in rice production

The proposed investment plan for AWD development includes four outputs and 15 investment activities (Table 5).

Table 5. Proposed investment plan for AWD in Mekong River Delta region thru 2030

No.	Outputs & activities	Scales & location	Requested budgets and proportion thru 2030	Expected results
I. Output 1. Improved instructional and policy instruments for developing AWD in MRD region				
1.	Review, revise and operate policy mechanisms to attract investments for AWD	National, regional, interregional levels and MRD region	5 billion VND (100% from the state budget)	Guidelines, circulars and policies
2.	Update and adjust national agricultural restructured and sustainable MRD development project when AWD has been integrated	National and MRD region	20 billion VND (70% from the state budget; 30% from a provincial budget)	Updated and revised restructured rice production when AWD has been integrated
3.	Develop technical guidelines for the dissemination of AWD in rice cultivation	13 provinces in MRD region	2 billion VND (20% from the state budget; 40% from the provincial budget; 40% from international support)	10,000 manuals for AWD
4.	Develop guidelines to measure emissions, and identify GHG emission reduction potential of AWD in rice production	13 provinces in MRD region	10 billion VND (100% from the state budget)	2000 guidelines with field testing
5.	Develop guidelines for the implementation of the measurement, reporting and verification (MRV) system for AWD	13 provinces in MRD region	10 billion VND (70% from the state budget; 30% from international support)	2000 guidelines with field experiments and training
II. Output 2. Capacity improvement for policymakers, private partners and farmers for developing AWD in MRD region				
1.	Training workshops for staff of management agencies of MARD, localities, private organizations and farmers on GHG emission reduction and priorities	Management units under MARD, 13 provinces in MRD region	5 billion VND (20% from the state budget; 40% from provincial budget; 40% from international support)	5000 training materials, 5000 trainees
2.	Develop a policy mechanism to support green offices and green rice products to enhance green production capacity for rice production	Management units under MARD, 13 provinces in MRD region	20 billion VND (40% from the state budget; 30% from provincial budget; 30% from private sector)	200 relevant offices and green enterprises, 20 green products originating from rice, materials and database

3.	Support local partnerships, investors for climate-smart agriculture, low-emission rice production and enhancing readiness for NDC implementation	13 provinces in MRD region	10 billion VND (40% from the state budget; 30% from the provincial budget; 30% from international support)	200 policy-makers, enterprise leaders with enhanced capacity and capability
4.	Exchange international experiences in implementing GHG emission reduction activities in NDCs for AWD in rice production	Enterprises, UNFCCC member countries, global allies in rice production	5 billion VND (40% from the state budget; 60% from the provincial budget from public-private partnership)	20 policy-makers, 60 leaders of enterprises related to rice production in the MRD region
5.	Strengthen the capacity of negotiation and access to AWD in rice production in the MRD region	Management units under MARD and 13 provinces in MRD region	1 billion VND (60% from the national budget; 40% as a bilateral fund from provincial budget)	50 management specialists and policymakers who can participate in negotiations
III. Output 3. Improved national capacity for NDC implementation for AWD in rice production				
1.	Review capacity and assess the efficiency of irrigation systems and field features that support AWD in rice production	13 provinces in MRD region	30 billion VND (70% from the state budget; 30% from international support)	Spatial maps of irrigation systems (commune level, rate: 1:200.000)
2.	Investment and support for the project on AWD development in rice production	900,000 ha (100,000 ha in 2020; +500,000 ha 2020-2025; +300,000 ha in 2025-2030)	2700 billion VND (20% from the state budget; 30% from provincial budget; 30% from international support; 20% from the private sector)	Designs, models, GHG reduction of 10.97 MtCO ₂ e; benefits of 8,500 B. VND to farmers
3.	Investment to improve irrigation system construction for AW	900,000 ha (100,000 ha in 2020; +500,000 ha 2020-2025; 300,000 ha 2025-2030) Duration: 20 years	13,500 billion VND (based on cost-norm for irrigation system improvement from the survey, equal to 15 M. VND ha ⁻¹) (40% from the state budget; 30% from international support; 20% from provincial budget; 10% from enterprises' counterparts)	Completed designs, buildings, operation reports M&E reports
4.	Operate MRV system for AWD in rice production	900,000 ha in 13 provinces in MRD region according to identified timeline	270 Billion VND, distributed accordingly to identified periods (40% from the state budget; 30% from provincial budget; 30% from international support)	MRV reports on AWD from rice production, MRV report verification from AWD in MRD region
IV. Output 4. Improved coordination mechanism among the parties involved in AWD in rice production				
1.	Support for policy dialogue on AWD in rice production with national and international stakeholders	National level and in 13 provinces in MRD region	3 Billion VND (60% from international support; 40% from provincial budget)	Evaluation reports, policy evaluation report, policy mechanisms
2.	Support to develop a relationship among stakeholders from financial sponsors, banks and traders for AWD in rice production	National level and in 13 provinces in MRD region	10 B. VND (40% from the state budget; 60% from international support)	Operation mechanism, financial and investment guidelines for LEDs, especially in rice production

It is proposed that the central government, local government, international government and agencies and private sector be involved in this investment plan. The total proposed budget is estimated at 16.6 thousand billion VND (USD 721.78 million), of which 36.90% is proposed from the state budget,

29.92% from the provincial budget, 21.77% from international support and the remaining 11.42% from the private sector (Table 6).

Table 6. Investment allocation by funding sources

No	Type and activities	State budget	Provincial budgets	International support	Private sector	Total	Ratio (%)
1.	Policy reform	1.35	0.57	0.34	0.26	2.52	0.35
	• Revise policy and mechanisms	0.22	-	-	-	0.22	0.03
	• Restructure MRD development	0.61	0.26	-	-	0.87	0.12
	• Policy dialogue on AWD	-	0.05	0.08	-	0.13	0.02
	• Stakeholders and network development	0.17	-	0.26	-	0.43	0.06
	• Develop a mechanism for green supports	0.35	0.26	-	0.26	0.87	0.12
2.	Technical capacity strengthening	0.35	0.40	0.25	-	1.00	0.14
	• Technical guidelines for AWD	0.02	0.03	0.03	-	0.08	0.01
	• Training workshops	0.04	0.09	0.09	-	0.22	0.03
	• Support for local partnerships, investors	0.17	0.13	0.13	-	0.43	0.06
	• Exchange international experiences	0.09	0.13	-	-	0.22	0.03
	• Strengthen the capacity of negotiation	0.03	0.02	-	-	0.04	0.01
3.	MRV operation	5.43	3.65	3.52	-	12.61	1.75
	• Technical guidelines to measure GHG reduction from AWD	0.43	-	-	-	0.43	0.06
	• Develop MRV system for AWD	0.30	0.13	-	-	0.43	0.06
	• Operate MRV system for AWD	4.70	3.52	3.52	-	11.74	1.63
4.	Research, performance and planning	24.39	35.22	35.61	23.48	118.70	16.44
	• Review capacity and assess the efficiency of irrigation systems	0.91	-	0.39	-	1.30	0.18
	• Investment and support on AWD	23.48	35.22	35.22	23.48	117.39	16.6
5.	Hard infrastructure	234.78	176.09	117.39	58.70	586.96	81.32
	• Investment to improve irrigation system	234.78	176.09	117.39	58.70	586.96	81.32
Total (million USD)		266.30	215.93	157.11	82.43	721.78	
Proportion (%)		36.90	29.92	21.77	11.42	100.00	100.00

The investment plan for AWD in rice production in the MRD region outlined in Table 6 proposes five types of investment: policy reform (USD 2.52 million, only 0.35% of total investment); technical capacity strengthening (USD 1.00 million, 0.14% of total investment); MRV operation (USD 12.61 million, 1.75% of total investment); research, performance and planning (USD 118.70 million, 16.44% of total investment) and hard infrastructure (USD 586.96 million, 81.32% of total investment). Although, the investment plan for AWD in rice production proposes a budget of USD 721.78 million, just over four-fifths (81.32%) of the budget is to invest in hard irrigation infrastructure to be used on 900,000 hectares for AWD in the next 20 years (discount rate at less than 5%). The remaining 18.19% of budget requires annual investments (MRV operation, research performance and planning).

4.3 Impact assessment from investment plan for AWD

As shown in Table 5, total cultivated area for AWD in the MRD region can reach 1.900 million hectares, with an average net benefit at 27.53 million VND ha⁻¹, compared to normal rice (non-AWD) at 4.43 million ha⁻¹. Table 7 shows how AWD will benefit farmers' net earnings from rice production. It is estimated that realization of this investment plan would allow farmers to earn a net

income of 52,960 billion VND (USD ~2.3 billion) per year by 2030, an addition of 8,540 billion VND (USD 371.36 million) in comparison with conventional rice due to increased revenue of USD 287.57 million and reduced costs of USD 83.79 million (land preparation, sowing seed, irrigated water, labor), based on assumptions of no previous use of AWD by farmers and using a 2016 conversion rate. (Additional interpretation is available in Table 3.) As estimated by MONRE (2015) on potential GHG reduction from AWD, this proposed investment plan would mitigate 10.97 MtCO₂e yr⁻¹ in alignment with the national GHG reduction strategy.

Table 7. Impact analysis of proposed investment plans for AWD in MRD region up to 2030 (based on local price in 2016).

Province	Potential GHG reduction by 2030 (MtCO ₂ e)	Net benefit earning			
		Net benefit value with AWD		Difference (-/+) to Non-AWD	
		B. VND	M. USD	B. VND	M. USD
Long An	0.49	2,378.04	103.39	383.51	16.67
Tien Giang	1.04	5,030.82	218.73	811.33	35.28
Ben Tre	0.48	2,310.31	100.45	372.59	16.20
Tra Vinh	0.84	4,077.74	177.29	657.62	28.59
Vinh Long	0.51	2,450.17	106.53	395.14	17.18
Dong Thap	1.41	6,799.90	295.65	1,096.63	47.68
An Giang	1.81	8,732.50	379.67	1,408.31	61.23
Kien Giang	0.78	3,751.23	163.10	604.97	26.30
Can Tho	0.94	4,553.46	197.98	734.34	31.93
Hau Giang	0.51	2,458.98	106.91	396.56	17.24
Soc Trang	1.48	7,142.92	310.56	1,151.95	50.08
Bac Lieu	0.30	1,463.49	63.63	236.02	10.26
Ca Mau	0.38	1,812.02	78.78	292.23	12.71
Total	10.97	52,961.58	2,302.68	8,541.20	371.36

Sources: Estimated from field survey and cost-benefit analysis application.

These results indicate that AWD in rice production not only contributes significantly to GHG reduction but would also help farmers in the MRD region earn higher incomes.

4.4 Determining financial sources for AWD investment plan

Possible domestic financial sources

Vietnam has several policies and programs with budget earmarks that could provide funding for scale-out AWD in the MRD region. They are described below.

- Investment in infrastructure plays an important role for AWD and can utilize medium and long-term public investment sources that have been strengthened for the period 2016-20, according to a report by the Ministry of Planning and Investment (MPI 2015).
- Financial resources designated for the rice restructuring project up to 2020 and envisioned to 2030 (according to Decision No 1898/QD-BNN-TT on 25 May 2016) have prioritized improvement of rice fields, irrigation, infield transportation, and electric power lines for specialized rice cultivation areas in the MRD region (5,000 billion VND or USD 217.39 million, proposed). Related, and also applicable, is the large field model development and rice field mechanization project (500 billion VND or USD 21.17 million, proposed).

- The national target program for new rural development is expanding in the period 2016-20 and subsequent years (Decision No 1600/QD-TTg on 16 August 2016 by the Prime Minister). During 2011-25, total investment for this program is planned 192,920 billion VND (USD 8.34 billion). Basic infrastructure serving agricultural production is considered the highest priority (Report No 507/BC-CP on 13 October 2015 by government of Vietnam).
- The National Target Program to Respond to Climate Change in 2011-15 raised and invested about 1,426 billion VND (USD 62 million) for responding to climate change; the program expended 72% of its total proposed budget. In the period 2016-20, climate change response has been integrated into the National Target Program for Climate Change Response and Green Growth (Decision No 1670/QD-TTg on 31 October 2017) with a total proposed budget estimated at 15,866 billion VND (USD 689.62 million.) Technical infrastructure, improvement of management models and effective irrigation operation are regarded as holding high promise and priority in this project.
- Programs that encourage cooperative links among farmers to enhance agricultural product markets and large farm development (Decision No 62/2013/QD-TTg on 25 October 2013 by the Prime Minister) also present considerable promise. Logically, the investment plans for AWD would be financially integrated into this project.
- Finally, there are programs that aim to create favorable conditions for private stakeholders to participate in investments in agriculture and rural development that include AWD in the MRD region. These include Circular No 57/2018/ND-CP on 17 April 2018, which replaced Circular No 210/2013/ND-CP, Resolution No 120/NQ-CP on 17 November 2017, Circular No 109/2018/ND-CP on 29 August 2018 on organic agricultural development, Circular No 67/2018/ND-CP on 15 May 2018 on guidelines for irrigation; and Circular No 154/2016/ND-CP on 16 November 2016 that applies environmental fees on water use for irrigation. All of these programs may direct financial resources toward investment plans for AWD in the MRD region.

International financial opportunities

Vietnam has actively and responsibly participated in the global forum on climate change. According to international financial experts, Vietnam can pursue financial resources for AWD as follows:

- Connect with and seek financial sources from multilateral partnerships under the UNFCCC through the Global Environmental Fund (GEF), Special Climate Change Fund (SCCF) and the Small Grants Program of the Adaptation Fund. These funds could finance numerous projects on GHG mitigation from multiple sectors. Agriculture in developing countries is highly prioritized.
- Multilateral and bilateral funds from the UNFCCC such as the Clean Technology Fund (CTF) and the Pilot Auction Facility (PAF) are a potential funding source for an AWD proposal.
- Vietnam is advantageously situated to cooperate with IKI partners and the NAMA Facility to pursue international financing for AWD in MRD.
- Finally, financial sources for AWD in MRD can be sought from bilateral cooperation with the governments of Australia, Germany, Japan, Korea, the United Kingdom, and the United States.

5. Conclusions and recommendations

The results and analysis presented in this working paper lead us to the following conclusions:

1. AWD is one of the most important technical solutions to achieving the country's NDC to climate change mitigation, and achievement can and should be supported through GHG-reduction policies. AWD offers high potential GHG reduction; it could achieve 14% of GHG reductions in unconditional mitigation options and nearly 18% of GHG reduction of its conditional mitigation goal. In our field survey, it contributed to helping farmers earn increase net income of 3.63 million ha⁻¹ in An Giang province, 6.03 million VND ha⁻¹ in Kien Giang province and 3.65 million ha⁻¹ in Soc Trong province due to significantly increasing farmers' revenue through higher yields and reducing costs of land preparation, sowing seed, irrigated water and labor in comparison with conventional rice.

2. The study proposed investment for AWD in MRD with four outputs and 15 investment activities for AWD to be practiced on 900,000 arable hectares in the MRD region. The budget for this plan is USD 721.78 million (81.32% for hard infrastructure, 18.19% for MRV operation, research, performance and planning) in which 36.9% is provided by the state, 29.92% from local provinces, 21.77% from international support and the remaining 11.42% from the private sector. This plan contributes to reducing 10.97 M.tCO₂, and results in additional net benefits for farmers of 8,540 billion VND (USD 371.36 million per year) compared to conventional rice cultivation.

3. Financial resources are potentially available from national targeted programs of rural development, public investment, rice restructuring, climate change response and green growth, and the policy of production linkages and large field models. The policy of encouraging private investment in agriculture and rural development is a domestic source for AWD, while international financial support can include Global Environmental Fund (GEF), the Special Climate Change Fund (SCCF), the Small Grants Program, Adaptation Fund, the Clean Technology Fund (CTF), the Pilot Auction Fund, International Climate Initiative (IKI), the National NAMA Facility and Green Climate Fund (GCF).

It is recommended that the government take the following actions to attract investment in AWD in the MRD:

1. The government should indicate to Vietnam's Paris Agreement executive board that they should consider prioritizing AWD combining with 1M5R, 3G3R in the MRD region in the agricultural NDC implementation plan.

2. The government should set prior investment in evaluation of existing irrigation works and their efficiency, and determine the potential for AWD in sub-regions within the MRD region.

3. The government should integrate the proposed investment plan for AWD in rice production in the MRD region into national programs and the mid-term economic plan as well as provide support to local provinces to mobilize financial sources from international aids and private sector.

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